

# **CONVENTION ON NUCLEAR SAFETY**

NATIONAL REPORT OF  
THE KINGDOM OF THE NETHERLANDS  
FIFTH REVIEW MEETING , APRIL 2011



# **CONVENTION ON NUCLEAR SAFETY**

## **National Report of The Kingdom of the Netherlands**

### **To be presented at the Fifth Review Meeting (April 2011)**

Ministry of Housing, Spatial Planning and the Environment  
Ministry of Social Affairs and Employment  
Ministry of Economic Affairs  
Ministry of Foreign Affairs  
Ministry of the Interior and Kingdom Relations

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## LIST OF SYMBOLS AND ABBREVIATIONS

<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
a.k.a.	also known as	
ALARA	As Low As Reasonably Achievable	
ANS	American Nuclear Society	
ANSI	American National Standards Institute	
AOT	Allowed Outage Times	
ASCOT	Assessment of Safety Culture in Organisations Team	(IAEA)
ASME	American Society of Mechanical Engineers	
ASSET	Assessment of Safety-Significant Events Team	(IAEA)
ATWS	Anticipated Transient Without Scram	
AVN	Association Vinçotte Nucléaire	(Nuclear safety inspectorate, Belgium)
Bkse	Besluit kerninstallaties, splijtstoffen en ertsen	Nuclear installations, fissionable materials, and ores Decree
BV	Besloten Vennootschap	Private company with limited liability
BWR	Boiling-Water Reactor	
Bvser	Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen	Transport of fissionable materials, ores, and radioactive substances Decree
BZK	(Ministerie van) Binnenlandse Zaken en Koninkrijksrelaties	(Ministry of) the Interior and Kingdom relations
COSYMA	Code SYstem from MARIa (MARIa = Methods for Assessing the radiological impact of accidents)	(Computer code for radiological consequence analysis)

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<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
COVRA	Centrale Organisatie voor Radioactief Afval	Dutch central organisation for interim storage of nuclear waste
CSF	Critical Safety Functions	
CSNI	Committee on the Safety of Nuclear Installations	(OECD/NEA)
ECCS	Emergency Core Cooling System	
ECN	Energieonderzoek Centrum Nederland	Netherlands Energy Research Foundation
EIA	Environmental Impact Assessment	
ENSREG	European Nuclear Safety Regulators Group	European group of regulators
EOP	Emergency Operating Procedure	
EPZ	NV Elektriciteits-Productiemaatschappij Zuid-Nederland	(Operator of Borssele NPP)
ESFAS	Engineered Safety Features Activation System	
ETC	Enrichment Technology Group	Subsidiary of Urenco and Areva, focussing on enrichment technology
EU	European Union	
EZ	(Ministerie van) Economische Zaken	(Ministry of) Economic Affairs
€	EURO	
FANC	Federaal Agentschap voor Nucleaire Controle	Belgian federal agency for nuclear supervision
GE	General Electric	
FRG	Function Recovery Guideline	
GBq	GigaBecquerel	(Giga = 10 <sup>9</sup> )
GKN	Gemeenschappelijke Kernenergiecentrale Nederland	(Operator of Dodewaard NPP)

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LIST OF SYMBOLS AND ABBREVIATIONS

<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit	(Nuclear safety experts organisation, Germany)
H <sub>eff</sub>	Effective dose equivalent	
HEU	High Enriched Uranium	
HFR	High Flux Reactor	Research reactor (in Petten, of the tank in pool type, 45 MW <sub>th</sub> )
HOR	Hoger Onderwijs Reactor	Research reactor (Delft Technical University)
HP&SC	Human Performance & Safety Culture	
HPES	Human Performance Enhancement System	
HSK	Hauptabteilung für die Sicherheit der Kernanlagen	Swiss nuclear regulatory body
I&C	Instrumentation and Control	
IAEA	International Atomic Energy Agency	
IEEE	Institute of Electrical and Electronic Engineers	
INSAG	International Nuclear Safety Advisory Group	(IAEA)
IPERS	International Peer Review Service	(IAEA)
IPSART	International PSA Review Team	Current name of IPERS (IAEA)
IRS	Incident Response System	
ISO	International Standards Organisation	
IWG-NPPCI	International Working Group on Nuclear Power Plant Control and Instrumentation	(IAEA)
JRC	Joint Research Centre of the European Communities	

## LIST OF SYMBOLS AND ABBREVIATIONS

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<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
KEMA	NV tot Keuring van Elektrotechnische Materialen	(Dutch utilities research institute)
KFD	Kernfysische Dienst	Department for Nuclear Safety Security and Safeguards (The Netherlands)
KTA	Kerntechnischer Ausschuss	Nuclear Standards Technical Committee (Germany)
KWU	Kraftwerk Union	(Siemens nuclear power group, nowadays Framatome ANP)
LEU	Low Enriched Uranium	
LOCA	Loss of coolant accident	
LPSA	Living PSA	
LTO	Long Term Operation	
MBq	MegaBecquerel	(Mega = $10^6$ )
MER	Milieu-effect rapport	Environmental Impact Assessment (EIA)
mSv	milliSievert	(Milli = $10^{-3}$ )
$\mu$ Sv	microSievert	(Micro = $10^{-6}$ )
MMI	Man Machine Interface	
MW <sub>e</sub>	Megawatt electrical	
MW <sub>th</sub>	Megawatt thermal	
NDRIS	National Dose Registration and Information System	
NERS	NEtwork of Regulators of countries with Small nuclear programs	
NEA	Nuclear Energy Agency	(An OECD agency)
NPK	Nationaal Plan Kernongevallenbestrijding	National Nuclear Emergency Plan (The Netherlands)
NPP	Nuclear Power Plant	

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LIST OF SYMBOLS AND ABBREVIATIONS

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<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
NRG	Nuclear Research and consultancy Group	(Private company uniting the nuclear activities of ECN and KEMA)
NRWG	Nuclear Regulators Working Group	(EU)
NUSS	Nuclear Safety Standards	(IAEA)
NUSSC	Nuclear Safety Standards Committee	(IAEA)
NVR	Nucleaire Veiligheids-Richtlijn	Nuclear safety rules (The Netherlands)
OECD	Organisation for Economic Cooperation and Development	
OLC	Operational Limits and Conditions	
OSART	Operational Safety Review Team	(IAEA)
P&Id	Process and Instrumentation diagram	
PIE	Postulated Initiating Event	
PORV	Power-Operated Relief Valve	
POS	Plant Operational State	
PRA	Probabilistic Risk Assessment	
PSA	Probabilistic Safety Assessment	
PSI	Proliferation Security Initiative	Initiative under UNSCR 1540
PSR	Periodic Safety Review	
PWR	Pressurised-Water Reactor	
QA	Quality Assurance	
RHR	Residual Heat Removal	
RID	Reactor Institute Delft	(Operator of the HOR research reactor in Delft)
RIVM	Rijksinstituut voor Volksgezondheid en Milieuhygiëne	National Institute for Public Health and the Environment (The Netherlands)

## LIST OF SYMBOLS AND ABBREVIATIONS

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<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
RPS	Reactor Protection System	
RPV	Reactor Pressure Vessel	
RSK	Reaktor Sicherheits Kommission	Reactor Safety Committee (Germany)
SAMG	Severe Accident Management Guidelines	
SAR	Safety Analysis Report	
SG	Steam Generator	
SGTR	Steam Generator Tube Rupture	
SR	Safety Report	Presents a summary of the most relevant information of the SAR.
SSCs	Structures, Systems and Components	
Sv	Sievert	
SZW	(Ministerie van) Sociale Zaken en Werkgelegenheid	(Ministry of) Social Affairs and Employment
TBq	TeraBecquerel	(Tera = $10^{12}$ )
TCDF	Total Core Damage Frequency	
TIP	Technical Information Package	at Borssele NPP a.k.a. SAR
TMI	Three Mile Island	
TÜV	Technischer Überwachungs Verein	(Safety inspectorate, Germany)
USNRC	United States Nuclear Regulatory Commission	
V&W	(Ministerie van) Verkeer en Waterstaat	(Ministry of) Transport, Public Works, and Water Management
VGB	Verein Grosskraftwerk Betreiber	(Power plant owners group, Germany)
VI	VROM Inspectie	(Inspectorate of the Ministry of Housing, Spatial Planning and the Environment)

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LIST OF SYMBOLS AND ABBREVIATIONS

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<b>Abbreviation</b>	<b>Full term</b>	<b>Translation or explanation (in brackets)</b>
VROM	Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer	(Ministry of) Housing, Spatial Planning, and the Environment
WANO	World Association of Nuclear Operators	
VWS	(Ministerie van) Volksgezondheid, Welzijn en Sport	(Ministry of) Health, Welfare, and Sport
WENRA	Western European Nuclear Regulators Association	
Wm	Wet milieubeheer	Environmental protection act





## INTRODUCTION

This section sets out the purpose of this document: ‘Convention on Nuclear Safety – National Report of the Kingdom of the Netherlands’. It then continues with an overview of the national nuclear programme followed by a description of the national policy towards nuclear activities in the Netherlands. The introduction finishes with a description of the structure of the report.

### **Purpose of the report**

On 24 September 1994, the Netherlands signed the Convention on Nuclear Safety. It was subsequently formally ratified on 15 October 1996 and entered into force on 13 January 1997. The Convention obliges each Contracting Party to apply widely recognised principles and tools in order to achieve high standards of safety management at its nuclear power plants. It also requires each Contracting Party to report on the national implementation of these principles to meetings of the parties to the Convention.

This report is the fifth in its series. It shows how the Netherlands meets the obligations of each of the articles established by the Convention.

The information provided by this report applies to the situation of July 1st 2010 unless explicitly specified otherwise. In June 2010 there were general elections, the outcome of which will have influence on the national energy policy, and also on the part that nuclear energy will play in our energy future. At the moment, it is unknown which direction the energy policy will take. At the review meeting in April 2011, the Netherlands will present the then available information on the intended policy of the new government.

### **Nuclear programme**

The Netherlands has a small nuclear programme, with only one nuclear power plant, 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, at the end of 2009, supplied 25% of world-demand for low-enriched uranium, of which its plant in Almelo, the Netherlands, provided 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 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 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.

According to Article 3 of the Convention, the Convention shall apply to the safety of ‘nuclear installations’. Article 2 of the Convention defines ‘nuclear installations’ as civil land-based nuclear power plants and facilities located on the same site as the NPP and related to its operation. This introduction provides an overview of the facilities in the Netherlands that are subject to the Convention and those that are not.

Nuclear facilities subject to the Convention:

- In the South-West of the country in Borssele, the Netherlands’ single operating nuclear power plant (NPP) is located. The technical details of this NPP are provided in Annex 1 and the NPP is also addressed in the section on Article 6.
- In the East, near Arnhem, a small NPP (60 MW<sub>e</sub>) is located. In fact this installation has ceased to be a nuclear installation, since its nuclear fuel elements have been removed from the reactor core and the plant is in so-called ‘Safe enclosure’, a stage of decommissioning. Refer to the section on Article 6 for more details.

Nuclear Facilities not subject to the Convention:

- There are three research reactors in operation. One is located on the premises of the Delft Technical University (Hoger Onderwijs Reactor, HOR, 2 MW<sub>th</sub>) and two are located on the Research Location Petten (HFR, 45 MW<sub>th</sub> and Low Flux Reactor, LFR, 30 kW<sub>th</sub>).
- Additional nuclear research facilities and laboratories can be found in Delft (Technical University) and in Petten (Nuclear Research & consultancy Group, NRG and the EU Joint Research Centre, the JRC);
- In the Eastern part of the country in Almelo, there are facilities related to uranium enrichment of Urenco Netherlands (uranium enrichment) and Enrichment Technology Netherlands (ET-NL, development and production of centrifuge technology). Throughout the years Urenco has been granted several licences for enlarged production capacity. Licensed capacity currently is 4950 tSW/a. March 2010, Urenco submitted a preliminary memorandum by which it announced its intention to expand its capacity to 6200 tSW/a.
- In the South-West of the country, in the municipality of Borsele<sup>1</sup>, the COVRA<sup>2</sup> interim radioactive waste storage facility is located. It has facilities for the storage of conditioned low, intermediate and high level waste. The latter category includes spent fuel of research reactors and waste from reprocessing of spent fuel of NPPs. The interim storage period should last at least 100 years. A little bit more information can be found in the section on Article 11 in this report and in the Netherlands' various editions of the national report for the Joint Convention on the Safe Management of Radioactive Waste and Safe Management of Spent Fuel.

Although it is not required to do so on the basis of the Convention on Nuclear Safety, this report includes both a separate annex containing the technical details of the Netherlands' largest research reactor, the High Flux Reactor (HFR) and, where applicable, discussions on the HFR in relation to the various articles. During the third review meeting (April 2005) and the fourth (April 2008), several Contracting Parties showed an interest in this research reactor and the particular issues surrounding it.

### *Short history of the nuclear programme*

The nuclear programme started with the construction of a research reactor in 1955, the High Flux Reactor in Petten, which achieved first criticality in 1961. It was originally thought that nuclear power would play an important role in the country's electricity generation programme. A small prototype reactor (Dodewaard NPP, 60 MW<sub>e</sub>) was put into operation in 1968, and in 1973 this was followed by the first commercial reactor (Borssele NPP, 450 MW<sub>e</sub>).

Although plans were made to expand nuclear power by 3000 MW<sub>e</sub>, these were shelved following the accident at Chernobyl in 1986. Instead, the government ordered a thorough screening of the safety of both the then existing plants. This led to major back-fitting projects at both of them. The back-fitting project at Borssele was successfully completed in 1997. Meanwhile, mainly because of the negative expectations for the future of nuclear energy in the Netherlands, the small Dodewaard reactor was shut down in 1997. In 2005 the owner of this NPP was granted a licence for a safe enclosure state for a period of 40 years, after which final dismantling shall commence.

In December 2007, company NRG launched a request for tenders for the PALLAS research reactor. PALLAS is to replace the High Flux Reactor (HFR) in Petten. In November 2009 NRG started the procedure for the environmental impact assessment. Whereas the financing process of PALLAS is still ongoing, the project had to be re-scheduled and, in accordance with the procedure, NRG has taken the decision to discontinue the tender. In 2010 NRG will develop and test the feasibility of various

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<sup>1</sup> Borsele (with one 's') is the name of the municipality in which the village of Borssele (with a double 's') is located.

<sup>2</sup> COVRA: Centrale Organisatie Voor Radioactief Afval, Dutch central organisation for interim storage of nuclear waste and spent fuel of research reactors.

financing plans and will synchronise the PALLAS project with the availability of financial resources. During this period, the project support structure will be further organised.

In 2009 plans were revealed by company Delta N.V. for nuclear new build at the site of the NPP Borssele. Delta owns 50% of the current NPP but also generates power using coal, biomass, natural gas and wind. In 2009, Delta started the environmental impact assessment procedure for realising 2500 MW of new nuclear power, adjacent to the current NPP. It currently considers two generation-III type PWRs: the EPR of Areva or the AP1000 of Westinghouse. No definite (pre)selection has been made.

The extended operation of the Borssele NPP and the plans for nuclear new-build poses challenges for the regulatory body in terms of workload, required expertise and financial constraints. More about these issues can be found in the text on Article 8 ‘Regulatory body’.

### **National policy**

The Netherlands is a parliamentary democracy. On behalf of the Dutch people, parliament scrutinises the Dutch government and approves laws and can propose lawmaking to the government. The parliament of the Netherlands is called the States General and is bicameral, i.e. it consists of two chambers: the House of Representatives (in Dutch: ‘Tweede Kamer der Staten-Generaal’) and the Senate (‘Eerste Kamer der Staten-Generaal’). General elections for the House of Representatives are held at least every four years.

The government comprises the Queen, the Prime Minister, the other Ministers and the State Secretaries. The cabinet is the government, excluding the Queen. It formulates and is accountable for the government’s policies.

#### *Policy on nuclear power*

The cabinet ‘Balkenende IV’, in office from February 2007 through February 2010, decided that during their term of office, no (additional) nuclear power plants would be built. In 2008 it published the Energy Report 2008, in which it set out its vision on energy, indicating what it would do in the coming years and what it expected from other parties. In this report the cabinet noted that no energy option can be excluded; and that it is too early to make a statement on the role of nuclear energy in the energy future of the Netherlands. Therefore a no-regret policy was adopted. The government prepared for decision-making by a subsequent government on nuclear energy in the Netherlands. For that purpose, it elaborated three scenarios: 1) no new nuclear power station or only ‘inherently safe’ nuclear power stations, 2) replacing the Borssele power station in 2033, and 3) more nuclear energy. Several studies were started, based on these scenarios. The cabinet studied the reports, and in April 2010 it published a memo on these matters, and sent it to Parliament, together with the supporting reports.

Earlier, in October 2009, a statement from government backed the idea of the construction of a new research reactor, the Pallas, to replace the High Flux Reactor (HFR) in Petten. A letter in support was sent from the cabinet to parliament. In this letter, three ministers, between them covering science, technology, planning, education, the environment and the economy supported the construction of Pallas.

The future policy on nuclear power will among others depend on the outcome of the current coalition formation. This national report for the fifth review meeting of the Convention is published too early to report on this. At the review meeting in April 2011, the Netherlands will present the then available information on the new energy policy of the government.

#### *Policy on the safe management of spent fuel and nuclear waste*

Spent fuel management and waste management are not the subject of the Convention on Nuclear Safety, thus this topic is addressed only briefly. Since the nuclear programme of the Netherlands is relatively small, both the total quantities of spent fuel and radioactive waste which have to be managed and the proportion of high-level and long-lived waste are modest. Many of the radioactive waste

management activities therefore are centralized in one waste management agency, COVRA, operating its facilities at one site. In this way as much benefit as possible is taken from the economy of scale. COVRA also manages radioactive waste from non-nuclear origin.

The policy in the Netherlands is that all hazardous and radioactive waste must be isolated, controlled and monitored. In principle this can be done by storage in buildings and institutional control. It can also be done by deep geologic disposal, in which case institutional control is likely to be discontinued at some moment. The current policy assumes that the radioactive waste will be stored in buildings for a period of at least 100 years and to prepare financially, technically and socially the deep geological disposal during this period in such a way that it can be implemented after the storage period. Of course at that time society has the freedom of choice between a continuation of the storage for another 100 years, to realise the final disposal, or to use new techniques or management options that may become available during the period of interim storage.

Part of the policy is also to have a research programme on underground disposal. The programme addresses among others issues like institutional control and prolonged retrievability of the waste from the repository.

The formal government policy on spent fuel management is that the decision on whether or not to reprocess spent fuel is in the first place a choice for the operator of a NPP. In the early days the operators have decided in favour of reprocessing their spent fuel for economic reasons, reuse of plutonium and reduction of the waste volume. Reprocessing contracts were concluded for all spent fuel generated by the NPPs until 2015. These decisions were endorsed by the government. However, for the spent fuel generated after 2015, a new discussion on reprocessing is foreseen.

### **Structure of the report**

This updated report follows the format of the previous national report for the Convention on Nuclear Safety, submitted in 2007. It is designed to be a ‘stand alone’ document to facilitate peer review. Some information from the 2007 report was not repeated because it seemed less relevant, and readers are referred to that report for such information.

The report offers an article-by-article review of the situation in the Netherlands as compared with the obligations imposed by the Convention. It shows how the Netherlands meets the obligations of each of the articles established by the Convention.

The numbering of its chapters and sections corresponds to that of the articles in the Convention.

Chapter 2(a) relates to the ‘General Provisions’; it contains a description of the existing installations with their main safety characteristics and activities, as required under Article 6.

Chapter 2(b) describes the legislative and regulatory framework, the regulatory body and the responsibility of the licensee, as referred to in Articles 7, 8 and 9 respectively.

Chapter 2(c) describes the priority given to safety (Article 10), the financial and human resources (Article 11), the human factors (Article 12), quality assurance (Article 13), the assessment and verification of safety (Article 14), radiation protection (Article 15), and emergency preparedness (Article 16).

Chapter 2(d) describes the safety of installations, in terms of siting (Article 17), design and construction (Article 18) and operation (Article 19).

A separate chapter is devoted to ‘Responses to remarks made at the fourth CNS review meeting’.

Five appendices provide further details of the regulations and their application. There are also four annexes containing factual data, and references to other relevant material.

## SUMMARY

### Changes to legislative and regulatory framework

The basic legislation governing nuclear activities is contained in the Nuclear Energy Act ('Kernenergiewet' or Kew). It is a framework law, which sets out the basic rules on the application of nuclear technology and materials, makes provision for radiation protection, designates the competent authorities and outlines their responsibilities. More detailed legislation is provided by associated Decrees.

The Nuclear Energy Act has seen several changes since the publication of the Netherlands' 4<sup>th</sup> national report to the Convention in 2007, a prominent one concerning the regulation of the financial provisions for the costs of the decommissioning of nuclear installations.

It is expected that in 2011, additional changes – for which preparations have been made – will go into effect. An important change is proposed establishing the ministry of Housing, Spatial Planning and the Environment (Dutch: VROM) as the *single authority regarding licensing* under the Nuclear Energy Act. This change is planned to take effect in January 2011. Currently, this authority is still shared by the ministries of VROM, Economic Affairs (EZ), and Social Affairs (SZW).

For *legislative issues*, like future changes to the Nuclear Energy Act, the minister of VROM will still *share its authority* with other relevant ministers.

Under the Nuclear Energy Act, a number of Decrees exist containing additional regulations related to the use of nuclear technology and materials. These continue to be updated in the light of ongoing developments.

Of recent date is the Council Directive 2009/71/EURATOM of 25 June 2009 establishing a Community framework for the nuclear safety of nuclear installations. In 2011, it will be implemented in Dutch regulations. The safety objectives of the Directive cover those of the Nuclear Safety Convention. As is the case in all member states of the European Union, EU regulations have a marked influence on Dutch lawmaking.

More detailed information on legislation and the expected changes can be found in the sections on Article 7 of the Convention.

#### *Special agreements*

The Dutch government in 2006 signed an agreement (Covenant) with the owners of the Borssele NPP, which allows for operation until the end of 2033, if requirements of the operating licence and the Covenant keep being met. The legal status of the agreement is such, that it can not easily be challenged by future policies on nuclear power. The Covenant is included in Annex 2 of this report that in addition provides a short discussion on the tasks of the 'Borssele Benchmark Committee' and its recent activities. This commission has to develop criteria that allow the regulatory body to establish whether the Borssele NPP meets an important requirement of the Covenant: to belong to the top-25% in safety of the fleet of water-moderated Light Water Reactors (LWRs) present in the European Union, Canada and the USA.

In July 2006 new French legislation entered into force, which prescribes that a return-scheme for the radioactive waste has to be formalised at the moment the spent fuel is sent to France. This condition also applies to the spent fuel that should be sent to France under the current contract between the operator of the Borssele NPP and AREVA. As a consequence a (new) bilateral agreement between the governments of the Netherlands and France needed to be concluded. The Dutch government started

the formal procedures to arrange this agreement by presenting a proposal to Parliament, establishing a return-scheme for the spent fuel under the current reprocessing contract. In 2009 the bilateral agreement between France and the Netherlands was signed. Parliament accepted the agreement by law of May 20<sup>th</sup> 2010<sup>3</sup>.

### *International Obligations*

The Netherlands is party to several Treaties and Conventions related to the use of nuclear technology and materials. More on this topic can be found in the section on Article 7. An important one is the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). Other important ones are for example the 'Paris Convention on Third Party Liability in the Field of Nuclear Energy' and the 'Brussels Convention supplementary to the Paris Convention', 'Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention', 'Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management', 'Convention on Physical Protection of Nuclear Material', and many others.

### **Regulatory body**

For the purpose of this report, the 'regulatory body' is the authority designated by the government of the State as having legal authority for conducting the regulatory process, including issuing authorizations, and thereby regulating nuclear, radiation, radioactive waste and transport safety.

In the Netherlands, the ministry of VROM is the principal authority for conducting the regulatory process under the Nuclear Energy Act. Two VROM-departments are involved, constituting the regulatory body for all things nuclear in the Netherlands:

- 'Directoraat Risicobeleid' (RB), directorate for Environmental Safety and Risk Management, is involved in the preparation of legislation, formulating policies and licensing;
- 'Kernfysische dienst' (KFD), is in fact the nuclear inspectorate, responsible for the assessment and inspection of nuclear facilities. It is a subdivision of the 'VROM Inspection', which is the general inspection branche of the ministry of VROM.

Plants operate under licence, awarded after a safety assessment has been carried out. This is based on the Safety Requirements and Safety Guides<sup>4</sup> in IAEA Safety Series 50, as amended for application in the Netherlands. The licence is granted by the regulatory body under the Nuclear Energy Act. More about this can be found in the text on Article 7.

The extension of the operating life of the Borssele NPP and the current plans for nuclear new-build of Delta and NRG, face the regulatory body with major challenges like providing adequate number of government staff with sufficient expertise to oversee the licensing procedures. Anticipating increasing workload, the number of staff is being increased. Financial constraints after the global 'Financial Crisis' forces government to cut the budgets of its ministries, posing an extra challenge to the proper performance of its regulatory tasks.

More about how the regulatory body is meeting the challenges can be found in the text on Article 8 and in Annex 4.

### **Recent regulatory and safety issues**

#### *Borssele NPP*

The plans for nuclear new-build will increase the workload for the regulatory body. In addition there are initiatives at the existing nuclear installation, the Borssele NPP. At the end of 2004, the Borssele

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<sup>3</sup> Published in Government Gazette, year 2010, No. 238

<sup>4</sup> Since the introduction of IAEA Safety Series No. 50 as the basis for the Dutch regulations, the nomenclature of the 'Codes' of the IAEA NUSS programme has been changed to 'Standards'. For this reason, the terms 'Code' and 'Standard' are both used in this report.

NPP was granted a licence for the use of fuel with a 4.4% instead of 4.0% enrichment. July 2010, the management of the plant submitted a licence application for the use of mixed oxide fuel (MOX). Because the Borssele NPP is a relatively old plant, ageing is an issue requiring serious attention. There is a special Long Term Operation programme (LTO), and modernisation plans for its Instrumentation and Control (I&C) will spark discussions about ‘digital I&C’. In addition, there is the next 10-yearly safety evaluation of the plant. These projects will require a lot of attention of the regulatory body and the licensee.

#### *High Flux Reactor, HFR*

Over the last decennium, more emphasis has been placed on the safety of the HFR. This 45 MW<sub>th</sub> research reactor in Petten is owned by the Joint Research Centre (JRC) of the European Commission. The licensee and operator is the company NRG. Past issues were the finished first 10-yearly periodic safety review and associated back-fitting, and the finished licensing procedure for the conversion from high enriched uranium (HEU) to low enriched uranium (LEU).

Current issue is the repair of a component of the primary cooling system. This issue received international media attention because of the impact on the world-wide supply chain of medical isotopes.

Since a few years deformations in the primary coolant system of the HFR in Petten were observed and monitored. In the summer 2008 a pinhole was revealed by a bubble jet, suggesting repair to be necessary. The government accepted a request by NRG to put back the HFR in service on a temporary basis, without the repair. This decision was based on a decision making process, divided into three steps:

1. assessment of the safety level of the reactor;
2. assessment of the need of radioisotopes production in the HFR;
3. balance of the needs.

Each step implied a “go/no go” decision. Backed by careful inspections, the confirmation that there were no leaks from the primary system, and research and advice provided by national and international experts of the IAEA, government decided to allow temporary operation with additional and precautionary safety measures for a strictly limited period of time, until March 2010. Currently, a restart of the repaired reactor before or in the autumn of 2010 seems feasible. More details about the repair strategy can be found in the text about Article 6 and in Annex 3 ‘High Flux Reactor (HFR)’.

#### **Important issues identified in previous report and follow-up**

This section is devoted to the main remarks made during the fourth review meeting of the Contracting Parties to the Convention on Nuclear Safety in 2008. Emphasis is given to the remarks made specifically in relation to the Dutch situation.

For questions answered via the CNS-website during the peer review process of 2007/2008, reference is made to the Q&A section of the CNS website, hosted by the IAEA.

During the last CNS review meeting, several challenges facing the Dutch regulatory body were identified. These challenges are addressed in a separate chapter of this report. Refer to ‘Responses to remarks made at the fourth CNS review meeting’.





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## CHAPTER 2(A) GENERAL PROVISIONS

### ARTICLE 6. EXISTING NUCLEAR INSTALLATIONS

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**6. Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.**

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This chapter gives the information requested by Article 6 of the Convention. It contains:

- a list of existing installations, as defined in Article 2 of the Convention;
- an overview of safety assessments which have been performed, plus their main results;
- an overview of programmes and measures for upgrading the safety of nuclear installations, where necessary, and/or the timing of shut-downs; and
- a description of the position of the Netherlands with respect to the further operation of the installations, based on a review of safety at the time when the Convention entered into force (i.e. 13 January 1997), plus details of the situation in the Netherlands regarding safety issues since the last review in 2008.

#### 6.1 Existing installations

The Netherlands has only one nuclear power plant in operation: the Borssele NPP (a PWR, Siemens/KWU design). There also is one shut-down plant which already is at an advanced stage of decommissioning (safe enclosure): the Dodewaard NPP (a BWR, GE design, 60 MW<sub>e</sub>). In addition there are three research reactors, the largest of which has a thermal power of 45 MW. The latter is the High Flux Reactor (HFR) in Petten.

##### 6.1.a Borssele NPP

The Borssele NPP is a two-loop Siemens PWR that has been in commercial operation since 1973. As it is the only NPP now in operation in the Netherlands, the emphasis in the remainder of this report is on this plant. It started with an electrical power of 450 MW<sub>e</sub> but a recent turbine upgrade has boosted its net electrical output to about 485 MW<sub>e</sub>. The NPP generates some 4% of the Netherlands' electricity demand.

In 1994 Dutch Parliament decided to phase out the plant by 2003. The decision was legally challenged and taken back. Instead, in 2006 a Covenant was signed by operator and owners of the plant and the government, allowing the plant to operate until 2034, under certain conditions.

The operator of Borssele NPP is the company EPZ, in which until recently, two companies had an equal share: Delta and Essent. However, in January 2009, the German company RWE offered to buy all the issued and outstanding shares of Essent, including the 50% of the NPP. Delta, owner of the other 50% of the NPP, objected to this. It claimed that its shareholders demanded that the NPP should

remain in public ownership, in line with EPZ's articles of association and the shareholders' agreement. The court ruled in favour of Delta. The current solution is that the Essent's stake in the NPP is owned by a Limited, "Publiek Belang Electriciteitsproductie bedrijf B.V.". This Limited is owned by local and provincial governments. The takeover of Essent by RWE does not include the Borssele NPP, but RWE and Essent have appealed to this provisional solution. However, legal procedures may take many years.

Technical details of the Borssele NPP are given in Annex 1.

#### **6.1.b Dodewaard NPP**

The Dodewaard NPP operated from 1968 until early 1997. The BWR-type reactor was designed to operate with natural circulation, and was equipped with an isolation condenser to remove excess heat, features that later became standard elements of the new BWR design with passive safety characteristics.

Since this is the only section where the Dodewaard NPP will be addressed, its history and current status are described in some detail here.

Originally intended to remain in operation until 1 January 1995, its projected operating life was extended first to 1 January 1997 and later to 2004. On 3 October 1996, the owners of the Dodewaard NPP (SEP: a former alliance of Dutch utilities) decided to shut down the reactor permanently. The plant had always performed a research function for the utilities and was important for maintaining the nuclear expertise necessary for expansion of nuclear power in the Netherlands. However the licensee judged that there was not enough support for a nuclear program. The plant was expected to be too small to compete on the liberalised electricity market if its research function was to become obsolete. The shutdown became effective on 26 March 1997.

In 1999 the licensee applied for a licence for 'deferred dismantling'. This decommissioning option features three stages: removal of fuel and conversion of the plant into a safe enclosure, a 40-years waiting period, and final dismantling, which completes the process. An environmental impact assessment (EIA) showed that with respect to the environmental impact, this decommissioning option did not differ much from the options of 'immediate dismantling' and 'in situ disposal' involving encapsulation of the reactor and subsequent restriction of access for a very long period.

In April 2003, all the spent fuel had been removed from the site and had been shipped to Sellafield. April 2005, the construction of the 'safe enclosure' was finished. June 1st, 2005, the 40-years waiting period started under a licence that requires to owner to commence dismantling activities in 2045. The current owner of the Dodewaard NPP (GKN) has no other activities than to maintain the safe enclosure during the waiting period. In 2009, all vitrified waste from reprocessing of Dodewaard's spent fuel was shipped to the national waste management authority, COVRA. COVRA is the central organisation for waste management in the Netherlands. Its facilities are designed to store all types of radioactive waste for at least 100 years, until a final solution for disposal has been agreed.

#### **6.1.c Plans for new Nuclear Power Plants**

In 2009 plans were revealed by the company Delta N.V. for nuclear new build at the site of the NPP Borssele. The new plant should benefit from the local infrastructure already present and the plentiful cooling water available. Delta owns 50% of the current NPP but also generates power using coal, biomass, natural gas and wind. In 2009, Delta started the environmental impact assessment procedure for the realisation of 2500 MW of new nuclear power. It currently considers two generation-III type PWRs: the EPR of Areva and the AP1000 of Westinghouse. Formally no definite (pre)selection has been made. In June 2010, the regulatory body issued the guidelines for the content of the Environmental Impact Assessment (EIA) report. Delta is now preparing the EIA report.

The challenges this initiative poses for the Competent Authorities, are discussed briefly in section 6.2.

#### **6.1.d Research Reactors: High Flux Reactor (HFR)**

Although research reactors formally are not subject to the Convention, in this report information is included about the High Flux Reactor (HFR), a relatively ‘large’ 45 MW<sub>th</sub> research reactor.

At the last two review meetings, several Contracting Parties showed an interest in this research reactor and the particular issues surrounding it. In the previous report, the HFR was mentioned because:

1. safety culture issues in 2001 attracted political attention, an action plan brought great improvements; for details and follow-up see Article 10;
2. the year 2005 saw a licence renewal for the HFR. The new licensing base features the application of several power reactor-like safety principles. For details refer to Annex 3.

This year’s edition of the report features the HFR because:

3. In August 2008 a routine in-service inspection detected jets of gas bubbles in one of the reducers that is part of the primary cooling system. Currently repair is being undertaken, which should be finished in August 2010, after which operation can be resumed. More details about safety evaluations and this repair can be found in section 6.2.

The HFR is a tank-in-pool type reactor commissioned in 1961 and is located in Petten in the province of North Holland. The owner is the Joint Research Centre (JRC) of the European Commission but since January 2005, the licensee and operating organisation is the Nuclear Research and consultancy Group (NRG). The HFR is used not only as a neutron source for applied and scientific research, but also for the production of isotopes for medical and industrial applications.

#### **6.1.e Plans for new Research Reactor: Pallas**

December 2007, NRG launched a request for tenders for the PALLAS research reactor under the European competitive dialogue procedure. PALLAS is to replace the High Flux Reactor (HFR) in Petten. The tank-in-pool reactor should feature a flexible core, enabling the reactor to operate in the thermal power range 30-80 MW, following market demand. Just like the HFR, the PALLAS will serve the medical isotopes production as well as the research into various aspects of nuclear technology.

Whereas the financing process of PALLAS is still ongoing, the project had to be re-scheduled and, in accordance with the procedure, NRG has taken the decision to discontinue the tender. In 2010 NRG will develop and test the feasibility of various financing plans and will synchronise the PALLAS project with the availability of financial resources. During this period, the project support structure will be further organised. In 2009 NRG started the procedure for the environmental impact assessment, which is an important part of the licensing procedure. In June 2010, the regulatory body issued the guidelines for the content of the Environmental Impact Assessment (EIA) report. NRG now can prepare the EIA report.

### **6.2 Overview of safety assessments and other evaluations**

#### **6.2.a Borssele NPP**

When the Convention took effect on 13 January 1997, it had already been decided to shut down the Dodewaard NPP. At that time, the Borssele NPP was just undergoing a major back-fitting and modernisation programme designed to bring it in line with modern safety standards. This project had been started in 1991 to fulfil the national regulatory requirement that the safety of existing installations should be reviewed on a regular basis. Further details of the programme can be found in Annex 1, which also provides an overview of the modifications made at the Borssele NPP. The programme brought the Borssele NPP as far as reasonably achievable up to the current safety standards of a modern plant. For some time after it, therefore, no further corrective action was felt to be necessary.

At the time of the second review, the intention of the Dutch government was to shut down the Borssele NPP by the end of 2003. Several elections have passed since then and the situation has changed considerably. In 2003 the then ruling coalition moved the closure date forward to 2013. Later the government that left office at the beginning of 2007, in June 2006 signed an agreement with the owners of the plant that – under certain conditions – grants operation of the plant until the end of 2033. In connection with agreements on keeping Borssele NPP open for longer, shareholders are obliged to give extra impetus to energy efficiency, the production of sustainable energy and/or projects that avoid or reduce greenhouse gas emissions, whereby the owners shall jointly achieve agreed CO<sub>2</sub> emission reductions. Details and background of this agreement can be found in Annex 2.

Further analysis commissioned by the Ministry of Housing, Spatial Planning and the Environment in 2005 showed that there are from a safety point of view no insurmountable objections to Borssele NPP remaining open until no later than 31 December 2033.

In addition, the second 10-yearly periodic safety review of the Borssele NPP was completed at the end of 2004. The implementation of improvements was completed in 2007. The descriptions under Article 14 and Annex 1 provide details of the special focuses of this review and of the improvement plan drawn up as a result of it.

Currently, the following issues require attention of the regulatory body:

- The extension of the operating life of the plant, requires a Long Term Operation (LTO) programme, giving attention to among others ageing issues;
- In 2009, the management of the plant started the licence application for the use of mixed oxide fuel (MOX). An environmental impact assessment report is being drafted and may be submitted for evaluation in the autumn of 2010.
- Soon the next 10-yearly safety review ('10-EVA') will start, requiring resources at the NPP and the regulatory body;
- The management of the plant is considering introducing digital I&C into the plant. Careful considering is to be given to the associated reliability and safety issues;
- The extension of the operating life of the plant also has consequences for the required storage capacity at the COVRA interim radioactive waste storage facility. Vitrified waste from reprocessing of spent fuel of the NPP (and spent fuel of research reactors) is stored in the dedicated HABOG building on the COVRA site. The capacity of the bunker-like building with 1.7 meter thick reinforced concrete walls, in time will have to be extended. This is very well possible because of its modular design.

### **6.2.b HFR**

As mentioned in section 6.1.d, the licensee of the HFR in August 2008 was confronted with a small trace of gas bubbles (as thin as a needle) that escaped from the pipe wall into the primary cooling system of the HFR. The source and composition initially were not known and an investigation was started immediately. As a precaution it was decided to not start up the planned irradiation cycle. This unplanned stop had immediate impact on the medical isotope market and therefore received international media attention.

#### *Decision making process*

Since a few years deformations in a component of the primary coolant system of the HFR in Petten were observed and monitored. In the summer 2008 a pinhole was revealed by a bubble jet at one of the inward deformations of the primary coolant system reducers, which are embedded in the concrete biological shield. The reactor no longer complied with its licence conditions, suggesting repair to be necessary. Therefore the reactor was shut down by NRG. The government accepted a proposal by NRG to put back the HFR in service on a temporary basis, without the repair. This decision was based on a decision making process, divided into three steps:

1. Assessment of the safety level of the reactor;
2. assessment of the need of radioisotopes production in the HFR;
3. balance of the needs.

Each step implied a “go/no go” decision. Backed by careful inspections, the confirmation that there were no leaks, and research and advice provided by national and international experts, government decided to allow temporary operation with additional and precautionary safety measures for a strictly limited period of time, until March 2010. During this period, NRG produced isotopes for the medical sectors and proceeded with all the necessary preparations to replace the relevant sections of the primary cooling water system in 2010. The isotope production was only interrupted during a planned maintenance from mid-July to mid-August 2009. Currently, restart of the repaired reactor in the autumn of 2010 seems feasible. Some details of the repair strategy can be found in Annex 3 ‘High Flux Reactor (HFR)’.

#### *Technical evaluations and peer review*

From inspections and research it was concluded that the deformations in the pipe wall and the gas bubble stream were caused by corrosion on the concrete side of the vessel. Following this, a research program needed to identify the cause into detail, was executed along with a detailed safety study. On the basis of this study extra technical measures were introduced, such as the installation of sealing and detection systems; so that safe reactor operation could be assured. In February 2009 an IAEA mission on request of the regulatory body reviewed the evaluations and concluded that the safety evaluation by the regulatory body was justified from a safety point of view.

The proposed repair plan was evaluated by among others members of an IAEA peer review mission, invited by the regulatory body in August 2009. January 2010 the mission team formulated 11 main recommendations, based on its discussions with the regulatory body and NRG. The team was satisfied with the follow-up and supervision strategy of the regulatory body related to the preparation and implementation of the repair programme. It also considered that the provisions proposed by NRG concerning the repair programme were satisfactory from the safety point of view, provided that the IAEA mission’s recommendations were taken into account. The mission team recommended that a follow-up of the implementation of these recommendations should be made. Lessons learnt should be documented by NRG, and applied for new research reactor projects. The team noted the use of mock-ups as a good practice, to train the staff and to establish the optimum repair techniques.

Some details regarding the repair can be found in Annex 3.

#### **6.2.c Challenges from plans for new-build**

The current new build initiatives of Delta and NRG, both proposing the construction of new nuclear facilities, face the regulatory body with major challenges in terms of resources. More information on staffing of the regulatory body can be found in the description under Article 8 ‘Regulatory body’, Article 11 ‘Financial and human resources’ and in Annex 4.



## CHAPTER 2(B) LEGISLATION AND REGULATION

### ARTICLE 7. LEGISLATIVE AND REGULATORY FRAMEWORK

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**7.1 Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.**

**7.2 The legislative and regulatory framework shall provide for:**

- i. the establishment of applicable national safety requirements and regulations;**
  - ii. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;**
  - iii. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences.**
- 

#### **7.1 Legislative and regulatory framework**

The Nuclear Energy Act (Kernenergiwet, Kew) has been amended twice since the publication of the 4<sup>th</sup> national report to the Convention in 2007. The first amendment in 2008 concerned the ratification and implementation of the Convention on physical protection of nuclear materials and nuclear facilities, and also introduced some requirements on nuclear security. The second amendment was adopted in 2009 and introduced three important modifications:

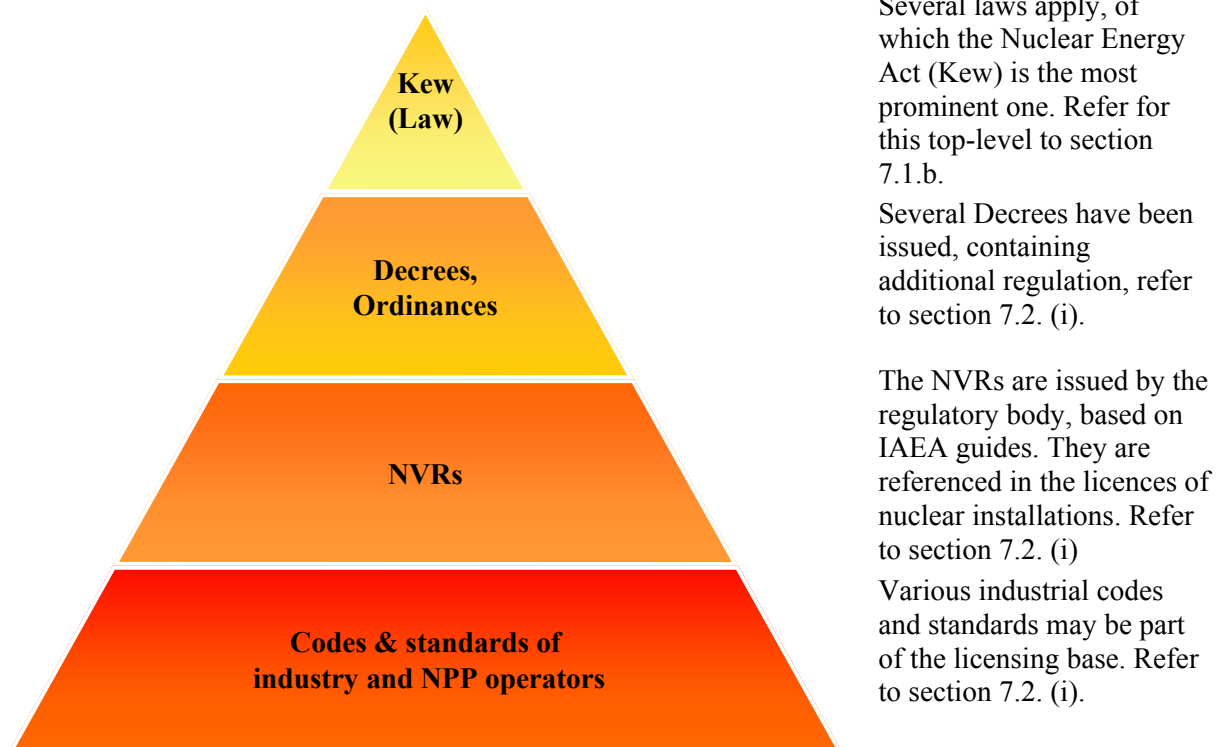
- Introduction of the obligation for the licensee to provide financial provisions for the costs of decommissioning of his installation. This requirement will enter into force in 2011.
- Introduction of the possibility for the competent authority, the regulatory body, to withdraw the licence of a nuclear facility after its decommissioning is completed.
- Reduction of the number of ministries involved in licensing nuclear facilities under the Nuclear Energy Act to one. This will be the minister of Housing, Spatial Planning and the Environment (Dutch: VROM). This change is expected to take effect in January 2011. Currently, this authority is shared by six ministries, although the procedures are coordinated by the ministry of VROM.

Despite the third modification, often more than one ministry will be involved in licensing procedures for nuclear facilities, because of the many different laws and regulations that may apply to a single facility and the activities performed in it and/or activities that support its proper performance.

#### **7.1.a Overview of the legal framework**

##### *Structure*

The legal framework in the Netherlands with respect to nuclear installations can be presented as a hierarchical structure. The following diagram illustrates this.



**Figure 1** Simplified representation of the hierarchy of the legal framework

In addition to the levels shown in Figure 1, there are international conventions and other legal instruments related to nuclear safety that also apply. Refer to section 7.1.c for more information.

#### *Responsibility for legislation*

Several ministries are responsible for the legislation concerning the Nuclear Energy Act. The ministry of VROM is the coordinating ministry for all issues related to the Nuclear Energy Act.

#### *Responsibility for Licensing*

An important change is proposed establishing the ministry of VROM as the *single authority regarding licensing* under the Nuclear Energy Act. This change is planned to take effect in January 2011.

Currently, this authority is still shared by the ministries of VROM, Economic Affairs (EZ), and Social Affairs (SZW). The ministry of VROM acts as the coordinating ministry. Refer to the text on Article 8 for more information.

### **7.1.b Primary legislative framework: laws**

The following are the main laws to which nuclear installations in the Netherlands are subject:

- The Nuclear Energy Act (Kernenergiewet, Kew);
- The Environmental Protection Act (Wet, Wm);
- The General Administrative Act (Algemene wet bestuursrecht, Awb), regulating the procedures of most acts.

In this section, the main elements of several acts are elaborated. For more information on secondary legislation, like the aforementioned Decrees and NVRs, refer to section 7.2. (i).



### **Nuclear Energy Act**

The basic legislation governing nuclear activities is contained in the Nuclear Energy Act ('Kernenergiwet' or Kew). It is a framework law, which sets out the basic rules on the application of nuclear technology and materials, makes provision for radiation protection, designates the competent authorities and outlines their responsibilities. More detailed legislation is provided by associated Decrees.

The Nuclear Energy Act originally had a twofold purpose: (1) to regulate the use of nuclear energy and radioactive techniques, and (2) to lay down rules for the protection of the public and workers against the associated risks. In practice, however, the law has developed almost entirely to do the latter.

With regard to nuclear energy, the purpose of the Nuclear Energy Act, according to its Article 15b, is to serve the following interests:

- the protection of people, animals, plants and property;
- the security of the state;
- the security and safeguarding of nuclear material;
- the supply of energy;
- the liability for damage or injury caused to third parties;
- the compliance with international obligations.

Within the framework of the Nuclear Energy Act, fissionable materials are defined as materials containing up to a certain percentage of uranium, plutonium or thorium (i.e. 0.1% uranium or plutonium and 3% thorium by weight) and used for the purpose of fission and/or breeding. All other materials containing radionuclides and exceeding the exemption levels, are defined as radioactive materials.

As far as nuclear facilities are concerned, the Nuclear Energy Act covers three distinct areas relating to the handling of fissionable materials and ores: (1) registration, (2) transport and management of such materials, and (3) the operation of facilities and sites at which these materials are stored, used or processed:

(1) The *registration* of fissionable materials and ores is regulated in Sections 13 and 14 of the Nuclear Energy Act; further details are given in a special Decree issued on 8 October 1969 (Bulletin of Acts and Decrees 471). The statutory rules include a reporting requirement under which notice must be given of the presence of stocks of fissionable materials and ores. The Central Import and Export Office, part of the Tax and Customs Administration of the Ministry of Finance, is responsible for maintaining the register.

(2) A licence is required in order to *transport, import, export, be in possession of or dispose of* fissionable materials and ores. This is specified in Section 15a of the Act. The licensing requirements apply to each specific activity mentioned here.

(3) Licences are also required for *building, operating and decommissioning* nuclear installations (Section 15b), as well as for nuclear driven ships (Section 15c). To date, the latter category has not been of any practical significance in the Netherlands.

Under item (3), the Nuclear Energy Act distinguishes between construction licences and operating licences. In theory, a licence to build a nuclear installation may be issued separately from a licence to actually operate it. However, the construction of a NPP involves much more than simply construction work. Account will be taken of all activities to be conducted in the plant, during and after its construction. The authorities need to decide whether the location, design and construction of the plant are suitable, offering sufficient protection of the public and the environment from any danger, damage or nuisance associated with the activities to be conducted in the plant.

In practice, the procedure for issuing a licence to operate a NPP or other nuclear facility will be of limited scope, unless major differences have arisen between the beginning and the completion of the construction work. For example, there may be a considerable difference between the Preliminary Safety Analysis Report (which provides the basis for the construction licence) and the Final Safety Analysis Report (for the operating licence). Views on matters of environmental protection may also have changed over the construction period.

#### *Modifications*

Amendments to a licence will be needed where modifications of a plant invalidate the earlier description of it.

The decommissioning of nuclear facilities is regarded as a special form of modification and is treated in a similar way. Refer to section 7.2. (i) for the Bkse decree, that provides more guidance on decommissioning issues.

For minor modifications, a special notification procedure in the Act applies, allowing the licensee to modify the facility without a formal amendment to the licence. This notification system can be used only if the consequences of the modification for man and environment are within the limits of the licence.

In addition to the secondary regulations provided by the aforementioned Bkse-decree on the handling of fissionable materials, the Nuclear Energy Act includes a separate chapter (Chapter VI) on intervention and emergency planning and response.

#### **Environmental Protection Act (Wm)**

In the case of non-nuclear facilities, this Act regulates all environmental issues (e.g. chemical substances, stench and noise); in the case of nuclear installations, the Nuclear Energy Act takes precedence and regulates both conventional and non-conventional environmental issues.

According to this Act and the associated Environmental Impact Assessment Decree, the licensing procedure for the construction of a nuclear facility includes a requirement to draft an Environmental Impact Assessment (EIA) report. In certain circumstances, an EIA is also required if an existing plant is modified. More specifically, it is required in situations involving:

- a change in the type, quantity or enrichment of the fuel used;
- an increase in the release of radioactive effluents;
- an increase in the on-site storage of spent fuel;
- decommissioning;
- any change in the conceptual safety design of the plant that is not covered by the description of the design in the safety analysis report.

The Environmental Protection Act states that an independent Commission for Environmental Assessments must be established and it should be consulted whenever it is decided that an EIA needs to be submitted as part of the licence application. On the level of the Decree, the types of activities for which such assessments are required are specified.

The general public and interest groups often use EIAs as a basis for commenting on and raising objections to decisions on nuclear activities. This demonstrates the value of such documents in facilitating public involvement.

#### **General Administrative Act (Awb)**

The General Administrative Act sets out the procedure for obtaining a licence and describes the participation of the general public in this procedure (i.e. objections and appeals). This law applies to virtually all procedures under any law.

Notice must be given, both in the Government Gazette and in the national and local press, of the publication of the draft decision to award a licence. At the same time, copies of the draft decision and of the documents submitted by the applicant must be made available for inspection by the general public. All members of the public are free to lodge written objections to the draft decision and to ask for a hearing.

All objections made to the draft version of the decision are taken into account in the final version. Anybody who has objected to the draft decision is free to appeal to the Council of State (the highest administrative court in the Netherlands) against the decision by which the licence is eventually granted, amended or withdrawn.

### **7.1.c Ratification of international conventions and legal instruments related to nuclear safety**

The Netherlands is party to Treaties and Conventions related to the use of nuclear technology and materials.

An important one is the ‘Treaty on the Non-Proliferation of Nuclear Weapons’ (NPT). Related are guidelines of the Nuclear Suppliers Group that prescribe limitations to the transfer of sensitive nuclear technologies like the enrichment and the reprocessing technologies. In addition, the Netherlands has joined the ‘Proliferation Security Initiative’ (PSI), which is based on a UN Security Council Resolution 1540 (UNSCR 1540) for the non-proliferation of Weapons of Mass Destruction (WMD).

The Netherlands is also party to several Conventions on liability, like the ‘Paris Convention on Third Party Liability in the Field of Nuclear Energy’ and the ‘Brussels Convention’ supplementary to the ‘Paris Convention’, and the ‘Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention’.

Other important Conventions are the ‘Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management’, and the ‘Convention on Physical Protection of Nuclear Material and Nuclear Installations’.

## **7.2 Provisions in the legislative and regulatory framework**

### **7.2. (i) National safety requirements and regulations**

This section describes the regulatory framework, that is sitting below the top-level (laws) of the hierarchy. Refer to section 7.1.a for the complete overview of the framework.

#### **Decrees**

A number of Decrees have also been issued containing additional regulations and these continue to be updated in the light of ongoing developments. Important examples of these in relation to the safety aspects of nuclear installations are:

- the Nuclear Installations, Fissionable Materials and Ores Decree (Bkse);
- the Radiation Protection Decree (Bs);
- the Transport of Fissionable Materials, Ores and Radioactive Substances Decree (Bvser);
- the Environmental Impact Assessment Decree.

The Nuclear Installations, Fissionable Materials and Ores Decree (Bkse) regulates all practices involving fissionable materials and nuclear facilities (including licensing). The Radiation Protection Decree (Bs) regulates the protection of the public (including patients) and workers against the hazards of all ionising radiation. It also establishes a licensing system for the use of radioactive materials and radiation-emitting devices, and prescribes general rules for their application. The Transport of Fissionable Materials, Ores and Radioactive Substances Decree (Bvser) deals with the import, export

and domestic transport of fissionable materials, ores and radioactive substances by means of a reporting and licensing system.

The Nuclear Energy Act and the aforementioned Decrees are fully in compliance with the relevant Euratom Directive laying down the basic safety standards for the protection of workers and the general public against the health risks associated with ionising radiation. This Directive (96/29/Euratom) is incorporated into the relevant Dutch regulations.

The Environmental Impact Assessment Decree, in combination with the Environmental Protection Act, stipulates that any licence application for a nuclear installation shall be accompanied by an EIA. This complies with EU Council Directive 97/11/EC.

In the next paragraphs, some details of the various degrees are addressed.

### ***Decree – Bs***

#### *The Bs and dose criteria for normal operation*

The main elements of the Bs are: (1) justification of the activity, (2) optimization - ALARA and (3) dose limits.

Practices involving ionizing radiation should be justified. Dutch regulation features a list of ‘justified and not justified practices’.

The exposure to ionising radiation should be kept As Low As Reasonably Achievable (ALARA). The ALARA principle is recorded in the Nuclear Energy Act (article 15 and 31 of that law), the Bs Decree and also in the Bkse Decree.

The dose limit for members of the public is a maximum total individual dose of 1 mSv and 20 mSv for workers in any given year as a consequence of normal operation from all anthropogenic sources emitting ionising radiation (i.e. NPPs, isotope laboratories, sealed sources, X-ray machines, industries, etc.).

For a single source (for instance a single NPP), the maximum individual dose is set at 0.1 mSv per annum. As a first optimisation goal, a dose level of 0.04 mSv per annum has been set for a single source in accordance with the ALARA principle.

### ***Decree - Bkse***

#### *The Bkse and licensing construction, commissioning & operation*

The Bkse sets out additional regulations in relation to a number of areas, including the licence application procedure for the construction, commissioning and operation of a nuclear reactor, and associated requirements. According to article 6 of Bkse, for such an application, applicants are required to submit (among others) the following information:

- a description of the site where the installation is to be located, including a statement of all relevant geographical, geological, climatological and other conditions;
- a description of the installation, including the equipment to be used in it, the mode of operation of the installation and the equipment, a list of the names of the suppliers of those components which have a bearing on the assessment of the safety aspects, and a specification of the installation’s maximum thermal power;
- a statement of the chemical and physical condition, the shape, the content and the degree of enrichment of the fissionable materials which are to be used in the installation, specifying the maximum quantities of the various fissionable materials that will be present at any one time;
- a description of the way in which the applicant intends to manage the relevant fissionable materials after their use;

- a description of the measures to be taken either by or on behalf of the applicant so as to prevent harm or detriment or to reduce the risk of harm or detriment, including measures to prevent any harm or detriment caused outside the installation during normal operation, and to prevent any harm or detriment arising from the Postulated Initiating Events (PIEs) referred to in the description, as well as a radiological accident analysis concerning the harm or detriment likely to be caused outside the installation as a result of those events (safety analysis report);
- a risk analysis concerning the harm or detriment likely to be caused outside the installation as a result of severe accidents (Probabilistic Safety Analyses);

#### *The Bkse and decommissioning*

For the application for a decommissioning licence, according to Bkse, the licensee shall submit the following information to the authorities:

- a copy of the operating licence;
- a decommissioning plan;
- a description of the measures to be taken either by or on behalf of the applicant so as to prevent harm or detriment or to reduce the risk of harm or detriment, including measures to prevent any harm or detriment caused outside the facility during normal operation, and to prevent any harm or detriment arising from the Postulated Initiating Events (PIEs) referred to in the description, as well as a radiological accident analysis concerning the harm or detriment likely to be caused outside the installation as a result of those events (Safety Analysis Report);
- a risk analysis concerning the harm or detriment likely to be caused outside the installation as a result of severe accidents.

In April 2011, Bkse will be amended, introducing new legislation on decommissioning and financial provisions for the costs of decommissioning. An important part of this legislation will be based on the WENRA<sup>5</sup> Safety Reference Levels on decommissioning.

The new legislation requires the licensee to have and periodically (every five years) update a decommissioning plan during the lifetime of the facility. The plan shall be approved by the authorities every time it is updated. In addition to this, minimum-requirements on the content of a decommissioning plan are defined. The decommissioning plan serves as the safety-basis for all the activities carried during the decommissioning phase, and it provides the basis for the financial provisions for the decommissioning costs. During decommissioning, the licensee is obliged to act according to the decommissioning plan.

Furthermore, the licensee is required to have a financial provision to cover the costs of decommissioning, which will have to be updated and approved by the authorities every time the decommissioning plan is updated. The licensee is in principle free to choose the form of the financial provision. Upon approval, the authorities will assess whether the financial provision offers sufficient security that the decommissioning costs are covered at the moment of decommissioning.

#### *Bkse and the Community framework for nuclear safety*

Of recent date is Council Directive 2009/71/Euratom for establishing a (European) Community framework for nuclear safety of nuclear installations. It will be implemented in Dutch regulation and as such will have its impact on the Bkse-decree. The safety objectives of this Council Directive cover those of the Nuclear Safety Convention.

#### *The Bkse and risk criteria for incidents and accidents*

The ministry of VROM has formulated a policy on tolerance of the risks posed by nuclear power

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<sup>5</sup> Western European Safety Regulators Association, WENRA.

stations. This policy has been formulated independently of the NVRs and is primarily incorporated in the Bkse Decree.

The basis and application of the regulations are discussed in some detail in Appendix 1, which includes more detailed references to official documents (Acts, Decrees, etc.). As far as the radiological hazard is concerned, the regulations can be seen as implementing the IAEA Safety Fundamentals (version 1993 The safety of Nuclear Installations) Radiation Protection Objective:

*To ensure that in all operational states radiation exposure within the installation or due to any planned release of radioactive material from the installation is kept below prescribed limits and as low as reasonably achievable, and to ensure mitigation of the radiological consequences of any accidents.*

The application of this objective requires the licensee to:

- verify that pre-set criteria and objectives for individual and societal risk have been met. This includes identifying, quantifying and assessing the risk;
- reduce the risk, if required, until an optimum level is reached (based on the ALARA principle);
- exercise control, i.e. maintain the level of risk at this optimum level.

In accordance with the probabilistic acceptance criteria for individual mortality risk and societal risk as laid down in Bkse, the maximum permissible level for the individual mortality risk (i.e. acute and/or late death) has been set at  $10^{-5}$  per annum for all sources together and  $10^{-6}$  per annum for any single source. These numerical criteria were developed as part of general Dutch risk management policy in the late eighties. Based on an average annual mortality risk of  $10^{-4}$  per annum for the least sensitive (highest life expectancy) population group (i.e. youngsters around 12 years old) from all causes, it was decided that any industrial activity should not add more than 1% to this risk. Hence,  $10^{-6}$  per annum was selected as the maximum permissible additional risk per installation. Furthermore, it is assumed that nobody will be exposed to risk from more than 10 installations and the permissible cumulative individual mortality risk is therefore set at  $10^{-5}$  per annum.

Where severe accidents are concerned, it is necessary to consider not only the individual mortality risk but also the group risk (= societal risk). In order to avoid large-scale disruption to society, the probability of an accident in which at least 10 people suffer acute death is restricted to a level of  $10^{-5}$  per annum. If the number of fatalities increases by a factor of  $n$ , the probability should decrease by a factor of  $n^2$ . Acute death means death within a few weeks; long-term effects are not included in the calculation of group risk.

In demonstrating compliance with the risk criteria, it is necessary to assume that only the usual forms of mitigating measures are taken (i.e. action by fire services, hospitals, etc.). Although the emergency preparedness organisation may take special measures like evacuation, iodine prophylaxis and sheltering, these are disregarded in the Probabilistic Safety Analysis (PSA). In the Dutch view, it is unreasonable to assume that any countermeasure will be 100% effective. It is more realistic to expect that a substantial part of the population will be unable or unwilling to adopt the prescribed countermeasure. The PSA results used to demonstrate compliance with the risk criteria, therefore need to reflect this more conservative assumption. However, for the sake of interest, the PSA results of the Dutch NPP show both situations: with and without credit being given for countermeasures.

See Appendix 1 for a discussion of the abovementioned dose- and risk criteria and their background.

### **Regulations and guides issued by regulatory body: the Nuclear Safety Rules (NVRs)**

The Nuclear Energy Act (Article 21.1) provides the basis for a system of more detailed safety regulations concerning the design, operation and quality assurance of nuclear power plants. These are referred to as the Nuclear Safety Rules ('Nucleaire VeiligheidsRegels', NVRs). The regulations of the NVRs apply to an installation, as far as they are referenced in the licence.

The NVRs have been developed under the responsibility of the ministry of VROM and the ministry of Social Affairs and Employment (SZW). Currently, the development of these guides is in the domain of the ministry of VROM.

The NVRs are based on the Requirements and Safety Guides in the IAEA Safety Standards Series (SSS). Using an agreed working method, the relevant SSS safety fundamentals, requirements and guides were studied to see how they could be applied in the Netherlands. This procedure resulted in a series of adaptations ('amendments' as they were termed) to the IAEA standards, which then became the draft NVRs. The amendments were formulated for various reasons: to allow a more precise choice out of different options, to give further guidance, to be more precise, to be more stringent, or to adapt the wording to specifically Dutch circumstances (e.g. the risk of flooding, population density, seismic activity and local industrial practices). VROM is in the process of modernizing and reconsidering the set of NVRs. More about that is explained in the next sections on establishing and revising the NVRs.

#### *NVRs and the licence conditions*

For a nuclear facility, the NVRs apply as far as they are referenced in the licence conditions mentioned in the licence. This mechanism allows the regulatory body to enforce the NVRs. At the Requirements level, the NVRs are strict requirements which must be followed in detail. At the Safety Guides level, the NVRs are less stringent: alternative methods may be used to achieve the same safety levels.

Appendix 5 contains a table of the NVRs and related IAEA Requirements and Safety Guides.

The foreword to the IAEA standards states that the standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance national practice, is also necessary. Moreover, there will generally be special aspects that need to be assessed by experts on a case-by-case basis.

#### *NVRs and overview of process of establishing NVRs*

In the Netherlands the amendments to the IAEA standards were developed by way of an agreed process of consultation between the regulatory body and a number of organisations involved with nuclear power plants, including the NPP operating organisations. This was in accordance with a general Dutch approach to regulatory activity whereby government initiates regulation but seeks to achieve it in cooperation with the organisations concerned, in order to build confidence and ensure eventual compliance. This process is without prejudice to the fact that the prime responsibility for regulation lies with government. In some cases, therefore, final decisions are taken by government even where the complete agreement of operating organisations has not been obtained.

#### *NVRs and their modernisation*

All the formally established NVRs are based on the original NUSS programme. However, in 1996 the IAEA launched a major programme to review and update the existing IAEA standards. The revised standards began to be published in the year 2000. At the time, implementation of the new standards was not considered to be particularly necessary in the Netherlands, given that the only NPP still in operation was then expected to shut down in 2003. A gradual change in politics took place leading first to a limited extension of operation and later on even to a fixed life time extension until 2034 under certain conditions. Refer to Annex 2 about 'the Borssele Covenant' which governs this extension of operating life.

After this change had taken place, the need for revision of the NVRs became obvious.

The revision process of the NVRs is ongoing since the beginning of 2006. The plan was not only to update the existing NVRs, but in addition to add others like those about siting. An important aspect is the adoption of the WENRA Reference Levels as far as they are not already included in the IAEA standards. In 2009 and 2010 a project was conducted to study the regulation in other - mostly

European - countries. This study should serve as inspiration for the further modernisation of the NVRs.

#### **Adopted foreign nuclear codes and standards**

The regulatory body's experience with the IAEA-based NVRs has been generally positive, although they have not proved to be a panacea for all problems related to regulation. Strong points are the clear top-down structure of the standards (fundamentals, requirements, safety guides) and their comprehensiveness. However, given that they are the result of international cooperation, the standards cannot cover all aspects in the detail sometimes offered by some national (nuclear) regulatory systems.

To cope with this difficulty, inspectors and assessors involved with their application, need to have an adequate knowledge of the current state of technology in the various areas relevant to safety. In addition, sometimes additional material is needed to define the licensing basis. Nuclear codes and standards of other countries often are adopted. Examples are the US Code of Federal Regulations, the USNRC Regulatory Guides, the USNRC Standard Review Plan, and the RSK recommendations (German). However, careful consideration needs to be given to application of these foreign standards, since using them out of their original context may lead to difficulties.

#### **Adopted industrial standards**

The Safety Guides in the NVR series give guidance on many specific items. However, they do not cover industrial codes and standards. Applicants are therefore required to propose applicable codes and standards, to be reviewed by the regulatory body as part of their applications. Codes and standards in common use in major nuclear countries are generally acceptable (e.g. ASME, IEEE and KTA). The regulatory body has the power to formulate additional requirements if necessary.

#### **7.2. (ii) System of licensing**

As discussed in the section on Article 7.1 of the Convention, the Nuclear Energy Act stipulates (in Article 15, sub b) that a licence must be obtained to construct, commission, operate, modify or decommission a nuclear power plant. Similarly, as indicated in the section on Article 7.1 of the Convention, the Act states (in Article 15, sub a) that a licence is required to import, export, possess or dispose of fissionable material.

Under Article 29 of the same Act, a licence is required in a number of cases (identified in the Radiation Protection Decree, Bs) for the preparation, transport, possession, import or disposal of radioactive material.

In addition, for the construction or major modification of a nuclear facility, a Building Permit is needed. This is governed by other laws and decrees, for which the local municipal authorities are the governing bodies.

The procedures to obtain a licence under the Nuclear Energy Act (and other acts), follow the guidelines specified in the General Administrative Act (Awb). These procedures allow for public involvement in the licensing process. Any stakeholder is entitled to express his views regarding a proposed activity. If the Environmental Protection Act applies, everybody may express his or her view. The regulatory body shall take notice of all views expressed and respond to them with careful reasoning. If a member of the public is not content with the reply, he can go to court.



### *A single authority for licensing*

As already mentioned in the section on Article 7.1 of the Convention, responsibility for nuclear activities will become centralised and the single authority for licences under the Nuclear Energy Act (Kew) will become the ministry of VROM. Currently several ministries share this responsibility.

However, on top of the Kew, several types of regulation may apply to a nuclear facility and the activities conducted in it and/or supporting it. Therefore often there are several authorities, sometimes at several levels in the governmental organisation.

### *Coordination Law*

For projects related to large scale energy generation, a special Coordination Law applies. Large scale projects that could be impacted by this law are for instance the construction of power plants with an electrical power greater than 500 MW<sub>e</sub>, investment in the power grid, etc. The Coordination Law supposes involvement of the ministry of Economic Affairs (EZ) and the ministry of VROM. With such large projects, the ministry of EZ is assumed to be the coordinator, organising the interaction between the many authorities, each of which will perform its duties. Typical of such projects is the involvement of many levels of governmental organisations; from the ministries down to the municipal level.

### *Advisory bodies*

Under the terms of the Public Health Act, a Public Health Council exists to advise ministers on issues concerning radiation protection and public health. There is nowadays no standing advisory committee on nuclear safety; an advisory committee (the Reactor Safety Commission) is formed on an ad hoc basis as required.

With a licence application, it very often is compulsory to conduct an Environmental Impact Assessment or EIA (Dutch: milieu-effectrapportage, m.e.r.). It is compulsory for all reactors with a thermal power higher than 1 kW. The Netherlands has a permanent institute, the Commission for the Environmental Assessment ('Commissie voor de m.e.r.', Cmer) that advises on the requirements of all EIAs conducted in the Netherlands, including those related to nuclear facilities.

### *Notified bodies*

The legal basis for oversight on nuclear pressure equipment has been transferred from the Steam Act to the Nuclear Energy Act. Consequently the prime responsibility for its enforcement is with the ministry of VROM and its nuclear inspection department, the KFD.

Notified Bodies under the European Pressure Equipment Directive<sup>6</sup> can qualify with the Ministry of VROM as nuclear pressure equipment inspectorate, if they can demonstrate additional qualifications in design, fabrication and inspection of nuclear pressure equipment. Under this new system, the licensee can select a Notified Body, accepted by VROM, to inspect his nuclear pressure equipment. Refer to section 7.2. (iii) for more information on Notified Bodies.

### *Specific licensing issues in the Nuclear Energy Act*

Article 15b of the Nuclear Energy Act enumerates the interests for the protection of which a licence may be refused. These interests are listed in section 7.1.a. The licence itself lists the restrictions and conditions imposed to take account of these interests. The licence conditions may include an obligation to satisfy further requirements that may be set by the regulatory body in relation to the subject of a licence condition.

In the case of very minor modifications, the licensee may obtain a more simple licence making use of a special provision in the Act (Article 17) that allows such modifications to be made with a minor licence change. The licensee need only submit a report describing the intended modification. This

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<sup>6</sup>Directive 97/23/EC of the European Parliament and of the Council of 29 May 1997 on the approximation of the laws of the Member States concerning pressure equipment

instrument can only be used if the consequences of the modification for man and the environment are within the limits of the licence in force. The notification is published and open to appeal.

The regulatory body conducts regular reviews to establish whether the restrictions and conditions under which a licence has been granted are still sufficient to protect workers, the public and the environment, taking account of any developments in nuclear safety that have occurred in the meantime. Should a review indicate that, given the developments, the level of protection can and should be improved; the regulatory body will amend the restrictions and conditions accordingly. It should be noted that this is not the same as the Periodic Safety Reviews (PSRs), which the licensee is required to perform.

### **7.2. (iii) Regulatory assessment and inspections**

#### *Entities performing assessments and inspection*

Article 58 of the Nuclear Energy Act states that the minister responsible for licensing procedures should entrust designated officials with the task of performing assessment, inspection and enforcement. The nuclear regulatory body in the Netherlands is formed by two entities:

- The directorate of Environmental Safety and Risk Management ('Risicobeleid', RB),
- The department of Nuclear Safety, Security & Safeguards (the nuclear inspectorate, the 'KernFysische Dienst', KFD).

Refer to section 8.1.b for a detailed description of these departments and their position within the organisational structure of the ministry of VROM.

The KFD is the main department regarding assessment and inspection of nuclear facilities. The KFD also is responsible for supervision of nuclear security and safeguards. At the same ministry, the RB Directorate is responsible for assessing whether the radiological safety objectives have been met in the licensing procedures. It should be noted that this directorate is responsible for policy development and licensing, but does not perform inspections.

With regard to nuclear fuel cycle installations and nuclear power plants in particular, almost all inspection and assessment tasks are carried out by the KFD, which possesses the technical expertise needed for the inspection of nuclear safety, radiation protection, security and safeguards. Further details of the tasks are given in the section on Article 8 of the Convention.

There is no specific regulatory body for the assessment and inspection of the integrity of pressure retaining components. Companies having the required knowledge and expertise, can qualify as a Notified Body. An example of such a Notified Body is Lloyds Register Nederland BV. 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. The assessments and inspections by the Notified Body are performed under supervision of the KFD. For developments regarding regulation and inspection of pressurized equipment, refer to the end of section 7.2. (i).

#### *Regulatory assessment process*

The regulatory assessment process is as follows. The regulatory body reviews and assesses the documentation submitted by the applicant. This might be the Environmental Impact Assessment (EIA) report and the Safety Report (SR) with underlying safety analyses submitted in the context of a licence renewal application or modification request, proposals for design changes, changes to Technical Specifications, procedural changes such as the introduction of Severe Accident Management Guidelines (SAMGs), etc.

During the licensing phase the KFD assesses whether the NVRs (i.e. requirements and guidelines for nuclear safety and environment), BRK93 (requirements and guidelines for security) and regulation for non-nuclear environmental protection have been met and whether the assessments (methods and input

data) have been prepared according to the state of the art etc. RB assesses the radiological consequences associated with postulated transients and accidents in the various plant categories. RB will verify in particular if the results are permissible in view of the regulations and the KFD will focus especially on examining the (system) analyses and the validity of the calculations.

Formally, RB lays down the guidelines for the required calculations (data for food consumption, dispersion, etc). The KFD is involved in these activities, especially concerning the interface with the plant (leakage rates, ventilation and off-gas systems, filter efficiencies, etc). Both the regulatory body and the licensee are very aware of the interface. However, in the case of design-basis accidents the source terms (in containment) do not directly follow the thermal-hydraulic accident analyses, since these source terms are conservatively postulated.

Acceptance criteria used in the assessments are specified in Appendix 1. Further details of the assessment process are given in the section on Article 14.

#### *Regulatory inspections*

The function of regulatory inspections is:

- to check that the licensee is acting in compliance with the regulations and conditions set out in the law, the licence, the safety analysis report, the Technical Specifications and any self-imposed requirements;
- to report (to the director of the KFD) any violation of the licence conditions and if necessary to initiate enforcement action;
- to check that the licensee is conducting its activities in accordance with its Quality Assurance system;
- to check that the licensee is conducting its activities in accordance with the best technical means and/or accepted industry standards.

All inspections with regard to nuclear safety, radiological protection of personnel and of the environment around nuclear sites, security and safeguards, including transportation of fresh and spent nuclear fuel and related radioactive waste to and from nuclear installations are carried out by the KFD.

The licensee has to act in compliance with the Nuclear Energy Act, the licence and the associated safety analysis report. The compliance is verified with a system of inspections, audits, assessment of operational monthly reports, and evaluation of operational occurrences and incidents. Inspection activities are supplemented by international missions and a special arrangement with the Belgian inspection authority, which participates frequently in Dutch inspections. An important piece of information for inspection is the two-yearly safety evaluation report, in which the licensee presents its own assessment of performance with respect to the licence base on technical, organisational, personnel and administrative provisions.

The management of inspections is supported by a yearly planning, the reporting of the inspections and the follow-up actions. Regularly a meeting between plant management and KFD management is held, devoted to inspections and inspection findings. During (more technical) regular meetings between plant staff and KFD staff, these inspection findings are discussed. There are also regular meetings with the plants' incident analysis group. Also, during other management meetings, which are held quarterly in order to discuss more general regulatory issues, the follow-up of any remedial actions is discussed.

Many inspections performed by the KFD are characterised by an emphasis on technical judgement and expertise. They are compliance-based, that is, the KFD investigates whether the licensee is acting in accordance with the terms of the licence. Inspections also need to focus on organisational aspects. There is a need to scrutinise the way the licensee has fulfilled its responsibility for safety and to ascertain whether the licensee's attitude shows a sufficient awareness of safety aspects. For this

reason, more performance-based inspections are now taking place. In addition, inspections are becoming more risk-oriented, i.e. placing more emphasis on the areas most relevant to risk.

Apart from these inspections, in-depth international team reviews are also carried out by bodies such as the IAEA (OSART, Fire Safety, IPERS, ASSET, IPPAS and INSARR). These reviews are the results of separate decisions mainly on the initiative of KFD. KFD teams carry out smaller inspections of a similar nature from time to time. In addition, the Borssele utility itself carries out self-assessments at regular intervals and invites others like WANO to perform assessments (see also section 10.2 and 14.(i) ). The self-assessments have been requested by the KFD. The HFR research reactor in Petten has introduced a systematic self-assessment programme too.

#### **7.2. (iv) Enforcement**

There is a special Decree on Supervision, which deals with the inspection and enforcement of the regulations and the terms of licences. An extended series of articles has been published covering all aspects for which supervision is required, from public health to security and financial liability. The Decree also specifies the responsible authorities.

Should there be any serious shortcoming in the actual operation of a nuclear installation, the Minister of Housing, Spatial Planning and the Environment (VROM) is empowered under Article 37b of the Nuclear Energy Act to take all such measures as deemed necessary, including shutting down the nuclear installation. Written enforcement procedures have been published describing the action to be taken if this article of the Act needs to be applied. Special investigators have been appointed to prepare an official report for the public prosecutor, should the need occur.

Article 19.1 of the Nuclear Energy Act empowers the regulatory body to modify, add or revoke restrictions and conditions in the licence in order to protect the interests on which the licence is based. Article 20a of the Act stipulates that the regulatory body is empowered to withdraw the licence, if this is required in order to protect those interests.

Article 15a of the Nuclear Energy Act empowers the regulatory body to compel the licensee to cooperate in a process of total revision and updating of the licence. This will be necessary if, for instance, comprehensive modifications are proposed or the licence has become unclear (or outdated) in the light of numerous changes since it was issued.

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## ARTICLE 8. REGULATORY BODY

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**8.1 Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.**

**8.2 Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.**

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### 8.1.a General

#### *Authority regarding legislation*

Several ministries are responsible for the legislation concerning the Nuclear Energy Act.

The ministry of VROM is the coordinating ministry for all issues related to the Nuclear Energy Act. As such it houses the regulatory body, for details refer to section 8.1.b. The various organizations within VROM and within the other ministries that are charged with legislative tasks, are listed below.

- Ministry of Housing, Spatial Planning and the Environment (VROM) (see also Figure 2)
  - Directorate-General for the Environment (DGM) also known as Environmental Protection Office
    - Environmental Safety and Risk Management Directorate ('Risicobeleid', RB)
  - Inspectorate-General (VI)
    - Department for Nuclear Safety, Security, Safeguards and Radiation Protection (KFD)
- Ministry of Social Affairs and Employment (SZW)
  - Directorate Health and Safety at Work
- Ministry of Economic Affairs (EZ)
  - Directorate-General for Energy and Telecommunications
    - Directorate for Energy Production

#### *Authority regarding licensing*

The ministry of VROM is planned to become in 2011, the single authority regarding licensing under the Nuclear Energy Act.

#### *Separation of licensing from inspection & enforcement*

Since January 1st 2002 all inspection bodies of the ministry of VROM, including the KFD, are part of a single unified Inspectorate-General ('VROM-Inspectie' or VI). This benefits the goal to separate inspection and enforcement from activities on licensing, legislation, and policymaking. The Inspectorate has its central office at the ministry and has five regional offices led by a regional inspector. In addition to these five regional organisations, the VI consists of the VROM-IOD (Investigation Service) and the KFD.

In the years 2011 – 2013 the VROM Inspectorate-General will reduce the number of offices in the region to three, and move its central office out of the ministry, in effect increasing the abovementioned separation. In the coming years the status of the Inspectorate will change, resulting in a more independent unit of the ministry of VROM.

Besides the abovementioned developments, it has been decided that KFD will remain a separate entity within the Inspectorate-General and stay at least until 2013 in the central office of the ministry:

- To enable KFD to expand in anticipation of the challenges ahead (longer operation of NPP, plans for nuclear new-build);
- To enable close cooperation with RB when new installations have to be licensed.

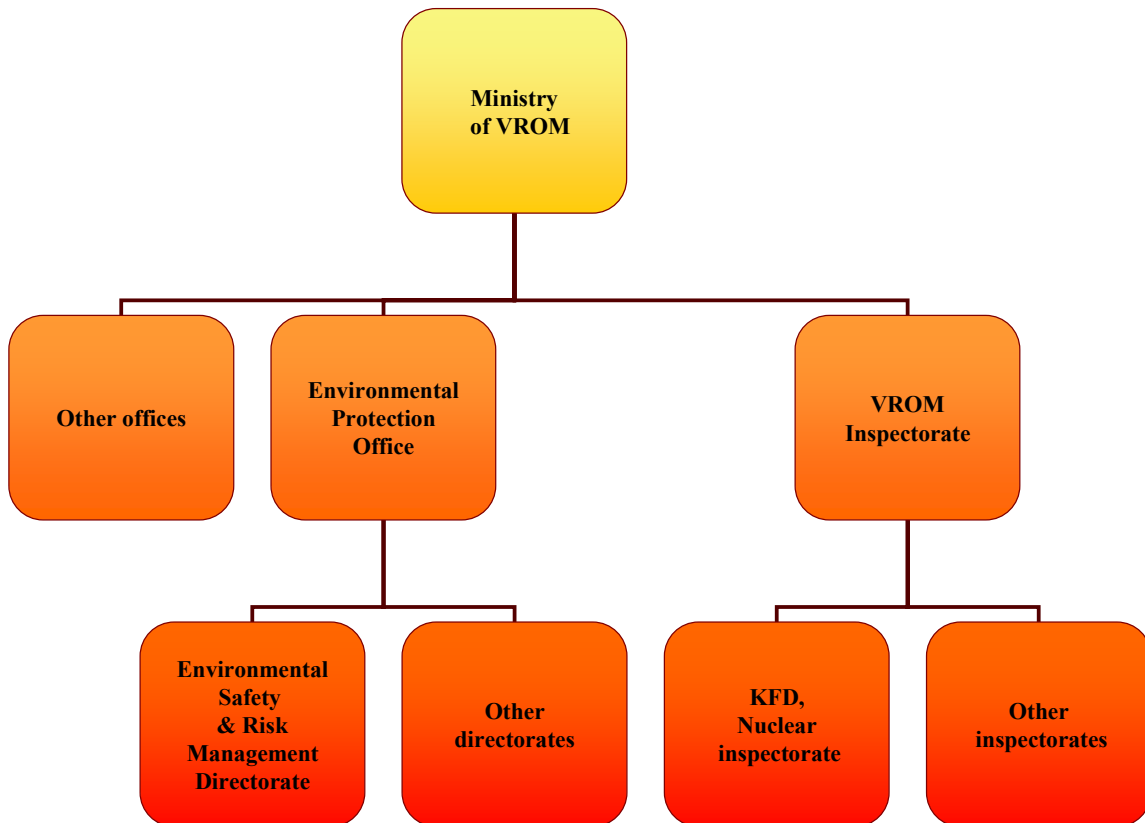


Figure 2 Nuclear safety and radiation protection within the Ministry of VROM

### 8.1.b Regulatory body

The departments RB and KFD together constitute the regulatory body, overseeing nuclear safety, radiation protection, security and safeguards. An organization chart has been presented in Figure 2. In addition to day-to-day contacts between these departments, there are also periodic bilateral meetings at managers and directors levels. The organisations RB and KFD are described in more detail in this section.

The VROM departments RB and KFD each have their own set of responsibilities and tasks, related to the Nuclear Energy Act. This division of tasks is explained below:

*Directorate for Environmental Safety & Risk Management (RB):*

- Coordinate and develop the safety and environment policy of the ministry of VROM regarding nuclear issues;
- Coordinate and contribute to legislative activities and develop the regulation regarding nuclear safety, security, and safeguards in compliance with national and international laws and treaties;

- Coordinate and execute the licensing process and issue licences with an appropriate set of licensing conditions.

*Department for Nuclear Safety, Security, Safeguards and Radiation Protection (KFD):*

- Assess whether licensees meet the licensing conditions documented in their licences, by evaluating documentation provided by the licensees, conducting inspections etc.;
- Contribute to the formulation of the licensing conditions in the licences and as such assist RB in drafting the licences;
- Advice to RB on many issues related to nuclear technology, radiation protection, and security.

The two departments, constituting the regulatory body, coordinate the licensing efforts under the Nuclear Energy Act and ensure that the current legislation is being adequately supervised and if necessary enforced. The decision to grant or to reject an application for a licence is based on legal requirements and safety assessments by the KFD, which advises the licensing body (RB) on licensing conditions and requirements.

*Challenges for the regulatory body*

Extension of the operating life of the Borssele NPP and recent initiatives in the Netherlands for nuclear new build, face the regulatory body with major challenges. One is providing adequate number of governmental staff with sufficient expertise to oversee the licensing procedures. The following measures have been taken to meet the challenges:

- Anticipating increasing workload, a formal request for expansion of the personnel and financial budget was sent to the cabinet in March 2010. In April 2010 a first expansion of about 22 fte was agreed, to be equally shared by RB and KFD.
- As far as the financing is concerned, currently an evaluation of practices in other countries is being carried out, as part of the preparations for developing an improved fee system.
- The budget for providing external international technical safety support to the KFD (the inspection branche), will increase in the years 2010 – 2020. This is solely for the assessment of existing installations.

*Education, training and participation in international networks*

The regulatory body provides tailor-made training for its staff. Examples of training courses for new staff are listed in Annex 4.

Apart from the general courses, training dedicated to the technical discipline is provided. This includes international workshops, but also conferences and visits to other regulatory bodies. In addition there is information exchange through the international networks of OECD/NEA, IAEA, EU etc. To be mentioned are the contributions to WENRA, ENSREG, NUSSC, TRANSSEC, WASSC, RASSC, NERS, NEA/CNRA and several of its Working Groups. Experts have to keep up to date with developments in their discipline and are also responsible for maintaining a network for a number of other disciplines that are not permanently available. It is the policy of the regulatory body that the core experts have sufficient knowledge to specify and assess work done by external experts.

**Environmental Safety and Risk Management Directorate ('Risicobeleid', RB)**

The main tasks of this Directorate of VROM, are licensing, legislation, policy development and implementation in the field of radiation protection, waste management, nuclear safety, security and safeguards in relation to the public and the environment. The subjects of security and safeguards have been included recently.

Recent example of policy development is the planned inclusion of WENRA harmonisation levels in the regulatory requirements. An other example is the drafting of requirements related to decommissioning planning and financial provisions. In the nuclear safety and security area these

policies are established in close cooperation with the nuclear department of the VROM-Inspectorate, the KFD.

The RB Directorate is responsible for regulatory body activities such as licensing nuclear installations and nuclear transports in general (all procedural aspects, since technical aspects are covered by KFD), as well as for all aspects of radiation protection and external safety.

#### *Disciplines*

The expertise of RB spans disciplines like radiation protection, nuclear safety, risk assessment, security and safeguards, and legal and licensing aspects. There has been a certain build-up of capacity and expertise in the fields of security and safeguards. Via RB an annual contribution is provided to support the work of the National Institute for Public Health and the Environment (RIVM). RIVM provides scientific support to the ministry of VROM.

#### *Manpower situation*

Of the RB staff, about 12 fte is dedicated to (1) general radiation protection issues, and (2) nuclear licensing and safety, security and safeguards issues related to all nuclear facilities and nuclear transports. KFD supports RB with technical safety assessments and safety status information. Most other applications and licensing activities like general radiation protection, are outsourced to the 'Agentschap NL', which is a service organisation, that executes programmes and regulations for many ministries and other governmental organisations.

### **Department of Nuclear Safety, Security and Safeguards (KFD)**

The main activities of the KFD, a department of the VROM Inspectorate, are assessment, inspection, enforcement and providing technical support of RB in the framework of licensing and the establishment of regulations. KFD has a formal nuclear inspection strategy, which is based on two pillars: (1) prevention of degradation and (2) continuous improvement of safety. The Inspector General has endorsed this strategy.

Although all KFD-professionals are also inspectors supporting the field inspector, their main job consists of assessing documents submitted by licensees in accordance with licence requirements. Assessments are performed e.g. in the framework of plant or organisational modifications and periodic safety reviews. Four professionals (tertiary vocational college-level) are available full-time to conduct routine installation inspections and audits (field inspectors). One of these field inspectors is dedicated full time to the inspection of Borssele NPP. However, during refuelling, all field inspectors and a number of experts are involved in the inspections.

#### *Current organisation*

The organisation has been changed from a line organisation with two divisions into a matrix organisation executing a programme with five projects managed by two programme managers, each having responsibility for about half of the KFD-staff. The five projects are:

- Technical support of RB
- Reactors and radioactive waste facilities
- Radiation protection
- Security and safeguards
- Operating experience feedback and emergency preparedness

The KFD-organisation is supported by an administrative bureau. The programme managers and projectleaders together form a coordination platform.

The basic key to deploying staff to the different types of nuclear installations is the potential safety risk. But other factors also have their influence, like operational occurrences and incidents, inspection findings or public attention.



KFD has a formal quality system that has been audited several times. The system will now be transformed to the Dutch INK system, which is comparable with ISO 9001: 2000.

*Available disciplines and cooperation with other inspection organisations*

The expertise of the KFD spans the major disciplines relevant for reactor safety, radiation protection, security and safeguards and emergency preparedness. For areas in which its competence is not sufficient or where a specific in-depth analysis is needed, the KFD has a budget at its disposal for contracting external specialists. This is considered one of the basic policies of the KFD: the core disciplines should be available in-house, while the remaining work is subcontracted to third parties or Technical Service Organisations (TSOs).

With the German Technical Support Organisation (TSO) GRS there is a contract to fill in the existing and expected gaps in the capacity and fields of expertise of KFD. From 2010 on, this cooperation will be expanded into a strategic partnership. In addition there is cooperation with regulatory bodies in other countries.

In accordance with the national policy to intensify cooperation between different inspection organisations (e.g. fire brigade, industrial safety inspectorate) dealing with the nuclear field, a Domain Nuclear Industry was established. Main task is to coordinate inspection plans and create an ICT platform to exchange information between inspection organisations, the licensees and the general public.

KFD also seeks to cooperate with other inspectorates in the Netherlands, taking advantage of the knowledge and facilities of those bodies. With the aviation inspectorate, some cooperation has been developed in the area of safety culture.

More about the available disciplines, and associated trainings, can be found in Annex 4.

*Recent changes regarding inspection & enforcement tasks of the KFD*

In line with a larger reorganisation plan within the Inspectorate (VI), several supervision tasks have been moved from VI-offices in the region to the KFD in The Hague:

- Since March 1<sup>st</sup> 2004 all supervision tasks for the nuclear installations in the Netherlands, including those for nuclear security and safeguards are the responsibility of KFD. Therefore tasks concerning the supervision of radiological consequences and non-nuclear aspects of the nuclear facilities and tasks concerning supervision of nuclear transports were transferred from the VI Region South-West (VI ZW) to the KFD.
- From January 1<sup>st</sup> 2009, the VI started to operate in a temporary organisation, as part of a reorganisation plan, which will be finished January 2011. With this reorganisation, the tasks of the regional VI ZW office regarding non-nuclear radiation protection have been transferred to KFD. These tasks are also activities under the Nuclear Energy Act.

*Manpower situation*

The current total KFD professional formation currently is about 23 fte, including three managers. Although the ministries, including the inspectorates have to reduce staff, the capacity of KFD is protected until at least 2011. For the last three years all vacancies have been filled. For the first time foreigners with nuclear experience have been employed, both from EU-member states (Lithuania, Germany). In the next three years, six very experienced employees will retire. To transfer their knowledge to their successors, the policy is to have a six to twelve months overlap. This is subject to stricter ministerial rules in a time of staff cuts.

## **8.2 Status of the regulatory body**

### *Governmental structure*

As described in section 8.1.a, the regulatory body for Nuclear Energy Act issues has two main components: the Environmental Safety and Risk Management Directorate (RB, developing policies and issuing licences) and the inspection branch, the KFD. Both are part of the ministry of VROM.

### *Reporting obligations*

The regulatory body reports to the minister of VROM. The minister of VROM reports to Parliament on nuclear safety, radiation protection, and other Nuclear Energy Act issues.

Results of major studies, conducted under the authority of RB are presented by the minister of VROM to Parliament. In addition, Parliament can and will now and then require the minister to report to Parliament on specific issues in which MPs may have expressed an interest.

Every year the inspection branch KFD prepares a report of its inspection activities and its findings. This publication always is made available to the public on the ministry's website.

The ministry of VROM has extensive dossiers on many issues published on its website, featuring many in-depth studies on issues related to nuclear-related activities. Information on all major licensees can be found online too. This is part of the ministry's policy on transparent governance.

### *Separation of protection and promotion*

On June 21, 1999, a decree was published, transferring responsibility for the maintenance and implementation of the Nuclear Energy Act and the regulations based on it, from the Minister of Economic Affairs (EZ) to the Minister of Housing, Spatial Planning and the Environment (VROM). This means, among other things, that the prime responsibility for the licensing of nuclear installations lies with the minister who is also responsible for the protection of the public and the environment. The influence of the Minister of Economic Affairs is confined to aspects relating to energy supply. This new arrangement fulfils the conditions specified in Article 8.2 of the Convention concerning effective separation.

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## ARTICLE 9. RESPONSIBILITY OF THE LICENCE HOLDER

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**9. Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.**

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The principle that the ultimate responsibility for safety lies with the licensee is established in the legislation at several levels.

First of all the Nuclear Energy Act prescribes that the licensee must produce a safety case for a new NPP (or a substantial modification of an existing NPP) to support its application for a licence. The regulatory body shall assess this safety case and can only refuse to grant the licence in case this safety case does not satisfy the requirements.

Secondly the Nuclear Energy Act, in the explanatory memorandum on Article 37b, states that the licensee must operate the installation in such a way as to reflect the most recent safety insights.

Thirdly, in the licence of Borssele NPP, NVR 1.2 is referenced (Safety requirements for Nuclear Power Plant operation). Three articles of this NVR stipulate the licensee's responsibilities in greater detail.

Article 201 reads:

*The operating organisation shall have overall responsibility with respect to the safe operation of the nuclear power plant. However, the direct responsibility shall rest with the plant management, and therefore the operating organisation shall delegate to plant management all necessary authority for the safe operation....*

Article 501 reads:

*The operating organisation shall be aware of the special emphasis that needs to be placed on safety when operating nuclear power plants. Although the operating organisation may already have an organisational structure for managing non-nuclear power plants, this special emphasis and the commitment to achieve safety will require more than a simple extension of the earlier organisational structure.*

Article 601 reads:

*The plant management shall have the direct responsibility for the safe operation of the plant. The operating organisation shall delegate sufficient authority to the plant management to ensure the effective discharge of this responsibility.*

Because this NVR is contained in a licence condition, these provisions constitute formal obligations.

The licence also states that the licensee must review the safety of the plant at both two-yearly and 10-yearly intervals. Safety evaluations are described in more detail in sections on other articles of the Convention. In addition, the licensee must draw up a decommissioning plan, which must be kept up-to-date to take account of any relevant change in circumstances.

Under Chapter 5 (Structure of the operating organisation) of NVR 1.2, the licensee must develop a policy plan addressing the licensee's responsibility for safety. This means that safety observance is not only an obligation or a licence condition, but also an institutionalised corporate objective. See the section on Article 10 of the Convention for further details.

### *Quality Assurance*

The licensee's own QA organisation is an important mechanism enabling the licensee to adhere to the licence and achieve its corporate safety objectives.

Finally, article 202 of NVR 1.3 (Quality assurance for safety in nuclear power plants and other nuclear installations) stipulates that the responsible organisation (i.e. the licensee in most cases) shall retain the overall responsibility if work is delegated to other organisations.

### *Other obligations*

With the Covenant of 2006, the licensee of the NPP Borssele has agreed to comply with the obligation to remain within the class of 25% of safest reactors in the Western world for its lifetime until 2034.

The EU-directive on nuclear safety adopted in 2009 and to be implemented in 2011 further dictates the licensee's responsibility for nuclear safety and the obligation for continuous improvement of safety.

### *Monitoring of compliance*

Compliance with the licence and its terms is monitored by means of an appropriate inspection programme, including international safety missions, as already discussed in the section on Article 7. In the beginning of 2011 a safety culture audit is planned at NPP Borssele, based on the experience with such an audit in the second half of 2008 at the HFR in Petten. These types of audits tend to have big impact on the organisation, including management.

An other example of the KFD monitoring compliance, is the case of the HFR. KFD since 2007 has increased pressure on the licensee of the HFR to make preparations for a repair on the primary piping, because ISI-measurements indicated that the thickness of the piping would in time decrease to unacceptable levels. After a pinhole inleak of gas was discovered in 2008, the reactor was shut for repair. Because a definitive repair would take a very long time to prepare, it was allowed after half a year to temporarily run the reactor for a year because of the extreme global need for medical isotopes. With additional safety measures this could be allowed. One of the restrictions in the temporary licence was, that a detection of a water leak would immediately require the licensee to shutdown the reactor.

## CHAPTER 2(C) GENERAL SAFETY CONSIDERATIONS

### ARTICLE 10. PRIORITY TO SAFETY

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**10. Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.**

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#### 10.1 Policy on nuclear safety

##### *Regulatory requirements and implementation*

The whole process of the design, construction, operation and decommissioning of a nuclear power plant in the Netherlands (as well as the licensing of all these stages) is characterised by a high priority given to safety at all stages. This is laid down in the Nuclear Energy Act, which requires (Art. 15c) that licence conditions shall be put in place in order to provide for the best possible protection against any remaining adverse consequences of operating a nuclear facility, unless this cannot be reasonably required. In the licence, reference is made to the Safety Requirements for nuclear power plant operation, NVR 1.2, Chapter 5, which states that the operating organisation must be aware of the special emphasis that needs to be placed on safety when operating nuclear power plants. This special emphasis and commitment to safety must be reflected in the organisational structure.

The policy plan of the Borssele utility is worth quoting in this context. It describes the priority attached to safety in relation to that given to financial considerations as follows:

*The prime objective of EPZ is the production of electricity in a cost effective way, but the environmental risk involved in nuclear generation demands that the highest priority be given to nuclear safety (overriding priority).*

In addition, the following policy statement can be found in the objectives of the QA system of the Borssele NPP:

*Operation consists of a safety function, i.e. maintaining and improving operational and nuclear safety, and an economic function, i.e. producing electricity. The economic function will only be fulfilled if the nuclear power plant is safe, from a process and technical viewpoint, and if the safety function is being fulfilled in an adequate manner. The 'conditions for operation' and the 'limits' as laid down in the Technical Specifications must be observed at all times.*

NVR 1.2 states that plant management has a direct responsibility for the safe operation of the plant. All safety-relevant management functions, such as decisions on financial, material and manpower resources and operating functions, must be performed and supported at the most senior level of management. This is the case. In addition, the organisational structure features a special senior manager who is responsible for the independent supervision of nuclear safety, radiation protection and quality assurance at the plant. He reports directly to the most senior level of management at the Borssele site. This ensures that safety is given a proper role in this economically oriented environment.

The licensee (EPZ) of the Borssele plant is a member of WANO. The director of EPZ is member of the board of WANO Paris centre. Further EPZ is member of the Framatome-ANP Reactors Owners Group and the German VGB, which provide a valuable source of information. Personnel take an active part in international WANO and OSART missions.

*Attention to organisational changes at the NPP*

The global description of the NPP organisation, including specifications of competences and authorities for key staff, is part of the Technical Specifications. On top of that there has been introduced a new licence condition to submit a safety case for organisational changes with safety relevance and it is therefore subject to regulatory review and inspection. In the years 2004-2006 there was a major cost savings operation (-15%) due to market conditions. This meant a personnel reduction of about 10%. At the same time the number of reported incidents had gradually increased. The 2006 Covenant allows operating the NPP till 2034. This faces the licensee with the challenge to carry out a number of important tasks at the same time: (1) project Long Term Operation, (2) 3rd Periodic Safety Review, (3) replacement of analog electronics and (4) staying within the class of 25% safest plants in the western world. This requires a major increase of the number of staff and financial means. Therefore KFD has been supervising these developments very closely. Additional information is presented in the sections on Articles 11 and 14 of this national report to the Convention.

*New safety insights*

Where new safety insights emerge, their relevance to the NPP is scrutinised and modifications are initiated if they are found to offer sufficient safety benefits to justify their cost. Although there is no formal requirement in the Netherlands to carry out a cost-benefit analysis, practical experience (such as the major back-fitting programme at Borssele) has shown that the modifications have comfortably met the criteria applied in other countries. EPZ has documented itself a cost-benefit procedure, where amongst other things a certain money value is related with the improvement of the core damage frequency. As already mentioned, regular safety improvements have to be performed. At two-yearly intervals the operation of the plant must be evaluated against the existing licence requirements and at 10-yearly intervals a thorough safety evaluation against modern safety requirements and current safety insights for design, operation, personnel and administration aspects. These Periodic Safety Reviews (PSRs) and the resulting improvement or modification projects are aimed solely at further improvement of plant safety.

As an illustration of the high priority given to safety, it is worth mentioning that the Netherlands participates actively in the Incident Reporting System and has bilateral contracts with Belgium and Germany with regard to the evaluation of incidents. Lessons learnt from foreign incidents are studied with a view to their relevance to the Dutch NPP.

*Decommissioning*

When a plant ceases to operate, the decommissioning stage starts. The first step is a careful study of the change in safety priorities, in view of the different requirements placed on the system with all the fuel in a permanent residual heat removal condition. A new licence is granted once the safety precautions are judged to be adequate.

## **10.2 Safety culture**

### **10.2.a Borssele NPP**

Although no formal criteria have been developed to measure ‘safety culture’, the inspections performed by the regulatory body include monitoring the licensee’s attitude to safety. The staff of the Borssele NPP is fully aware of the necessity of having a ‘safety culture’ and of its relevance to the operating organisation. Although many elements of a safety culture are believed to be in place, improvements and continuous alertness are still necessary in order to cope with the changing operating climate, such as the liberalisation of the electricity market. The increasing number of reported incidents in 2006 and evaluation of international practise has led to an increased and strong effort at the NPP to improve safety culture together with KFD. This effort was reinforced after the WANO-peer review in 2008. WANO will revisit in September 2010. See text below and text on Article 11 and Appendix 4 for further information.

Organisations that have always been alert to the importance of safety had a safety culture even before it was acknowledged as a programme topic. As early as 1986/1987, an OSART mission was performed at the Borssele plant at the request of the regulatory body. In those early days, several other missions followed; in 1994 a pilot ASCOT review was conducted as a complement to an ASSET review, in 1999 a first WANO peer review and in 2000 a WANO peer review follow-up mission.

Some more recent missions are described below to some detail.

In 2003, an IAEA Ageing Management Assessment Team (AMAT) reviewed the management of ageing at the Borssele power plant. The AMAT team concluded that safety-related systems, structures and components were generally in good condition and that the existing ageing management programmes and arrangements provided for timely detection and mitigation of ageing to ensure the required integrity and functional capability of SSCs over the next 10 years. Still there were some recommendations and suggestions, which have been included in the findings of the 10-yearly safety review.

In November 2005 a second OSART mission was conducted. The team gave 4 recommendations and 23 suggestions for improvement to the plant. Also there were 15 good practices identified. The overall impression of the team was there is a strong safety culture. Despite this good result, the team warned that any plant should be careful about complacency. Further the team noticed that the following of procedures deserved even more attention than was already current practice. In June 2007 the follow-up was conducted. Practically all issues were found to be resolved or on the right track.

In September 2008 a second full scope WANO peer review was conducted. The most important areas for improvement identified were strongly related to the plant management and its leadership. Internal discussions about the improvement plan with the plant management resulted into a change of management in the second half of 2009.

For the future the plant has decided to increase the frequency of extended missions (WANO/OSART) from every 5 to every 3 years, with every 10 years an OSART-mission. Although assessment of the human performance and safety culture is part of the WANO and OSART missions, a regular additional independent assessment will be performed of which the type and frequency is being discussed with KFD. In the second half of 2009 a KFD safety culture audit was planned, but it is postponed to the beginning of 2011.

More details of the safety culture at the Borssele NPP are given in Appendix 4.

### **10.2.b Research Reactor HFR in Petten**

In the previous report for the forth review conference of the CNS, published in 2007 and reviewed in 2008, mentioning was made of safety culture issues at the research reactor in Petten, as identified in 2001. A special IAEA-INSARR mission was conducted, with an emphasis on safety culture. After this the licensee drafted an action plan. After approval by the regulatory body, the reactor started up again.

As a result of the action plan, a large number of actions have been taken over the last 6 years. Consequently, the safety culture has been greatly improved. In order to verify the situation, in the second half of 2008, KFD conducted a safety culture audit, using the IAEA-SCART guideline. The main conclusion was that still improvements were possible. The licensee was advised not to reduce efforts in this area, to prevent jeopardizing the achievements.

Annex 3 contains detailed information about the HFR and – among others – the safety culture improvements.





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## ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

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**11.1 Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.**

**11.2 Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety related activities in or for each nuclear installation, throughout its life.**

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### 11.1 Adequate financial resources

#### 11.1.a Social and economic background

In the last 15 years operators of electric power generating systems have had to cope with political and social changes as well as new economical and technological factors. Examples of these changes and factors are electricity market liberalisation, increasing oil and gas prices and constraints in their availability, growing environmental constraints and extraordinary ICT development.

##### *Liberalisation*

The European electricity market is undergoing major changes. Prompted by EU legislation, the EU member states are restructuring their electricity sector to allow for more competition. A well-functioning competitive European electricity market should deliver on access to competitive electricity prices, on security of supply and ensuring investments. Due to liberalization of the electricity market, several competing operators are created and the market is still changing. As a result of these developments electricity companies consider different alliances and merging options.

In all EU countries, the European electricity market introduces new dynamics. The interest in commercial and economical aspects has increased. Therefore regulatory attention on the relationship between production and safety is continuously required.

##### *Unbundling*

In the past, the electricity markets were almost completely controlled by the electricity companies with large, vertically integrated utilities that used to be regulated by state monopolies. These companies typically owned almost all generators, as well as transmission and/or the distribution network. Such ownership pattern is believed to be an obstacle for free competition. The EU's executive body has been a strong advocate of unbundling generation and network activities to prevent these companies from using their influence to reduce competition. Several EU countries are opposed to full unbundling. As a compromise, European states are free to choose from several options to promote competition.

#### 11.1.b Legislative aspects of responsibility and ownership

The principle that the ultimate responsibility for safety lies with the licensee is laid down in several layers of regulation. The highest level is the Nuclear Energy Act where in the explanatory memorandum of Article 37b it is stated that the licensee must operate a nuclear facility in a manner that reflects the most recent safety insights. More about this can be found in the text on Article 9.

The Nuclear Energy Act contains a number of articles, which deal with criteria, interests and conditions under which a licence can be awarded. The explanatory memorandum on Article 70, which states that a licence is to be awarded to a corporate body, refers to guarantees of necessary expertise and trustworthiness in relation to safety. Trustworthiness in relation to safety can amongst other things also be associated with financial solvability.

The licence does not automatically pass to the licence holder's successor in title. In the case where major changes in ownership of EPZ (licence holder of the Borssele NPP) are planned, the licensee is obligated to inform the regulator three months in advance. Article 70 of the Nuclear Energy Act stipulates that any transfer of ownership must take place with the consent of the ministers who issued the licence. This allows the authorities to assess whether a potential licence holder can offer the same standard of expertise, safety, security etc. as the previous one. The authorities will refuse to issue a licence to a potential licensee where a change in ownership alters certain circumstances that are of vital importance from a licensing point of view.

Facing the possibility of nuclear new-build, the regulatory body is developing a new set of (safety) requirements for new NPPs.

### **11.1.c Rules and regulations on adequate financial resources for safe operation**

NVR 2.2.9 (Management of nuclear power plants for safe operation) is referenced in the licence of Borssele NPP. It contains no direct requirement to have adequate financial resources. To ensure the safe operation of an NPP, it does require the licensee to cope with the costs for safe operation. For instance, it stipulates that the management of an NPP must act promptly to provide adequate facilities and services during operation and in response to emergencies. The personnel involved in reviewing activities have to have sufficient independence from cost and scheduling considerations. This applies to reviews of all safety-related activities.

The requirement to provide these services and facilities implies the requirement to provide the necessary financial resources for them. In the near future an actualisation of the regulation on this topic will be proposed, based on the guide NS-G-2.4 (The Operating Organization) and guide NS-G-2.8 (Recruitment, Qualification and Training of Personnel).

### **11.1.d Financing of safety improvements at Borssele NPP**

A major policy principle of the licensee is the overriding priority of nuclear safety. This includes that licensee's management will act promptly to provide adequate facilities and services during normal operation and in response to emergencies.

The licensee's policy is part of the EPZ corporate plan. The corporate plan comprises a period of three years and is published every year. They are presented to the corporate shareholders for approval. One of the main programmes in the corporate plans is the continuous enhancement of the nuclear safety on the power plant. From the corporate plan every year there will be written an annual plan for implementing the programmes.

Before those annual plans will go to the shareholders, they have undergone an internal budgeting process to finance the programmes for that year. During that budgeting process the Quality Assurance Department will see to it that the budgeting process does not have negative consequences for nuclear safety.

According to the licence the licensee has to do a periodic safety review every two years (against the current licence conditions) and a more thorough safety evaluation (against the state of the art) every ten years. In the 10 yearly evaluations, the evaluation points will be assigned with safety significance on basis of:

- A deterministic approach described in the NVRs and IAEA Safety Standards;
- A probabilistic approach (PSA) with emphasis on the significance for the core damage frequency and individual risks;
- Considerations from the perspective of radiation protection for workers, the public and the environment;
- The defence-in-depth approach according to INSAG 10.

This evaluation will result in a list of possible actions to improve the safety. On a basis of cost-benefit considerations, it is decided which measures from that list will be implemented within a certain timeframe.

Because the operating life of the Borssele NPP has been extended with the Covenant signed in 2006, a number of investments have to be made in the near future:

- Long Term Operation project, giving attention to among others ageing issues;
- Replacement of analog electronics by digital I&C;
- Proactive replacement of a large number of components, the reliability of which may not be guaranteed until the new end date of operation;
- Complete overhaul of the Final Safety Analysis Report (FSAR) based on the next Periodic Safety Review;
- Redesign of the organisation;
- Continuous striving for excellence.

#### **11.1.e Rules and regulations on financial resources for waste management activities**

The Netherlands' policy on the management of radioactive waste and spent fuel is to isolate, control, and monitor radioactive waste in above ground structures for an interim period of at least a hundred years, after which geological disposal is foreseen. During the period of interim storage all necessary technical, economical, and social arrangements are to be made in such a way that geological disposal can really be implemented afterwards.

Implementation of this policy lead to the establishment of COVRA, the Central Organisation for Radioactive Waste, located in Borsele. COVRA is a 100% state owned organisation, and is the only organisation allowed to manage and store the radioactive waste and spent fuel. Upon transfer to COVRA, COVRA takes over all liabilities, including the responsibility for final disposal.

According to the generally applied 'polluter pays' principle, the generator of the waste is charged for all costs related to the management of radioactive waste and spent fuel, including the envisaged costs for final disposal. Once the transfer of the waste has been accomplished, the customer is exempted from further responsibility for the waste. No surcharges can be made to make up for exploitation losses by COVRA and no waste can be returned to the customers.

With regard to the management of Spent Fuel (SF) and High Level Waste (HLW), the utilities and the operators of research reactors agreed to jointly build a facility for treatment and long-term storage of Spent Fuel (SF) and High Level Waste (HLW) at the COVRA site. This building (HABOG) was commissioned in 2003 and is now receiving vitrified and other HLW from reprocessing plants as well as SF from the research reactors. Both the construction costs and the operating costs are borne by the generators of the SF and the waste.

For Low and Intermediate Level Waste (LILW) there are fixed tariffs for specified categories of radioactive waste, which take into account all management costs. While the tariffs are annually adjusted with the price index, every five years the tariff structure is evaluated with the aim to reconsider the need for any structural adjustment. However, the utmost restraint is exercised to any proposal for an increase of the tariffs, in order to prevent the temptation of environmentally irresponsible behaviour with the waste by the customer.

While it is recognised that COVRA as a waste management agency has a public utility function, negotiations with the utilities on the transferral of shares to the State have resulted in an agreement in which they take a fair share in the future management costs of COVRA for this category of radioactive waste. In 1986 a study was conducted with the aim to estimate the cost for the construction and operation of a repository for radioactive waste in salt formations in the deep underground. It is envisaged that all radioactive waste, LILW and HLW, will be placed in this repository. The total cost

was estimated at 1230 MEuro of which 820 MEuro for the disposal of HLW (1986 price level). These cost estimates formed the basis for the establishment of financial provisions by the operators of nuclear facilities and have been taken into account in the calculation of the discounted costs as mentioned before. A real interest rate of 3.5% and a discounting period of 130 years were used in the calculations for disposal of HLW. This sum was disbursed to COVRA in the framework of the transfer of ownership of COVRA to the State and put in a separate fund which is managed by COVRA. Every 5 years since the basis for the cost estimate has been re-assessed, the last time in 2003. Based on the COVRA report, the estimated costs for a repository decreased, because of lower volumes of waste to be disposed of. This development was due to the national waste separation and reduction policy. Based on the developments of interest rates over the last years, the real interest rate used in the calculation of discounted values has been set at 3%. For LILW a separate procedure is followed: COVRA raises a surcharge for waste disposal on the fees of generators of radioactive waste. This sum is added to the fund.

For more information waste management issues, refer to our national report for the 'Joint Convention on the Safety of Management of Spent Fuel Management and on the Safe Management of Radioactive Waste Management'.

#### **11.1.f Rules and regulations on financing decommissioning**

According to new legislation, planned to be in force in April 2011, a nuclear facility shall be decommissioned directly after final shut down<sup>7</sup>. Decommissioning implies the implementation of all administrative and technical measures that are necessary to remove the facility in a safe manner, and to create an end state of 'green field'. Therefore, the licensee is required to develop a decommissioning plan, describing all the necessary measures to safely reach the end state of decommissioning, including the management of radioactive waste. This decommissioning plan shall be periodically updated every five years, and shall be approved by the authorities.

The new legislation also requires the licensee to make available adequate financial resources for decommissioning at the moment that these are required. Therefore, the licensee will have to calculate the costs of all the activities described in the decommissioning plan, and provide for a financial provision offering sufficient security that all costs are covered at the envisaged start of decommissioning. The licensee is free to choose the form of the financial provision; however, it shall be approved by the authorities.

Also refer to the text on Article 7 of the Convention for the recent updates of the legislation.

### **11.2 Human resources**

#### **11.2.a Legislative aspects**

The Nuclear Energy Act stipulates that an application for a licence must contain an estimate of the total number of employees plus details of their tasks and responsibilities and, where applicable, their qualifications. This includes supervisory staff. The relevant regulations referenced in the licence of Borssele NPP are NVR 2.2.1 and the specific Safety Guide NVR 3.2.1 for control room personnel.

The safety relevant part of the organisational structure of the plant is described in the Technical Specifications, with clear details of the responsibilities, authority interfaces, lines of communication, requisite level of expertise, and the requirements for training and education. It is therefore part of the licence, and hence subject to inspection by the regulatory body. Another part of the licence is that any planned organisational change with possible safety relevance, must on forehand be reported to the authorities.

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<sup>7</sup> The NPP Dodewaard, brought into a state of Safe Enclosure in 2005, is excluded from this requirement.

Under N.V.R. 2.2.1 the responsibility for ensuring that individuals are appropriately qualified and remain so rests with the operating organisation. It is the responsibility of the plant manager, with reference to each position having importance to safety to ensure that:

- The appropriate qualification requirements are established;
- The training needs are analysed and an overall training programme is developed;
- The proficiency of the trainee at the various stages of the training is reviewed and verified;
- The effectiveness of the training is reviewed and verified;
- The competence acquired is not lost after the final qualification;
- The competence of the persons occupying each position is periodically checked and continuing training is provided on a regular basis.

The licensee has to submit its education and training plan for its control room staff to the regulatory body for information and approval.

In 2009 the NVR 3.2.1 for control room personnel has been changed with respect to the former 60-years limit of the age of control room personnel. Now the qualification is based on performance.

#### **11.2.b Training and qualification of EPZ staff**

The Borssele NPP has a training department that is responsible for delivery of in-house developed training courses; for organizing training courses that are delivered by contractors; for maintaining competency management system and training records keeping. For conduct of the in-house developed training, subject matter experts are extensively used. Training responsibilities for conduct of practical (on-the-job) training are distributed among respective plant departments.

Training and personal development programmes are developed based on competency analysis and consequent training matrix for each job position. Nuclear safety, ALARA principles, industrial safety, operating experience (domestic and international) are included and re-enforced during general employee training, during conduct of initial training programmes and during refresher courses. Training programmes are structured to cover required theoretical knowledge, practical training and on-the-job training. Training material for the basic course is under QA review scheme.

The contracted staff for the conduct of simulator training is of appropriate size and comparable to general industry practice. External organizations are extensively used for delivering training. For specialized training on specific equipment vendor facilities are used. For safety related subjects, equipment vendors or recognized institutions in the nuclear field are used, for example Westinghouse, Framatome, WANO, and NRG (Nuclear Research and consultancy Group, Petten).

Training on emergency preparedness is conducted regularly. Individuals having the position of Site Emergency Director attend position specific training and once per year a simulator retraining course together with one shift team. Large scale emergency exercises are supported also by training on the full scope simulator. Nine simulator scenarios have been prepared for this purpose.

Additionally, an average of 5 persons of EPZ is yearly involved in WANO, OSART, AMAT and other similar missions.

Observations regarding the number of staff employed after the recent reorganisation can be found in section 12.5.

#### *Training facilities*

A replica full scope simulator, located at the training centre KSG&GfS near Essen in Germany, is used for training of Borssele plant personnel. The training is given in Dutch. The annual retraining

programme for operations control room personnel is developed corresponding to a 5-year training plan. Learning objectives are developed based on competences and operational feedback (communication skills). Additional topics are added based on operations management inputs and feedback from trainees. Operators attend two weeks of on-site training where one part is on plant modification (just before outage) and the second part is on applicable portions of the annual refresher course. Both the training programme and the simulator need to be approved by the regulatory body.

For shift team evaluation the plant developed a method for continuous evaluation based on 20 elements that are documented in each scenario exercise guide; results are followed for recognition of weak areas in performance and used for future attention.

The electrical and instrumentation training facility includes fully equipped classroom and separate rooms for practical (on-the-job) training. A high number of comprehensive mock-ups is available and most of them were developed in-house. Many mock-ups have capability to introduce malfunctions and are excellent tools for training on troubleshooting techniques.

The mechanical maintenance training facility, intended for on-the-job training is located inside the radiological controlled area. The inventory of mock-ups to train the most critical work sequences, especially from the ALARA standpoint, includes a steam generator bottom section, special valve types (disassembly/reassembly), part of reactor vessel and adjacent wall to train on replacement of rupture plate special seals.

*Formal authorization before assigning certain persons*

A formal authorization issued by the regulatory body or by another body delegated or authorized by the competent authority is required before certain persons are assigned to a designated safety related position. According to NVR 3.2.1, control room operating personnel need to be in possession of a special licence. This is issued once the candidate has completed a specified period of training and passed an examination which is supervised by the regulatory body. The licences are signed by the plant manager and co-signed by the director of the KFD. All training, education, examinations and medical checks of licensed personnel are documented.

There are three levels of control room licences that require renewal every two years:

- reactor operator;
- senior reactor operator;
- shift supervisor.

There is no difference between the qualifications required for operators working on the nuclear side and those working on the turbine side, as the policy is that operators should be fully interchangeable.

*Instructions to plant staff on management of accidents beyond the design basis*

For the management of accidents beyond the design basis an emergency plan is implemented and agreed with the authorities. Instructions from the emergency procedures are applied. From these are initiated for example the symptom bases procedures and the Severe Accident Management Guidelines (both originally from the Westinghouse Owner's Group). In addition the emergency staff in case of an incident can use the software package WINREM which features a reliable model for the dispersion of radioactivity and the calculation of the potential consequences of accident releases.

## ARTICLE 12. HUMAN FACTORS

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**12. Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.**

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### 12.1 Introduction

Human Factors (HF) are all those factors where the interface between humans and technology plays a role. They consist basically of two elements: internal factors such as talent, competence, professional skills, motivation, stress resistance and situational flexibility, and external factors such as work environment, actual and potential process control, procedures, training and education, accessibility of components and automation. The emphasis in the design of man-machine interfaces is on the external factors.

Although man-machine interfaces have always played a role in the design and operation of complex machinery such as nuclear power plants and aircrafts, it is only in recent decades that they have become part of the evaluation and attention processes and as such are widely recognised. With the development and performance of PSAs, systematic data collection and structural modelling have become part of the process of evaluating Human Factors.

### 12.2 Legislative aspects of HF

Human Factors play an important role in nuclear safety. The Dutch rules and guidelines (NVRs) referenced in the licence of Borssele NPP – especially those in the Quality Management and Operation series – do take account of Human Factors, as do the original IAEA Codes and Safety Guides. In Safety Guide Q10, Quality Assurance in Design is stated:

*‘Suitable working environments shall be provided and maintained so that work can be carried out safely and satisfactorily without imposing unnecessary physical and psychological stress on personnel.’*

Since the NVRs are part of the licence, the licensee is required to give full consideration to Human Factors.

### 12.3 New developments on HF

When the control room was completely rebuilt at Borssele NPP in 1997, the optimisation of man - machine interface in the main control room was performed with active participation of the control room personnel. This is a good example how the staff can contribute to the process of safety improvements in their own working environment. The increase of reportable incidents in 2006 amongst other things has led to a special three year program at the Borssele NPP on Human Performance and Safety Culture (HP&SC program) to enhance its performance. In the second half of 2008 the WANO-report also revealed a number of HP&SC issues to be resolved. Therefore the program was further increased and will last at least for another couple of years. In 2007 the licensee and the regulatory body agreed on having a meeting every year to discuss improvement plans and the progress and developments in this area.

The most interesting HP&SC actions that have been implemented at NPP Borssele in the last three years were:

- In the Operations Department, a human performance (HP) programme is carried out and shift leaders have been trained to reinforce human performance, team spirit and problem resolution.
- Based on Lufthansa guidelines, in partnership with Essen Simulator Training Centre (in Germany) so called FORDEC guidelines have been developed for a safe conduct of operations in the control room.
- Periodic field tours for management, intended to check the equipment, have been reviewed to focus more on the work practices. Managers are now expected to be in the field with the technicians to improve the vertical communication, detect potential problems and check if the management expectations are well understood and met.
- A strong communication is also made to promote safe work practices with the ‘issue of the month’ published in the company magazine, in the team meeting (‘toolbox meeting’) and with posters around the plant.
- The manuals describing the Management Expectations are being issued and taught in classes.
- TV-like displays are mounted on 3 places in order to better highlight important topics.
- Management will be further and specifically coached on leadership, with the purpose to enhance the HP&SC.
- As a consequence of all of the above, staffing is reconsidered.

Both the regulatory body and the licensee are considering an adequate method to monitor the safety performance by a set of indicators, periodic external audit or a combination of both. In September 2010 the follow-up of the WANO-review takes place. The safety culture audit planned by the regulator in 2009 is postponed to the beginning of 2011.

#### **12.4 Human factors in incident analysis**

The evaluation method to be used when inspecting and assessing the influence of Human Factors on incidents needs to be based on a well-proven systematic approach. The method being used since 1992 by the Dutch licensees and regulatory body is the original American method known as the HPES (Human Performance Enhancement System).

At the Borssele NPP all information on event reports and analysis results and near miss reports is accessible for everyone through the intranet. The categories ‘written procedures’ and ‘personnel work practices’ are causing most human errors. Lessons learned or corrective actions from operating experience can lead to corrections or enhancements of the work instructions or the lessons learned from individual events or trend analysis can lead to a toolbox meeting e.g. to raise the awareness about the human factor in events. For operations personnel, the feedback on operating experience is part of the yearly refresher training which is also attended by other people. Some statistical information derived from the annual report, lessons learned and important external events are on the agenda of that training.

In the Netherlands, licensees address the subject of Human Factors in their annual reports. Good examples are the licensees of the Borssele NPP (licensee: EPZ) and the High Flux Reactor in Petten, (licensee NRG, owner European Union).

#### **12.5 Human factors in organisational changes**

Several of the licensees are (or have been) engaged in processes of organisational change, often paralleling changes in their hardware. Recently a significant reorganization was finished at the Borssele NPP in 2005. The reorganization meant to clarify the responsibilities; to shorten the management lines; to improve cross functional functions (particularly during outage); and anticipate and adjust the resources accordingly.



The reorganization process put some pressure on the relationship between management and employees. The main reason for this was the limited scale on which employees were involved. The management has started a company culture programme and carried this out in 2007-2008 to improve this relationship.

Since 2006 - after the decision of the government to agree with an extended operating life - the plant is preparing for the future with an increased number of programmes. During the last years it was noticed more frequently that staff shortages in several areas emerged. It also became apparent that management should spend more time to supervision to solve structural or longer lasting issues. The plant management now is taking a number of steps to improve the situation:

- Improvement of the lack of resources;
- More proactive resources planning
- More delegation to improve management availability to lead and supervise;
- More involvement of and communication with all staff.

### **12.6 Fitness for duty**

In the Netherlands there are several laws that regulate the protection of the health and safety of employees. Examples are the law on working hours ('Arbeidstijdenwet') with the aim to keep personnel fit for duty and a specific law focused on a safe and healthy work environment ('Arbo-wet').

The nuclear safety rules require specific medical tests:

- Under NVR 3.2.1, control room operating personnel need to be in possession of a special licence. This is issued once the candidate has completed a specified period of training and passed an examination and medical test. The medical test is repeated every twelve months.
- Under NVR 2.2.5, all site personnel who may be occupationally exposed to radiation at the nuclear power plant shall be subjected to an initial and to periodic medical examinations as appropriate.

The management of the Borssele NPP in 2009 introduced alcohol and drugs test.



## ARTICLE 13. QUALITY ASSURANCE

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**13. Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.**

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### 13.1 Introduction

The quality assurance programmes originally formally introduced at the nuclear installations in the Netherlands were based on the first IAEA Safety Series on QA. They have since been modified in line with international developments. A description of the initial period, the development of the programmes and cooperation between the parties involved was given in the Netherlands' first and second national reports on compliance with the Convention on Nuclear Safety.

In the nuclear sector, there has been a change of policy in the form of a shift from simply complying with a set of rules towards performance-based Quality Management Systems (QMSs) accompanied by processes of continuous improvement.

The importance of good safety management at nuclear installations is well recognized in the Netherlands. The aim of safety management is to formulate good safety policies for the relevant installation and this includes ensuring that the reasons, effects and consequences of those policies are communicated downwards to every level in the organization.

### 13.2 Regulations

The rules and guidelines used by the regulatory body in the Netherlands are still based on the requirements and safety guides in the IAEA Safety Series (50-C/SG-Q), where necessary amended for specific use in the Netherlands. A project to update the NVRs to the latest IAEA-standards is underway. More about the update can be found in section 7.2. (i).

In the explanatory memorandum of Article 37b of the Nuclear Energy Act it is stated that the licensee must operate a nuclear facility in a manner that reflects the most recent safety insights. This statement is especially applicable to safety management because safety management is an area that is developing rapidly. The latest known insights are not specifically covered by current regulations. In the near future there will be a proposal to actualise the regulation on this topic based on recently published IAEA requirements and guides on safety management<sup>8</sup>.

One of the major adaptations in the Netherlands reflects the realisation of the importance of software (organisational) modifications and takes the form of a requirement to inform the regulatory body in advance of any organisational modification that may directly or indirectly influence nuclear safety. Like hardware modifications, major organisational changes require the approval of the regulatory body and the licensee's application for this must be accompanied by a safety analysis. UK licence condition no. 36 has been used as a guideline in drawing up this requirement.

### 13.3 The QMS at the licensee

The quality management programmes at the nuclear installations were originally based on the old Dutch NVRs and were subject to regular audit by the regulatory body. Together with the licensees'

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<sup>8</sup> GS-R-3; Management System for Facilities and Activities (Safety Requirements) and GS-G-3.1; Application of the Management System for Facilities and Activities (Safety Guide).

self-assessment activities, they gave the regulatory body a good insight into the current state of affairs. As from 1998 onwards, the Borssele NPP is the only operating nuclear power plant in the Netherlands and as such the main focus of attention in with respect to Quality Management Systems.

Over the last few years, the policies and elements of the revised IAEA QA Safety Series have been introduced in close consultation and cooperation with the management of this plant. Performance-based quality assurance has required a modification of the plant's written processes and instructions, together with a change in attitude on the part of management and staff. The use of critical success factors and of performance indicators has led to a process control based on more quantitative criteria. The interfaces with safety culture and safety management have added to the complexity of the introduction of the new QMS.

The interface of the QMS with Human Factors is important too. One aspect is the minimum staffing level for the various sections of a licensee's organisation.

Specific attention also needs to be paid to the subject of outsourcing. Criteria for what is acceptable in this area appear to differ very widely in the various countries of the OECD/NEA. Some countries like the Netherlands have at present almost no specific official criteria. Others have made provisions in general terms or even have defined specific regulations or guidelines to manage outsourcing. International cooperation and exchange of knowledge and experience may lead to a better understanding of these problems in the near future, which may lead to a set of criteria and/or regulations for the Netherlands.

The lifetime extension of the Borssele NPP has prompted the licensee to plan for the transformation of the QMS into a genuine Safety Management System (SMS) in the next three years.

#### **13.4 The QMS at the regulatory body**

As described in the Netherlands' earlier national reports on compliance with the CNS, the inspection branche (the KFD) of the regulatory body is subject to a requirement to execute its tasks in conformity with a quality assurance programme. Until recently, this programme was based on the 1994 version of ISO 9001. Both the IAEA and the ISO subsequently revised their QA standards, leading to the IAEA 1996-suite of standards and the 2000 version of ISO 9001. These new standards were produced in cooperation of ISO and IAEA and are based on the same principles. The industry-based ISO standard was more appropriate for the work of the regulatory body than the IAEA programme, the latter being exclusively safety-based. The ISO standard requires a QMS that is performance-based. In mid-2004 the KFD obtained the ISO 9001 version 2000 certificate.

Several years ago it was decided not to prolong the certificate, but to integrate the QMS with the existing system of VROM-Inspection. This should lead to a more simplified QMS in 2011.

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## ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY

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### 14. Each Contracting Party shall take the appropriate steps to ensure that:

- i. **comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;**
  - ii. **verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.**
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#### 14.(i) Assessment of safety

##### *Regulatory requirements*

In the Netherlands, a licence is needed for the construction or modification of a nuclear installation and for the operation beyond the design life. Such a licence is only granted if the applicant complies with (among others) the NVRs on Design, Operation and Quality Assurance (see Appendix 5) and with the probabilistic safety criteria. These criteria include dose-frequency constraints within the design-basis envelope. Appendix 1 gives a detailed overview of the probabilistic safety criteria.

The NVRs are fairly general and lack the technical detail found in national nuclear regulations of some other countries. In addition there are no nationally developed nuclear codes and standards in the Netherlands. Therefore additional material is needed to define the licensing basis. This includes parts of e.g. the US Code of Federal Regulations, the US NRC Regulatory Guides, the US NRC Standard Review Plan, the ASME code, the ANS/ANSI standards, KTA standards, and RSK recommendations. These documents have no formal status in the Netherlands. The NVRs require the applicant to specify and defend the technical basis and industry standards he is going to use. In this process, the regulatory body expects the applicant to demonstrate that:

- the chosen set of foreign regulations and industry standards are consistent with the relevant NVRs;
- if more than one set of standards or regulations is to be applied, the various sets should be consistent.

The section on Article 7 gives a more comprehensive overview of the applicable legislative framework.

To support his licence application, the licensee shall draft (among others) a Safety report (SR) and a Safety analysis report (SAR), which he shall submit to the regulatory body with the application. The SR is the report that is attached to the licence, and as such it is a public document. It describes the organisation, the design, the outcomes of the safety analyses, etc. into some detail. The SAR gives a more detailed description of the proposed facility and presents an in-depth analysis of the way in which it complies with the NVRs. Its claims are supported by detailed descriptions of the safety analyses, simplified system diagrams, and other supporting documents. To illustrate the difference between SR and SAR: the Borssele NPP SR is a two-volume document, whereas the associated SAR is a twenty-volume document. Both documents are updated with each modification of the installation.

The SAR is supported by a Probabilistic Safety Analysis (PSA), comprising levels 1, 2 and 3 (see Appendix 3). The PSA – in particular the level-3 part of it – is needed to demonstrate that the facility meets the probabilistic safety criteria as laid down in the regulations (Bkse, see section on Article 7).

#### *Review by the regulatory body*

The regulatory body (mainly the inspection branch, the KFD) studies the SAR in depth. The underlying and supporting documents are also reviewed in depth to ensure that the regulations have been met. In the review process, selected items are analysed with computer codes other than have been used for the original analyses provided by the licensee. Often, assessments of similar power plants performed by a foreign regulatory body are also considered.

Since the KFD is a small organisation, it often seeks the help of Technical Support Organisations (TSOs) like GRS, AVN and TÜV.

The KFD has asked the IAEA to provide support to ensure the proper assessment and review of PSA results. The IAEA has undertaken peer reviews of the PSAs (the IPSART missions, formerly known as IPERS missions) and has given training courses in PSA techniques and PSA review techniques. Appendix 3 provides further information both on the role of the PSA in relation to safety assessment and on the associated regulatory review and guidance.

Once the reviews and regulatory assessments have been completed and it has been established that the applicant is acting in accordance with the rules, regulations and radiological safety objectives, the licence can be granted. The main elements of the assessment are documented, as required by the regulatory body's internal QA process.

#### *Periodic Safety Reviews (PSRs)*

One of the conditions of the licence is that the safety of the nuclear installation is to be periodically reviewed in the light of operating experience and new insights. A review of operational aspects must be performed once every two years, whilst a more comprehensive review must be conducted once every 10 years. The latter may involve a review of the plant's design basis in the light of new developments in research, safety thinking, risk acceptance, etc. The policy on the fundamental review is documented in Appendix 2 (Policy Document on Back-fitting). This document was established in 1989. It should be noted that this policy has not been formally adopted, but is used by the regulatory body as guidance and has been accepted by the licensee. It is considered to introduce formalised guidance on this subject in the near future. The guidance would be based on international practice.

#### *# First 10-yearly Periodic Safety Review*

In the late 1980s, mainly as a result of the Chernobyl accident, the Dutch government formulated an accident management and back-fitting policy for the two NPPs in operation at the time. Both utilities were asked to upgrade the safety of their plants by incorporating state-of-the-art features and investigations of possible ageing, and hence to guarantee safe operation in the next decade. With the aid of the respective reactor suppliers, the two utilities developed a new safety concept for their plants in the early 1990s. The safety issues were very much related to lack of separation, lack of redundancy and lack of resistance against external events. This first formal ten-yearly safety evaluation of the Borssele NPP has resulted in the MOD-modification project. This project, which was concluded in 1997, has led to a level of safety that complied with the current risk standard of the Dutch government. For this purpose, major investments have been made, mainly for spatial separation of redundancies (mostly concerning design aspects) and to a lesser extent for Organisational, Personnel and Administrative (OPA) provisions.

In Annex 1 of this national report of the Netherlands, a detailed description is given of the modifications of the Borssele NPP resulting from this first 10-yearly periodic safety review.

### *# Second 10-yearly Periodic Safety Review*

In the beginning of 2004 a second ten-yearly safety review of the Borssele NPP was finalised. It included a safety evaluation of the period 1993-2002, the drawing-up of proposals for adaptations of the technical, organisational, personnel and other provisions to achieve state-of-the-art conformity, as well as the implementation of the proposed measures. This second ten-yearly safety review results in a fine-tuning of the safety concept of the plant rather than major changes.

Specific attention in this safety review was paid to:

- International developments and views relating to e.g. back-fitting programmes and other reactor designs;
- Ageing, including selection of the Structures, Systems and Components to be reviewed and ageing management;
- State-of-the-art PSA analyses;
- Evaluation of good practices;
- Safety analyses with respect to external conditions;
- Accident management and severe accidents;
- Fire protection.

In Annex 1 an overview is given of the most important technical, organisational, personnel and administrative measures due to the evaluation. Some measures were implemented in a slightly different but agreed way due to increased understanding of processes and phenomena in the phase of detail-engineering.

### *# Third 10-yearly Periodic Safety Review and Long Term Operation*

According to the licence the licensee must issue a third 10-yearly safety review in the beginning of 2014. The present Safety Report contains a statement that the design of the plant is based on an operating period of 40 years starting from 1973. Therefore the licensee must apply for a licence approving Long Term Operation (LTO) supported by sound evidence that the plant can be safely operated for a longer period. It was decided between the regulatory body and the licensee not to combine the two subjects but to execute two complementary projects, each having its own time frame. The LTO project must result in a licence application that should be submitted for regulatory review in the second half of 2011 in order to complete its processing before the end of 2013.

The LTO project will cover among others:

- The so called preconditions referenced in IAEA Safety Report Series 57, like adequate programs for maintenance, in-service inspection, surveillance, chemistry and equipment qualification;
- The assessment of design calculations and safety analyses containing time related (40 years) assumptions;
- The ageing assessments and ageing management programs;
- A number of non-technical issues in the area of organisation, administration and human factors.

As part of the coming periodic safety review the whole set of deterministic safety analyses will be renewed with state-of-the-art thermo-hydraulic and severe accident codes.

### *Safety Assessments related to modifications*

Significant changes to the installations that imply changes to the design assumptions, as laid down in the safety report, require a licence. New safety analyses have to be performed to demonstrate that the safety impact of these modifications remain within the prescribed limits. An example of a change requiring a safety analysis is the following.

In the late nineties the safety report and some safety analyses were updated when the licensee of the Borssele plant submitted a request for a modification of the licence in order to be able to use higher

enriched fuel elements (from 3.3% up to 4%). External experts were consulted for the review. There was special emphasis on issues associated with high burn-up fuel in relation with prevention of reactivity insertion accidents (RIA-accidents). The review was repeated at the end of 2003. A modification of the licence was requested to use 4,4% enriched fuel and a burn-up limit for fuel rods averaging 68 MW day/kg U by using the new Niobium-Zirconium cladding material M5 (Framatome) with an improved corrosion behaviour. Up to now the average burn-up of the fuel never exceeded 60 MW day/kg U due to the constraints (heat, radiation) imposed by the specifications of the spent fuel containers. The power plant will provide additional tests of the fuel quality before going from 60 to 68 MW day/kg U for the whole core.

*Safety assessments initiated by the licensee – audits and peer reviews*

Apart from the assessments of the impact of proposed operational or design changes on safety or the periodic safety reviews, which are both regulatory and institutionalised requirements, the licensee regularly performs self-audits, or requests audits or peer reviews by others in order to evaluate its own operation. In particular the Organizational, Personnel and Administrative aspects of operation are subjects for these audits and peer-reviews. Examples of this practice are the WANO-Peer Reviews in 1999 (see Article 10) and a second OSART mission to the Borssele NPP in 2005. At least every 10 years there will be an OSART mission at the NPP. The licensee has communicated its plan to increase the number of international missions to once in about three years.

An important aspect in the assessment of safety is the ability of the assessor to make use of the state-of-the-art. Therefore, experts of the licensee participate in audit and peer-review teams of IAEA and WANO to evaluate other plants. The insights gained from these participations are used in their assessment work at Borssele NPP.

At Borssele NPP, the internal safety review of technical and organisational modifications is organised as follows:

- *Technical*: All aspects of technical modifications relevant to safety are documented in a 'Modification Plan'. This report is verified by all relevant specialists. After their comments have been taken into account, the report is independently reviewed by staff in the Safety Design Department. Once accepted by this department, the original report and the independent review report are sent to the Internal Reactor Safety Committee to advise the Plant Manager for authorisation. The last step in the review is an assessment under the authority of the regulatory body. In the case of minor modifications likely to have no impact on safety, a simplified procedure is applied.
- *Organisational*: Proposals for organisational modifications are prepared by the Human Resources Management Department. The final proposal is outlined in a report describing the changes relating to the organisation (structure, tasks/responsibilities, systems, documents, staffing and potential associated impact on nuclear safety). The (internal) independent nuclear safety officer checks the final proposal against all the organisational requirements laid down in the licence, NVRs (amended IAEA codes and guides) and other relevant regulatory documents and produces a report on his findings. The two reports (the final proposal and the independent verification) are then reviewed by the internal and external reactor safety committees of the Borssele NPP before being submitted to the authorities

**14.(ii) Verification by analysis, surveillance, testing and inspection**

In general, the licensee is responsible for inspecting and testing all NPP equipment and systems in order to guarantee their safe operation. The regulatory authority checks that the inspection and test programme is adequate for this purpose.

The relevant NVRs are 2.2.2 for in-service inspection, 2.2.3 for periodic testing according to the 'Operational Limits and Conditions' (also known as Technical Specifications), 2.2.8 for surveillance



and 2.1.2 for fire protection. In addition, the licence requires that the Borssele NPP has a control system for monitoring wear and tear on all components and structures which are important to safety, so as to enable plant management to take appropriate action in good time. A specific department at the Borssele NPP reviews information on ageing of structures, systems and components (SSCs). This includes internal information (maintenance, in-service inspection etc.) and external information (event reports on ageing, direct information from other plants etc.). This experience feedback programme operates in addition to the existing programmes involved in ageing management (surveillance, maintenance, chemistry etc.).

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. Refer to section 7.2(i) for recent developments with respect to these types of inspections.

The KFD conducts regular inspections and audits to check the other inspection and test activities at the power plant.

The current licence of the Borssele NPP includes a requirement that a Living PSA (LPSA) is operational. The reason for this is that the regulatory body recognises an LPSA as being a suitable and sufficiently mature instrument of analysis to support certain aspects of safety-related decision-making in matters of design or procedures. These LPSA applications can reveal the effects of apparently insignificant changes in design or operating procedure. The requirement in the licence is qualitative. It means that the PSA must reflect the latest configuration of the plant and that the PSA must be used by plant staff when making safety-related decisions. In that respect, the NPP uses a risk monitor, e.g. for configuration control during outages.



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## ARTICLE 15. RADIATION PROTECTION

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**15. Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.**

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### 15.1 Radiation protection for workers

#### *Current legislation*

As stated in the section on Article 7, the basic legislation on nuclear activities in the Netherlands is the Nuclear Energy Act. A number of Decrees have also been issued, containing more detailed regulations based on the provisions of the Act. The most important Decrees in relation to the safety aspects of nuclear installations and the radiological protection of workers and the public are:

- the Nuclear Installations, Fissionable Materials and Ores Decree (Bkse); and
- the Radiation Protection Decree (Bs).

These Decrees are fully in compliance with Council Directive 96/29/Euratom establishing basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation.

Bkse requires the licensee of every nuclear power plant to take adequate measures for the protection of people, animals, plants and property. Article 31 of Bkse states that a licence must contain requirements aimed at as far as possible preventing the exposure and contamination of people, animals, plants and property. If exposure or contamination is unavoidable, the level must be as low as is reasonably achievable. The number of people exposed must be minimised, and the licensee must observe the individual effective dose limits.

Bkse also states that these activities must be carried out by or under the responsibility of a person judged by the regulatory body to possess sufficient expertise. This expert must occupy a post in the organisation such that he or she is able to advise the management of the NPP in an adequate way and to intervene directly if he or she considers this to be necessary.

Written procedures must be available to ensure that the radiological protection measures that have to be taken are effective and to ensure that the aforementioned expert is properly informed. Full details of these conditions are given in the Radiation Protection Decree (Bs), which also lays down more specific requirements for the protection of people and the environment from radiation.

In conformity with the Euratom basic safety standards, the Radiation Protection Decree stipulates a limit of 20 mSv per annum as the maximum individual effective dose for radiological workers. In practice, no cases have been recorded which exceeded the 20 mSv per annum standard. If a problem should occur, there is an article in the Radiation Protection Decree that permits a higher dose in exceptional situations subject to stringent conditions. To date, the nuclear installations in the Netherlands have never experienced such a situation.

#### *Implementation by the licensee, Borssele NPP*

The licensee has set a dose constraint of 6 mSv per annum as the objective for the individual effective dose limit for radiological workers at the Borssele NPP. The licensee furthermore applies a 5 years average of 3 mSv per annum (meaning that a radiological worker who receives a dose of 7 mSv during a particular year should receive less during subsequent years, until his average dose is no higher than 3 mSv per annum).

The average effective individual dose for both in-house personnel and externally hired personnel at the Borssele plant has shown a decreasing trend since 1983. The average effective individual dose over the last two years has been about 0.5 mSv per annum. Over that period, the trend in the collective dose has been very similar to that of the individual doses. In the early eighties, the total collective dose amounted to 4 manSv per annum. Over the two decades it decreased to about 0.3 manSv per annum. See Annex 1 for details.

One of the conditions of the licence issued to the Borssele NPP is that the manager responsible for radiation protection should be adequately qualified. The person in question is also required to hold a sufficiently independent position in the organisation to allow him to advise the plant or site manager directly on all matters of radiation protection. A precise description of the requirements for this manager's qualifications, as well as the qualifications which a number of other radiation protection officers need to possess, is given in the Technical Specifications (TS). The appropriate training programme covers the qualifications of the other officers.

#### *Personal dosimetry records*

Article 90 of the Bs requires that the operator records doses incurred by each exposed worker using personal dosimetry. As regards personal dosimetry no distinction is made between Category A and B workers. Only by the Ministry of Social Affairs and Employment (SZW) approved dosimetry services are allowed to provide dosimeters, to assess the received dose and to manage the dose records of exposed individuals.

Dose summaries of all dosimetry services are made available to the National Dose Registration and Information System (NDRIS). NDRIS has been established in 1989 by the Ministry of Social Affairs and Employment and had as main objective to preserve dosimetric data for the period required by the Euratom Basic Safety Standards as well as bring together all data from all registered radiation workers, including those of foreign workers whose data are identified through the radiation passport.

NDRIS is managed by NRG, department of Radiation & Environment. In the beginning only data from individuals employed at institutes which had subscribed to the dosimetric services of NRG (and its predecessors) were collected but gradually also data from other approved dosimetric services were added. In 1994 and 2002 respectively, NDRIS was extended with data from external workers and with data from aircraft crew. NDRIS generates statistical data with the following features:

- personal data
- social security number
- dosimetric data
- branch of industry (e.g. hospitals, nuclear industry)
- job category (e.g. veterinary X-ray diagnostics, radioactive waste treatment)

NDRIS is designed to process the collected data, to make statistical analyses of the recorded doses and to present various cross-sections for management purposes. It enables employers to collate information on occupational doses and to optimise operational radiation protection.

The yearly average occupational dose and the yearly collective dose at Borssele NPP, shows a trend of continuing decrease in radiation exposures. Refer to Annex 1 for details.

### *Reporting of worker doses*

The current licence requires that the licensee monitors, quantifies and registers all relevant radiological data. It also specifies the situations in which (and the terms on which) it must inform the regulatory body. Another example of a 'radiation protection' requirement in the licence is the licensee's obligation to monitor and record the radiation levels and levels of contamination at those locations where workers may receive an effective dose of 5 microSv or more in less than one hour.

Workers who work in places where there is a risk of internal contamination must be checked for this at least once a year. The results must be documented and kept for inspection purposes.

The licensee is required to report to the regulatory body every three months the individual doses received by workers who work at locations where they are exposed to an effective dose of at least 5 microSv in less than one hour. If a worker has received an effective dose exceeding 15 mSv within a period of three months, the licensee must investigate all the circumstances that could have caused this dose level and must inform the regulatory body of the results. These results have to be reported to NDRIS and are being kept in that system for at least 30 years.

The licence also requires the Borssele NPP to comply with the amended IAEA codes and Safety Guides (i.e. the NVRs). In the domain of radiation protection, Safety Guide NVR 2.2.5 complements the requirements set by the Radiation Protection Decree (Bs), and lays down more specific requirements for:

- the lay-out of the controlled zones;
- the facilities within the controlled zones;
- staff qualifications and training; and
- the radiation protection programmes.

In order to comply with all the radiological conditions, the licensee must have adopted adequate procedures for the implementation of such a radiation protection programme. The regulatory body inspects the site to check the effectiveness of these procedures.

Prior to any reactor outage, the licensee must give the regulatory body an estimate of the anticipated collective dose. Once the outage activities have been completed, the licensee must produce a dose evaluation report and inform the regulatory body of the results.

If the anticipated collective dose relating to any job exceeds 10 man-mSv or the maximum individual effective dose is greater than 3 mSv, the regulatory body will request the licensee to produce an ALARA report showing that it has indeed taken the best possible radiation protection measures. The ICRP-60 publication is used as a guideline for this optimisation process. The criteria or considerations for submission of ALARA reports are based largely on a qualitative judgement rather than a quantitative assessment. The choice of the 10 man-mSv limit is pragmatic and is motivated by the legal difficulties concerning the definition of a specific job and the dose history associated with previous jobs.

## **15.2 Radiation protection for the public**

The licence of the Borssele NPP requires it to comply with the amended IAEA codes and Safety Guides (i.e. the NVRs). The Safety Guide NVR 2.2.5 (Radiation Protection) and NVR 2.2.11 (Radioactive Waste Management) complements the requirements set by the Radiation Protection Decree (Bs). More specific requirements are laid down in the Technical Specifications of the NPP. Also refer to Annex 1 'Technical details of the Borssele NPP'.

The monitoring of all discharges in air and water has to comply with the German regulations 'Sicherheitstechnische Regel des Kerntechnischer Ausschuss (KTA) 1503 and 1504'. The actual releases are normally less than 5% of the discharge limits (Annex 1).

The design of the installation is the first step towards achieving the radiological safety objectives. The Safety Report (SR) must demonstrate that the design of the plant and planned operational conditions and procedures conform to these objectives. In addition, the radiation dose received by members of the public due to the operation of the NPP, including the discharges of radioactivity in water and air, must be controlled and optimised (ALARA) whenever the plant is in an operational state.

In article 48 of the Bs a source constraint amounting to one tenth of the annual effective dose limit for the population has been set for any facility. Both the licensee (Borssele) and an independent institute (State Institute for Public Health and the Environment, RIVM) monitor the radiation levels at the border of the establishment continuously.

As prescribed in the licence, all discharges of radioactive effluents must be monitored, quantified and documented. The licensee must report the relevant data on discharges and radiological exposure to the regulatory body. On behalf of the regulatory body, the National Institute for Public Health and the Environment (RIVM) regularly checks the measurements of the quantities and composition of discharges.

The licensee is also required to set up and maintain an adequate off-site monitoring programme. This programme normally includes measurements of radiological exposures (with Thermo luminescence Dosimeters, TLDs) and possible contamination of grass and milk in the vicinity of the installation. The results are reported to – and regularly checked by – the regulatory body. Under Article 36 of the Euratom Treaty, the discharge data must be submitted to the European Commission each year. The discharge data are also reported to OSPAR, the Convention for Protection of the Marine Environment in the North-East Atlantic.

The framework for off-site nuclear and radiological emergency response, is described in the text under Article 16.

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## ARTICLE 16. EMERGENCY PREPAREDNESS

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**16.1 Each Contracting Party shall take the appropriate steps to ensure that there are on site and off site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.**

**16.2 Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.**

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### 16.1 Emergency plans

There are no statutory regulations in the Nuclear Energy Act requiring the presence of an on-site emergency preparedness plan. However in the licence conditions, reference is made to relevant guidelines, like the Code on Operation, NVR 1.2, Ch. 11 and NVR 2.2.6 'Preparedness of the Operating Organization for Emergencies at Nuclear Power Plants'. Licence condition 23 of the Borssele NPP requires the licensee to establish and maintain an emergency plan and an emergency organisation, and also to ensure that exercises are conducted regularly. The on-site emergency plan and emergency organisation must be consistent with the off-site emergency planning.

There are certain statutory regulations on off-site emergency planning and the actions that shall be taken in the event of an emergency at a nuclear power plant. The National Nuclear Emergency Management and Response Plan (NPK<sup>9</sup>) provides the framework for off-site nuclear and radiological emergency response in The Netherlands. In 2010 an update of the NPK was published. Preparation and implementation of specific Nuclear Emergency Management and Response plans on national, regional and local level, is the responsibility of the national and the regional or local governments.

#### 16.1.a On-site emergency provisions

An on-site emergency plan includes a specific emergency organisation with adequate staff, instructions and resources.

The emergency plan has three principal goals:

- to ensure that the operating organisation of the NPP is prepared for any on-site emergency situation;
- to mitigate as much as possible the effects on the operating personnel of the NPP and on the environment in the vicinity of the plant;
- to advise the relevant governmental bodies as effectively as possible on emergency actions that should be taken.

Specific procedures have been developed and adopted in order to prevent emergency situations and mitigate their consequences. With respect to the operation of the plant in abnormal situations, two types of emergency procedures exist:

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<sup>9</sup> Nationaal Plan voor de Kernongevallenbestrijding, NPK

- procedures for abnormal situations (incidents); and
- procedures for emergency situations, i.e. the symptom-based emergency procedures or ‘function-restoration procedures’ that are applicable in design-basis and beyond-design-basis accidents.

An important help for the on-site emergency provisions is the use of Severe Accident Management Guidance (SAMG), which is a system of written guidelines to guide the plant management and operating staff through all stages of a core melt accident until a final stable state has been reached. The development and implementation of the SAMGs were completed in 2000.

The incident/accident classification system used by the Borssele plant is in line with the classification system used in the National Nuclear Emergency Management and Response Plan (NPK). This, in turn, corresponds to the IAEA emergency classification system, incorporating: ‘Emergency Stand-by’, ‘Plant Emergency’, ‘Site Emergency’ and ‘Off-Site Emergency’. The various types of emergency procedures, and the emergency plan and the emergency organisation of the operating organisation, are sent to the regulatory body for review and approval.

If an emergency occurs, the plant management must inform the relevant authorities immediately, advise them of the classification of the accident, and provide whatever information is required in order to assist the KFD to assess the nature and potential consequences of the accident, to determine the potential for mitigating its effects and to make a prognosis of potential radioactive discharges. Real-time data and process information is available to the ministry of VROM and its inspection branche, the KFD. This is part of the plant information supplied to the KFD during an emergency. The regulatory body has a strict 24/7 schedule to secure the availability of KFD during any actual or potential accident or serious incident.

#### *Training of the emergency organisation*

The training requirements are described in the various procedures and in the manual on emergency drills. The plant management is required to provide a schedule of regular emergency drills and classroom training. A part of the obligatory training plan for shift staff is devoted explicitly to teaching them how to deal with emergencies. Larger-scale emergency exercises are also held about once every four to five years, although the intervals between them are not fixed. These exercises incorporate the participation of the various government organisations at local, regional and national levels, like the National Crisis Centre, NCC. The last full-scale exercise was in May 2005, the next full-scale exercise will be in 2011.

During these exercises, KFD inspectors assess the performance of the plant emergency organisation and observe whether established procedures have been properly followed.

#### **16.1.b Off-site emergency provisions**

Chapter VI of the Nuclear Energy Act describes the responsibilities and tasks of the authorities that are responsible for preparing and managing the organisation for dealing with emergencies of (among others) nuclear power plants. Under Article 40 of the Act, central government carries the bulk of the responsibility both for the preparatory work and for actually dealing with any emergency that may arise in practice. The operational structure of nuclear emergency preparation and response is embedded in the National Nuclear Emergency Plan (NPK). The NPK organisation consists of the following structures/groups:

- A National Warning Point (NWP) at the ministry of VROM to which all nuclear incidents and accidents (and other environmental incidents) are reported. This centre is staffed and accessible 24 hours a day. This NWP is part of the departmental crisis coordination centre of the ministry of VROM.
- A policy team at the National Crisis Centre (NCC) of the ministry of the Interior and Kingdom Relations. This team decides on the countermeasures to be taken to mitigate the consequences of



the accident. It is composed of ministers and senior civil servants, and chaired by the minister of Housing, Spatial Planning and the Environment or the minister of the Interior and Kingdom relations.

- The national nuclear assessment team, EPAn<sup>10</sup>. This team advises the policy team whenever 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). The 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 foodstuffs. It is located within the National Institute for Public Health and the Environment (RIVM). RIVM operates the national radiological monitoring network (NMR<sup>11</sup>) and in addition monitoring vans. It also collects data from other institutes. Alongside the radiological experts, 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 accident site to support the emergency organisation.
- The national information centre, the cluster Risk- and Crisis communication of the NCC (NCC/cRC<sup>12</sup>), is located within the ministry of the Interior and Kingdom relations. This centre is responsible for the coordination of information to be supplied to the public, the press, other national and international authorities and specific target groups, such as farmers.

Under Article 41 of the Act, the local authorities also have a responsibility in making regional/local contingency plans for emergencies. The mayors of municipalities liable to be affected by accidents involving nuclear power plants located either within their boundaries or in their vicinity (including those across national borders) have established emergency contingency plans in consultation with representatives of central government (e.g. VROM). These plans are obligatory under Article 3 and others of the Disasters and Major Accidents Act<sup>13</sup>, and encompass all measures that need to be taken at both local and regional levels. Exercises are also held at regular intervals.

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<sup>10</sup> Eenheid Planning en Advies nucleair, EPAn

<sup>11</sup> Nationaal Meetnet Radioactiviteit, NMR

<sup>12</sup> Nationaal CrisisCentrum, cluster Risico- en Crisiscommunicatie, NCC/cRC

<sup>13</sup> Wet rampen en zware ongevallen, Wrzo

*Intervention levels and measures*

The following measures are to be taken at the various intervention levels:

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Measure	Intervention level
Preventive evacuation:	1000 mSv $H_{\text{eff}}$ (24 hours dose)
First day evacuation:	200 mSv $H_{\text{eff}}$ (48 hours)
Late evacuation:	50-250 mSv (first year dose)
Relocation/return:	50-250 mSv (first 50 years after return)
Iodine prophylaxis:	100 mSv (child, 48 h); 1000 mSv (adult, 48 h)
Sheltering:	10 mSv $H_{\text{eff}}$ (48 h)
Cattle grazing prohibition:	5000 Bq I-131 per m <sup>2</sup>
Milk (products), drinking water etc:	500 Bq/l I, 1000 Bq/l Cs, 125 Bq/l Sr, 20 Bq/l alpha emitters.

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The intervention measures and levels have been established by the regulatory body following discussions with national experts in the relevant fields. International expertise and guidelines were also taken into account. There was no direct involvement of other stakeholders because the protection of the public in case of possible emergencies is a primary responsibility of national government. There are also derived intervention levels for foodstuffs, based on the appropriate EU regulations.

The intervention level for the protection of the public varies widely from one country to the next. While awaiting harmonisation directives from the European Commission in this respect, arrangements have been made with neighbouring countries to introduce matching measures in border areas, regardless of any differences in national intervention levels.

Recently Iodine tablets were (pre)distributed to the citizens/households in the emergency planning zones of the NPP Borssele. In the process of predistribution, a special communication campaign was executed. In this region, Iodine tablets are also available at pharmacies and at town halls.

*Dimensions of emergency planning zones for Borssele*

The planning zone covers all municipalities that are involved in the preparation, based on the reference accident-scenario for the nuclear installation. This zone has a radius of 10 km from the Borssele NPP. The mayor of Borssele coordinates the preparatory aspects of the emergency plan and the execution of measures during an accident.

The various zones for countermeasures are defined geographically:

- Evacuation zone: circle with a radius of 2 km
- Iodine prophylaxis: circle with a radius of 10 km
- Sheltering zone: circle with a radius of 20 km.

It should be noted, however, that measures are coordinated at the national level in case of nuclear emergencies. Decisions will be made based on the technical information available during the emergency. The proper emergency zoning will be established, where countermeasures will be taken. In most cases this will be in the planning zone, but when needed it can be outside of this zone.

*Criteria for emergency situations*

Following consultation with the Ministry of the Environment and particularly with the KFD, Borssele NPP has adopted the four classification levels in the IAEA system for use in its Emergency Plan. Each level is associated with incident/accident parameters ranging from a small fire to a large actual off-site release. Difficult elements to capture in the criteria are potential/probable consequences which have not yet occurred but which nevertheless call for larger-scale protection and prevention measures.

The specific parameters are:

1. Emergency stand-by: Emission  $< 10$  \* permitted daily emissions (noble gases; this means for the Borssele NPP  $1.3 \cdot 10^{15}$  Bq Xe-133 equivalent). No intervention levels are reached.
2. Plant emergency: Emission  $\geq 10$  \* permitted daily emissions (noble gases). No intervention levels are reached.
3. Site emergency: Emission  $\geq 0.1$  \* accident emission (the accident emission for the Borssele NPP is defined as  $\geq 3 \cdot 10^{17}$  Bq Xe-133 and  $\geq 5 \cdot 10^{13}$  Bq I-131), or an emission which leads to the lowest intervention level for indirect measures. This lowest level is a soil concentration of 5000 Bq I-131 per  $m^2$ ; at this level a grazing prohibition must be considered. Furthermore, as the  $0.1$  \* accident emission may lead to a dose level of  $0.5$  mSv  $H_{\text{eff}}$  or  $5$  mSv  $H_{\text{th}}$  in the first 24 hours after commencement of the emission, off-site measures may be considered in the form of population sheltering.
4. Off-site emergency: Emission  $\geq$  accident emission, being the emission that leads to the lowest intervention levels for direct measures. These lowest dose level is  $10$  mSv  $H_{\text{eff}}$  in the first 48 hours after commencement of the emission. At this level, population sheltering must be considered.

The emission level at which the 'Emergency stand-by' category changes to the 'Plant emergency' category (the transition point) follows directly from the permitted emission as laid down in the licence. The two other transition points depend, among other things, on the accident emission chosen. Determination of the accident emission is based on an emission of noble gases from the chimney. The reason for not using other nuclides as the trigger is that the classification on the basis of plant status will take place before a certain emission level of the nuclides has been reached; this does not apply to noble gases. In addition, a noble gas emission can be measured directly, and is therefore more suitable as a first trigger than say, an I-131 emission, which can only be measured with any degree of accuracy after a period of around an hour. The Xe-133 equivalent has been adopted as the yardstick for noble gas emission.

*NPK response plan*

Based on the lessons learnt from the National Full Scale Nuclear Exercise of 2005, the arrangements for nuclear emergency management and response were updated in a NPK response plan. This new response plan was published in 2009. The plan describes the structure and responsibilities of the various organizations involved in nuclear emergency management. It also describes the scenarios of potential nuclear and radiological accidents. The key organization managing nuclear accidents is the National Nuclear Assessment Team (EPAn) which operates under the responsibility of the ministry of VROM. The NPK Response plan is available in Dutch only.

In the framework of the NPK Response plan, a long-term strategy for training and emergency exercises was developed. Based on this strategy a yearly schedule for training and exercises has been implemented. Every four to five years a national full scale exercise is planned. The next exercise is planned for 2011.

## 16.2 Provision of information

Chapter VI of the Nuclear Energy Act also deals (in Article 43) with the provision of information to those members of the population who might be affected by a nuclear accident. Consistent with its responsibility for managing the response to a (potential) nuclear accident, national government also is responsible for informing the public. This will be done in close cooperation with the local authorities in the threatened or affected area.

For communication purposes, within the structure of the National Crisis centre (NCC), a national risk and crisis communication centre (NCC/cRC<sup>14</sup>) has been established. In case of a threat or emergency that needs national coordination, and needs the involvement of various ministries, the NCC/cRC will set up a national crisis communication centre to inform the public. Experts from the various ministries will help and support the local and regional Public Information Units based on the recently developed Communication Strategy for Nuclear and Radiological Emergencies. Public information about the potential risks of nuclear power plants and the existing emergency plans is provided by the municipalities (EU directive). The material needed for the information may be provided by central government, as has been the case for the municipalities in the vicinity of the Borssele and Doel NPPs, the latter being in Belgium but close to the Dutch border.

In addition, the website of the Ministry of Housing, Spatial Planning and the Environment [www.vrom.nl](http://www.vrom.nl), has a link to the topic of 'crises', where information can be found on numerous aspects of nuclear accidents. Another part of the site, to be open to the public only in emergency situations, contains a more comprehensive set of relevant questions and answers.

The provision of information to the authorities in neighbouring countries is the subject of Memoranda of Understanding that have been signed with bordering countries. The exchange of technical data (such as monitoring results and modelling-assessments) takes place on a regular basis and in a response-phase between the Netherlands and Germany. With Belgium, the same approach is in preparation and with the United Kingdom, a similar process started. Information exchange at the international level is regulated by the Early Notification Convention of the International Atomic Energy Agency and the European Commission's ECURIE directive on urgent information exchange. On bilateral bases, information about (potential) nuclear or radiological emergencies will be exchanged between the respective national crises-coordination centres also.

In the Regional Nuclear Emergency Plans for nuclear facilities such as the Borssele NPP and the NPP Doel (Belgium) in close bilateral cooperation, arrangements for better and efficient information-exchange and compatibility of countermeasures are being set up. To learn more about national nuclear emergency plans and the approaches for decision making, arrangements are made to exchange observers from bordering countries in case of relevant exercises with NPPs in border areas.

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<sup>14</sup> Nationaal CrisisCentrum, cluster Risico- en Crisiscommunicatie (NCC/cRC)

## CHAPTER 2(D) SAFETY OF INSTALLATIONS

### ARTICLE 17. SITING

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**17. Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:**

- i. for evaluating all relevant site related factors likely to affect the safety of a nuclear installation for its projected lifetime;**
  - ii. for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;**
  - iii. for re-evaluating as necessary all relevant factors referred to in subparagraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;**
  - iv. for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.**
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#### **17.(i) Site-related factors**

The discussion of site-related factors has been merged with the discussion of the safety impacts in the next section.

#### **17.(ii) Site-related factors and safety impact**

Soon after the Chernobyl accident in 1986, the government decided to halt the siting procedure for a new nuclear power plant, which was then in progress. To date (July 2010), there has been no licence application for the construction a new nuclear power plant. In June 2009 Delta submitted a preliminary memorandum (Dutch: 'Startnotitie') by which it announced its intention to build a new nuclear power plant in Borssele. The requirements (Dutch 'Richtlijnen') for the EIA report have been issued by the Competent Authorities in July 2010 and the assessment is now in progress. The report is not expected before 2011.

The IAEA Codes and Safety Guides on siting have not been amended and adopted as a Dutch Nuclear Safety Rule (NVR). A number of elements from these Codes and Safety Guides have, however, been used to amend the Code and Safety Guides on design (e.g. factors relating to seismicity).

Before a licence is granted, the applicant has to specify all 'relevant site-related factors that may affect the safety of the plant'. Examples of site-related factors are events induced by human activities, such as aircraft crashes or gas cloud explosions, and events due to natural causes such as seismic phenomena and high tides.

In September 2009 the third Electricity Supply Structural Plan (SEV III <sup>15</sup>), became operational. SEV-III reserves space for large-scale production and transport of electricity. In SEV-III, on the basis of a preliminary selection procedure, three locations have been selected and in principle warranted for the

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<sup>15</sup>Structuurschema Elektriciteitsvoorziening III

siting of a nuclear power plant. However, the site selection process during the licensing procedure should further assess the consequences and the suitability of the site.

The main site-relevant factors that have been taken into account in the preliminary selection are:

- Any special circumstances which prohibit the building of a nuclear power plant on a particular site, e.g. the presence of an airport or of industries with the potential for the release of explosive or toxic substances in the vicinity, or certain difficulties involving the existing electrical power grid;
- The population density within a radius of 20 km around the site, and especially in the most densely populated 45° sector around it. If these weighted population densities are too high compared with the weighted population densities for a reference site, the proposed site will be removed from the initial list.

#### **17.(iii) Re-evaluating of relevant factors**

Pursuant to NVR 1.2 (Safety Code for Nuclear Power Plant Operation) as well as to a separate licence condition, the licensee is required to perform regular safety assessments. The licence describes the nature of these assessments and also specifies the maximum period between them. For example, the safety of the nuclear power plant as a whole must be re-evaluated every 10 years in the light of new safety insights and generally accepted safety practices (Periodic Safety Reviews, PSRs). Account must be taken of ‘site-relevant factors’ as mentioned in the section on Article 17.(ii). Also refer to the section on Article 14 for the PSRs.

#### **17.(iv) Consultation with other contracting parties**

The procedure for obtaining a construction licence for a nuclear installation includes an obligation to submit an Environmental Impact Assessment (EIA). As part of this procedure, neighbouring countries that could be affected by the installation are notified on the basis of the Espoo Treaty and an EU Directive:

- The Espoo Treaty of 26 February 1991. The Netherlands ratified this treaty on 28 February 1995 and the European Union ratified it on 24 June 1997; the treaty came into force in September 1997.
- Council Directive 97/11/EC of 3 March 1997, amending Directive 85/337/EEC on the assessment of the effects of certain public-sector and private-sector projects on the environment. The Espoo Treaty has been subsumed under this Council Directive.

The Netherlands has incorporated the provisions of the Espoo Treaty and the EU Directive into its Environmental Protection Act. Chapter 7 of this Act deals with environmental impact assessments and the relevant procedures. These include the provision of information to neighbouring countries and the participation of the authorities and the general public.

A special bilateral committee for nuclear installations (NDKK<sup>16</sup>) has been set up with Germany to promote an effective exchange of information between the two countries. Originally the prime function of the NDKK (established in 1977) was to improve and guide participation by citizens (living in the proximity of the border) in the licensing procedures of the neighbouring state. Later, it assumed the additional function of a platform for the exchange of information on more general nuclear topics such as the technical aspects of installations near the border, developments in regulations and emergency preparedness activities.

A bilateral Memorandum of Understanding of a similar nature has been agreed with Belgium.

The government is also bound by the provisions of Article 37 of the Euratom Treaty, under which all relevant data on the safety and environmental impacts of any nuclear installation that could affect a neighbouring EU Member State must be submitted to the Article 37 Expert Group before a licence can

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<sup>16</sup> The NDKK is the Dutch-German committee for nuclear installations in the border regions.

be granted. This Expert Group advises the European Commission on the acceptability of the proposed installation on the basis of safety evaluations. The Commission thereafter informs the Member States concerned of the outcome of these evaluations.





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## ARTICLE 18. DESIGN AND CONSTRUCTION

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### 18. Each Contracting Party shall take the appropriate steps to ensure that:

- i. the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence-in-depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;
  - ii. the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;
  - iii. the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.
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#### 18.(i) Defence in depth

A design must be based on the defence-in-depth concept as defined in NVR 1.1 (Nuclear Safety Guide 1.1: Safety Code for Nuclear Power Plant Design) in order to achieve the general safety objectives laid down in the various NVRs. 'Defence-in-depth' is the name given to a safety philosophy consisting of a set of diverse and overlapping strategies or measures, known as 'levels of defence'. The 'Defence-in-depth' principle is described and implemented in various nuclear safety standards and documents. An important one is the INSAG-10 report 'Defence in Depth in Nuclear Safety' which identifies five levels of defence. An important principle is that the means provided on one level of defence should be independent from those of other levels. This ensures that the failure of one system will not affect more than one level of defence.

The Borssele NPP meets the requirements regarding the defence-in-depth concept:

- The first level of defence shall prevent abnormal operation and failures. Operational experience, especially as indicated by collected plant-specific component failure data, data resulting from the non-destructive testing of the primary pressure boundary, as well as the programmes for inspection, maintenance, testing, ageing etc. applied to plant systems and components, has shown that the first level of defence is adequately preserved.
- The second level of defence shall control abnormal operation and timely detect failures. In the Operational Limits and Conditions (OLC) document the limits are defined within which the Borssele NPP must operate. In order to ensure that the limits are not exceeded, the safety systems are subject to an extensive set of in service inspection, surveillance and maintenance procedures. These procedures together with the Operational Limits and Conditions document form the second level of defence.
- The third level of defence shall control accidents within the design basis. The essential means provided consist of the safety systems and other measures to control Postulated Initiating Events (PIEs) including Limiting Design Basis Events. The safety analyses that are reported in the Safety Report have to prove that the radiological consequences of design-basis events meet the radiological criteria. These radiological criteria specify smaller acceptance doses if the assumed frequency of the PIEs increases. These criteria are specified in Appendix 1.
- The fourth level of defence shall control severe plant conditions. This is realised by the symptom-based Emergency Operating Procedures (EOPs) and the Severe Accident Management Guidelines

(SAMGs), that need to prevent or mitigate consequences of severe accidents should they happen despite the presence of levels 1-3.

- The fifth level of defence shall mitigate the radiological consequences of significant releases of radioactive materials in the unlikely event that they would occur. It is covered by the strategies for off-site emergency preparedness. See the section on Article 16 for more information on these strategies.

In 2010 the Borssele NPP finalised most of the last modifications derived from its second 10-yearly periodic safety review that was undertaken in 2003. For each level of defence, modifications have been implemented by the licensee. These consist of technical, organisational, personnel and administrative measures. With regard to the five levels of defence, 25 of the technical measures relate to the prevention of incidents, 17 to the control of incidents, 23 to the control of design-basis accidents, 17 to the control of severe accidents and 5 to the mitigation of large radioactive releases. These measures will considerably reduce the risk of core damage and potential radiological consequences. See Annex 1 and Appendix 2 for more details.

#### *Structures, systems and components*

The NVRs are continuously revised and updated. In view of the nuclear new-build plans in the Netherlands of NRG in Petten (construction of a new research reactor Pallas) and Delta NV in Borssele (new NPP) supplementary nuclear safety codes will have to be taken into account. An evaluation has started of nuclear safety codes in use in other countries, with a focus on their applicability for The Netherlands. The remainder of this section will report on the current situation, based on the current set of NVRs.

The identification and classification of the function and significance of structures, components and systems on safety is based on NVR 2.1.1. This Safety guide is an amended version of SS 50-SG-D1 defining four safety classes. Classes 1 to 3 are equivalent to the first three safety classes of SS 50-SG-D1. Class 4 is an extension for:

- Components whose malfunction or failure could put a demand on a safety system in case of an anticipated operational occurrence;
- Components whose malfunction or failure could lead to a significant release of radioactive materials and/or could cause a significant exposure of the site personnel or the public and for which no safety system might be provided;
- Components that may perform significant functions with respect to the prevention, termination or mitigation of anticipated operational occurrences and/or accident conditions, including severe accidents. A function is considered to be ‘significant’ if it ultimately improves the safety level of the plant.

For system and component design, acceptance criteria are being used based on standard engineering practices. The responsible contractor is left free to choose which specific code to use – within the restrictions of respective safety guides. The regulatory body assesses the selected code and may formulate additional acceptance criteria. By allowing the contractor to work with a familiar code the occurrence of inadvertent errors may be reduced.

The original design and construction Safety-relevant fluid-retaining components of Borssele NPP (safety classes 1, 2 and 3, as defined by NVR 2.1.1) were designed and constructed in accordance with the earlier ASME Code, Section III, Division 1 ‘Code for the Operation and Maintenance of Nuclear Power Plants’, the Dutch Design Code for pressure-retaining equipment, and various Siemens/KWU component specifications. In the 1990s the KTA safety code was introduced at Borssele NPP including significant additional operational experience.

Conventional electrical installations must comply with standards NEN 1010 and NEN 3410 and electrical equipment, where applicable, to NEN 3125 and NEN-EN 50.014 up to 50.020. The design codes and standards used for nuclear electrical installations are the IEEE standards and the KTA code. For digital equipment the standards are used that are provided by the International Electro technical Commission (IEC), the European Committee for Electro technical Standardisation (CENELEC) and the Verband der Elektrotechnik, Elektronik und Informationstechnik e.V. (VDE). The periodic safety review (PSR) finalised in 1993 found the original design basis to be conservative, based on recent versions of the respective industry codes.

To prevent propagation of a failure from a system classified in a lower safety class into a system classified in a higher safety class, NVR 1.1 prescribes that appropriate independence must be maintained between systems or components of different safety classes. This independence can be achieved by using functional isolation and physical separation.

The Borssele NPP is a two-loop system that was built in the 1970s. Therefore, in the original design physical separation was limited. In the first 10-yearly Periodic Safety Review (PSR), a significant effort was put into creating a physical separation between redundant systems of the two loops. This separation was further improved in the second 10-yearly PSR.

#### **18.(ii) Technology incorporated proven by experience of qualified by testing or analysis**

##### *Safety Analysis*

The Safety Report (SR) of the Borssele NPP is a two-volume document of little less than 700 pages. In this report a condensed representation is given of all safety related aspects regarding the installation and its surroundings. In addition to the Safety Report, the twenty-volume Safety Analysis Report (SAR), also known as the 'Technical Information Package' (TIP), provides extensive background information on all safety related aspects regarding the installation, plant layout and the safety analyses. The SAR also includes all details of the design base accident (DBA) analyses. The licence of Borssele NPP requires keeping the SAR/TIP up-to-date at all times.

The SAR is the starting point for all modifications and maintenance activities and is updated with each modification.

NVR 1.1 (Safety Code for Nuclear Power Plant Design) states that a full range of events must be postulated in order to ensure that all credible events with potential for serious consequences and significant probability have been anticipated and can be accommodated by the design base of the plant. Appendix 1 specifies the acceptance criteria for the analysis. Refer to the section on Article 14 for regulatory requirements governing the issuance of SARs (and SRs) or their updates.

For the safety analysis of the Borssele NPP, the design basis accidents (DBAs) have been grouped in the following ten categories:

- 1) Increased heat removal by the secondary cooling system
- 2) Decreased heat removal by the secondary cooling system
- 3) Decrease in flow in the primary cooling system
- 4) Pressure changes in the primary system
- 5) Inadvertent changes in reactivity and power distribution
- 6) Increase of cooling inventory in the primary system
- 7) Leakage of cooling inventory from the primary system
- 8) Radioactive releases from subsystems and components
- 9) External events (containing among others earthquakes, plane crashes, flooding and external fires)
- 10) Miscellaneous (containing among others fire and explosions inside the power plant, internal flooding of safety relevant buildings and leaks in reservoirs with highly energetic contents inside the reactor building)

From the 90 postulated initiating events, a selection has been made of a group of representative enveloping events that cover the consequences of all these events.

Where it is credible that combinations of randomly occurring individual events could lead to anticipated operational occurrences or accident conditions, they are considered as a basis for the design. In the case where events occur as the consequence of other events, these events are considered as a part of the original postulated event.

In the analysis of design basis accidents, the single failure criterion has to be taken into account. The single failure criterion is satisfied when an assembly or equipment is able to meet its purpose despite a single random failure occurring anywhere in the assembly. For the design base accident analysis it is assumed that exactly the one safety-related component fails that has the greatest effect of aggravating the consequences of that accident.

NVR 1.1 prescribes the limitation of the impact of common cause failures by the application of diversity. The design of the Borssele NPP incorporates diversity in several ways, such as diversity in process parameters (e.g. high pressure or high temperature) to initiate safety system actions, diversity in equipment's driving force (e.g. steam driven and motor driven emergency feed water pumps), and diversity in manufacturing (e.g. different manufacturers for 'normal' and 'bunkered' emergency feed water pumps). In the two 10-yearly PSRs this diversity has been enhanced.

#### *Severe accident vulnerability of the installation*

During the first 10-yearly Periodic Safety Review (PSR), the Borssele NPP made a thorough study on the capabilities of the installation with respect to severe accidents. Based on this study both hardware and procedural measures were taken to expand its capabilities to prevent and mitigate the consequences of a severe accident. The hardware measures involved amongst others the installation of passive hydrogen recombinators, filtered pressure relieve of the containment and filtered air supply to the control room and a separate emergency control room. The procedural measures consisted of the introduction of an extensive set of symptom-based Emergency Operating Procedures (EOPs, for prevention) and Severe Accident Management Guidelines (SAMGs for mitigation). The EOPs are based on the Westinghouse Owners Group guidelines and consist of guidelines for the Emergency Support Centre, which initiates required actions, and procedures for the control room staff.

With the implementation of the measures of the second 10-yearly PSR further measures have been taken like for example improved extinguishing agents and capability to fight large kerosene fires, the implementation of automatic pressure relieve hatches to improve natural circulation inside the containment in order to prevent too high local hydrogen concentrations and the introduction of SAMGs for non-power conditions.

#### *Qualification of systems and components*

The safety-relevant fluid retaining components of the Borssele NPP were constructed in accordance with German material specifications. For example the steam generator tubing is made of Incoloy 800 and the control rod drive penetrations are of ferritic steel rather than Inconel 600. The PSR confirmed the low nil-ductility transition temperature of the reactor pressure vessel. New mechanical components installed during the Modifications Project (1997), were made in accordance with the KTA design and construction rules, Siemens/KWU Konvoi component specifications (updated in 1992) and other international standards for nuclear products. Advanced (and proven) technology was introduced with the Super Compact Tandem Safety Valves on the primary system, which were qualified by analysis, laboratory tests and test loop experiments.

Dutch design and construction codes for pressure vessels do not contain a nuclear section. For all construction and modification activities, the licensee proposes which nuclear design and construction code to use. The Dutch regulatory body assesses the norms, standards and constructions of this code

and depending on the result additional requirements are formulated. In order to ensure that the design codes used are applicable, adequate, sufficient and up-to-date only design codes have been approved that are internationally accepted, like ASME III, KTA and RCC-M.

The technology for the design and construction of safety systems and components for the Borssele NPP has been qualified by analysis, testing and experience in accordance with the requirements of the relevant safety regulations (NVRs 2.1.3, 2.1.7, 2.1.8 and 2.1.13).

Two examples of this process are the introduction of new fuel elements and the large-scale replacement of electrical components.

Starting with the refuelling outage of 2005 new fuel elements with the improved corrosion and hydrating resisting Zirconium-Niobium cladding material M5 have been deployed. Other features of these new HTP fuel elements are the presence of a debris filter in the bottom of the fuel assembly, and new spacers to avoid grid-to-rod fretting. The M5 material had already been tested in other reactors and in laboratory experiments. The relatively high burnups of 67 MWd/tU prompted the regulatory body to require the licensee to follow the results from measurements in other plants and research facilities and report this on a yearly basis.

In the 1980s, Borssele undertook a programme of partial replacement of electrical components, including instrumentation and control, in order to improve the environmental qualifications of the equipment involved. Since then, electrical components etc. in safety classes 1, 2 and 3 placed inside the containment have met the IEEE class 1E qualifications. Borssele components that must meet design-basis LOCA environmental conditions now also meet the Konvoi or VGB (Association of German Power Plant Operators) qualifications. Electrical equipment is qualified on the basis of type testing, analysis and experience.

All products and services were delivered by suppliers that are either qualified by VGB or by the architect engineering company (Siemens, Framatome) under an extensive quality control programme verified by independent inspectors. Quality assurance programmes were introduced in the 1980s and resulted in the partial transfer of quality control work to suppliers.

### **18.(iii) Design in relation to human factors and man-machine interface**

The 1997 modification programme undertaken at Borssele included consideration of a whole range of man-machine interface elements (also discussed in the section on Article 12). The most notable elements of the programme included the redesign of the control room, the addition of a backup emergency control room and additional local control capabilities to improve process information and controllability in all plant states, including emergency situations. Other important elements were the redesign of interlocking control processes (i.e. bridging, key-operation, and automatic blocking), tackling communication problems, evaluating and improving the accessibility (in terms of physical access and radiation doses) of systems and components during operational states and in emergency situations, and adding remote controls and indicators for safety-relevant components.

A representative mock-up was used to optimise the design of the control room in terms of human factors. Uninterrupted sightlines, readability, communication, manageability and walking distance optimisation were all studied and the results implemented. Control room staffs were also involved in planning the layout. See Annex 1 for a more detailed description of man-machine interface aspects at the Borssele NPP.

In addition to the Reactor Protection System (RPS) there is the Engineered Safety Features Actuation System (ESFAS) that is designed such that for all design base accidents no operator action is required during the first 30 minutes after start of the event. An exception is allowed for simple actions with clear criteria after the first 10 minutes. In addition, there is a 'limitation' system that initiates corrective actions to prevent activation of the RPS and ESFAS systems. All relevant safety related

parameters are shown on a special panel, so that the operator is able to check all important safety parameters at the same time.

The design also ensures that the plant is kept in a controlled safe state during a minimum of 10 hours after an external event, without any operator actions (autarky). After the most recent PSR, the time that the plant can be kept in a controlled safe state after an event, without the need for off-site assistance or supply (autonomy) has for external events been expanded from 24 hours to 72 hours minimum, which is equal to that for internal events.

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## ARTICLE 19. OPERATION

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**19. Each Contracting Party shall take the appropriate steps to ensure that:**

- i. the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;**
  - ii. operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;**
  - iii. operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;**
  - iv. procedures are established for responding to anticipated operational occurrences and to accidents;**
  - v. necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;**
  - vi. incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;**
  - vii. programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;**
  - viii. the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.**
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### **19.(i) Safety analysis and commissioning programme for initial authorisation to operate**

It should be noted that experience with initial safety analysis and commissioning is limited, as no new nuclear power plants have been built in the Netherlands since 1973. This section is therefore related to comparable experience with:

- Periodic Safety Reviews (PSRs) of the Borssele NPP (see Article 14(i)),
- the results of inspection by international team reviews like OSART and;
- commissioning after significant changes to the installations as a result of a PSR.

As discussed in the section on Article 14(i), an in-depth safety assessment of the NPP has been made. The commissioning aspects concerning modified structures, systems and components are reviewed once the assessments have been completed.

Pursuant to NVR 1.2 (Safety Code for Nuclear Power Plant Operation), the licensee must set up a 'Commissioning Programme' (CP). Instructions for this task are provided by NVR safety guide 2.2.4 (Commissioning procedures for NPPs). The CP has to be approved by the KFD. The KFD's chief task is to assess the completeness of the programme but some parts are evaluated in detail. The findings are discussed with the licensee so that necessary changes can be made, after which the programme can be approved.

The regulatory inspectors select certain items for closer monitoring during the actual commissioning process. Audits are performed, both by the licensee and by the KFD, where necessary assisted by external experts, to ensure that the CP is being properly executed. They focus on the organisation and quality systems of both the licensee and its contractors. Nevertheless, the establishment and performance of an appropriate CP remains the full responsibility of the licensee.

After refuelling the reactor including all maintenance activities, the licensee must submit to KFD the results of all relevant analyses, tests, surveillances and inspections. KFD will evaluate this information to establish whether all SCCs important to safety meet certain criteria for reliability, before granting a restart.

The Dutch government in 2006 signed an agreement (Covenant) with the owners of the Borssele NPP, which allows for operation until the end of 2033, if requirements of the operating licence and the Covenant keep being met. In effect, the agreement allows the plant to operate an extra 20 years. The Covenant can be found in Annex 2. The licensee has started a project which should demonstrate that the plant and its organisation are capable of safe operation during the additional period of time. This project is based on guidance provided by IAEA Safety Report Series n. 57 'Guidance for Safe Long Term Operation'. An important part of the project is the assessment of all safety and design analyses containing design life related assumptions together with ageing management review of all safety and safety related SCCs.

#### **19.(ii) Operational limits and conditions**

The Borssele NPP licence states that *'the conditions must be described and approved by the KFD with which the systems, system components and organisation of the operation of the installation must comply, as well as the measures taken in order to operate the installation in such a way that all requirements described in the licence are satisfied'*.

These conditions are described in the Technical Specifications (TS). The basis for these is NVR 2.2.3 (Operational limits and conditions for NPPs), but NUREG 1431 was used as a basis for their revision. A project team was formed to tailor the standard Westinghouse TS to the Siemens/KWU design. The team included representatives of Siemens (vendor information), Sciencetech (standard TS information) and the owner of the Borssele NPP, EPZ (plant maintenance and operation procedures). A set of documents was generated showing all changes made to the old TS. Any change to or difference from NUREG was also explained and justified in separate documents. Many new items were introduced into the TS. A separate background document contains the link to the existing safety analysis documents. The TS include the limits and conditions for operation, allowable outage times and surveillance requirements.

All deviations from the TS must be reported to the KFD. The KFD checks on compliance with the TS during its regular inspections.

According to NVR 2.2.3 the plant management has the primary responsibility of ensuring that the operational limits and conditions are complied with. To fulfil this responsibility, relevant checks and control systems have been established. All personnel holding responsibility for the implementation of operational limits and conditions are provided with the latest version of the associated documentation. There are written procedures providing for issue and control of operational limits and conditions and their approved modifications. The operating organisation conducts audits to verify compliance with the operational limits and conditions.

The quality assurance system of the Borssele NPP requires the conditions for operation and the limits as laid down in the Technical Specifications to be observed at all times. This has priority over the



economic production of electricity. NVR 1.2 states that plant management has a direct responsibility for the safe operation of the plant. All safety-relevant management functions must be supported at the most senior level of management. In addition, the organisational structure features a special senior manager who is responsible for the independent supervision of nuclear safety, radiation protection and quality assurance at the plant. He reports directly to the most senior level of management at the Borssele site. This ensures that safety is given a proper role in this efficiency oriented production environment. A project of Borssele concerning risk-informed optimisation of improved allowable outage times has been approved by KFD. Proposals concerning surveillance interval requirements based on the risk-informed approach are now submitted to KFD for approval.

### **19.(iii) Approved procedures**

The NVR 1.2 Safety Code and Guides state that operation, maintenance, inspection and testing must take place in accordance with established procedures. Since the NVRs are part of the licence, the licensee is bound by these conditions. The plant is operated in accordance with the instructions given in the Operating Manual, which is an extensive document describing all relevant details of plant operation. Specific instructions are given for abnormal conditions, as well as for incidents and accidents (see also the section on Article 19(iv)). These documents are approved by plant management, but are in general not submitted to the regulatory body for approval. However, the Technical Specifications, major changes of the EOPs/SAMGs, the code of conduct and the rules and regulations of the internal and the external reactor safety committee of the plant and the ISI programme have to be approved by the KFD.

The establishment of an Internal Reactor Safety Committee (IRSC) and an External Reactor Safety Committee (ERSC) is a licence condition for Borssele NPP and the HFR research reactor. The IRSC is a reviewing body within the plant management structure to evaluate and review all matters important to nuclear safety and radiological protection. The IRSC advises and reports to the plant management and reports also to the ERSC. The ERSC is a committee under responsibility of the operating organisation to provide independent review and surveillance of the functioning of all internal safety control and safety evaluation provisions within the operating organisation such as quality assurance, IRSC, plant management and structure of the operating organisation. In addition, the ERSC may evaluate and review matters important to nuclear safety and radiological protection. The ERSC advises and reports to the operating organisation. The terms of reference, function, authority and composition of both IRSC and ERSC are subject to approval by the KFD. The Borssele licensee has described the utility management processes in relation to functions such as operation, maintenance and testing in more fundamental terms. The emphasis is on the 'key processes' of the utility organisation. Each key process describes the kind of essential processes needed, how communication between various groups and departments is to be performed and what kind of instructions and forms must be used.

The system of key processes enhances the utility's self-assessment capability. The management processes were implemented as a 'first generation' quality system in the late eighties and the system was improved in the early nineties to produce an integrated quality management system (in accordance with the IAEA codes and guides) incorporating a process-based approach. The management system comprises all the main processes in the plant: Management & Organisation, Training, Operations, Nuclear Fuel Management, Chemistry, Maintenance, Radiation Protection, Radwaste Treatment, Procurement, Configuration Management, Environmental Management, Industrial Safety, Security, Emergency Planning & Preparedness and Auditing.

The associated management procedures describe not only tasks and responsibilities, but also the input-documents (instructions, periodical programmes, checklists and specifications) to be used and the

output-documents (forms and reports) to be generated.

The Operations process covers all activities in the operations field and their interfaces with other processes (like Maintenance, Chemistry and Fuel Management), for example:

- plant status control, Technical Specifications;
- work-order process, work licensing procedure;
- (functional) surveillance testing;
- surveillance rounds;
- event procedures, EOPs;
- event reporting;
- procedures for taking the plant to shut-down;
- procedures for start-up of the plant.

The Maintenance process covers all activities in the maintenance field, including interfaces with other processes (like Operations and Procurement), for example:

- preventive maintenance programmes, ISI programme, calibration & test programmes;
- ageing management;
- preparation and execution of maintenance tasks, work-order system;
- maintenance reporting.

The KFD checks the use of instructions and forms during its regular inspections. The quality assurance system for each key process is verified during audits (carried out by the licensee, the KFD or a third party).

According to NVR 1.2, any non-routine operation which can be planned in advance and any test or experiment will be conducted in accordance with a prescribed procedure to be prepared, reviewed and issued in accordance with established procedures in order to ensure that no operational limit and condition is violated and no unsafe condition arises. However, should this operation nevertheless lead to an unexpected violation of one or more operational limits and conditions, standing orders shall instruct the personnel supervising or operating the controls of the plant to comply with the operational limits and conditions and consequently to bring the plant back into a safe condition. It shall be demonstrated that there is a definite need for the test or experiment and that there is no other reasonable way to obtain the required information.

Programmes and procedures for maintenance, testing, surveillance and inspection of structures, systems and components important to safety have been prepared and implemented. These programmes are regularly re-evaluated in the light of experience as mentioned in Article 14.

#### **19.(iv) Anticipation of operational occurrences and accidents**

The Borssele NPP has developed a comprehensive set of procedures to enable it to respond to anticipated operational occurrences and accidents. Simpler malfunctions are the subject of event-based instructions and procedures. Emergency situations are dealt with by symptom-based emergency operating procedures (EOPs). Severe Accident Management Guidelines (SAMG) have been introduced. These are intended to provide guidance on accidents involving core damage and potential radioactive discharges into the environment.

The Borssele NPP licensee follows the approach adopted by the Westinghouse Owners Group (WOG), both for EOPs and SAMG. The severe accident management guidance defines priorities for operator

actions during the various stages of a core melt process, sets priorities for equipment repairs and establishes adequate lines of command and control. Care has been taken to tailor the WOG approach to the particular characteristics of this Siemens/KWU station.

Both operators and staff are given frequent training in the use of emergency operating procedures. This takes the form of courses on the full-scope simulator located in Essen, Germany, and emergency exercises at the plant. A data link has been created between the plant and the simulator to enable calculating real time accident progression in the phases before core melt.

In the event of a severe accident, support is also available from the plant vendor, AREVA (formerly Framatome ANP and Siemens/KWU), which operates a round-the-clock service to assist affected plants and is available on call.

#### **19.(v) Engineering and technical support**

The Borssele NPP licensee has built up considerable expertise and is able to manage most safety-related activities. The staff is suitably qualified and experienced as stated in Article 11.2. In addition, the licensee works in close collaboration with the plant vendor and other qualified organisations in the Netherlands and abroad. Among the companies and institutions in question are the VGB, AREVA, NRG, Belgatom and AVN.

Procedures have been developed and implemented for contractors. For instance, contractors are made familiar with the installation and normal working procedures by showing them training films explaining 'work practices'.

Since the regulatory body has only a very small staff, it frequently uses outside support for its assessments and inspections. The RIVM in the Netherlands, GRS in Germany and AVN in Belgium are organisations that provide support. Inspections and assessments have also been carried out with the aid of the IAEA. In addition, the privately owned Nuclear Research and consultancy Group (NRG) sometimes give assistance. However, this assistance is very limited since NRG provides technical assistance to the Borssele NPP and NRG is also the licensee of the High Flux Reactor in Petten, thereby creating possible conflicts of interest. In all cases, full attention is paid to the qualifications of the contractors and to the avoidance of any conflict of interest.

Because of the small size of the Dutch nuclear programme, nuclear safety in the Netherlands has always been dependent on international contacts. Given the current reduction in the flow of government funding for education in nuclear engineering and for research programmes, this dependency will increase. There has been some concern about the future of courses in nuclear engineering at Delft University of Technology and funding for the operation of the 2 MW<sub>th</sub> research reactor (HOR) at the Reactor Institute Delft (RID). However, financing for the coming years is guaranteed now.

Recently the new Dutch government announced plans to reduce the number of governmental officials significantly the next four years. This may threaten capacity and expertise of the regulatory body (for current staffing, see Article 8).

#### **19.(vi) Reporting of incidents**

An incident-reporting system is a condition of the licence and is in operation for all existing nuclear installations. The system is based on IAEA Safety Series No. 93, Systems for Reporting Unusual Events in Nuclear Power Plants.

The criteria for reporting to the regulatory authorities are described in the Technical Specifications. Depending on its nature, an event must be reported to the KFD:

- category (a) events have to be reported within eight hours by telephone and within 14 days by letter, or
- category (b) events have to be reported within 30 days by letter (this type of incident is normally also reported the same day by telephone).

Examples of category (a) events are:

Violations of the licence and the Technical Specifications limits, exposure to high doses (as referred to in the Bkse), activation of the reactor protection system leading to reactor scram, ECCS actuation and/or start of the emergency power supply (diesel generators).

Examples of category (b) events are:

- (Minor) leakages of fuel elements, leakage of steam generator tubes and of the primary system, non-spurious activation of the reactor protection system and events causing plant staff to receive a dose in excess of 10 mSv.
- Degradation of safety systems or components, and events induced by human activities or natural causes that could affect the safe operation of the plant.

In exceptional situations, i.e. if there is a major release of radioactive material or if a specified accident occurs (> 2 on the International Nuclear Event Scale, INES), the NPP is obliged to notify the National Emergency Centre directly. Depending on the nature of the accident, various government bodies are alerted. The KFD is always alerted. Further information is given in the section on Article 16.

KFD houses the national officer for INES (International Nuclear Event Scale) and also the national coordinator IRS (Incident Reporting System) and IRSRR (Incident Reporting System for Research Reactors).

#### **19.(vii) Sharing of important experience**

A standing task force at the nuclear power plant assesses incidents. As already mentioned, the establishment of this task force is required under the licence. A second standing task force assesses ageing issues. It is recognised that the effects of ageing may pose technical challenges in the future, and that expertise and adequate data on operational history need to be available to cope with these potential problems. The nuclear power plant operates databases for its own use and these contain data on incidents from various sources, including the plant itself. The following organisations are also sources of data: WANO, IAEA and OECD/NEA IRS, IAEA News, VGB, AREVA, USNRC, GRS, etc. All reports of incidents received under IAEA/NEA IRS are transmitted by the KFD to the Borssele NPP.

The Netherlands is an active member of the IAEA and OECD/NEA mechanisms for sharing key operational experience, the Working Group on Operational Experience (WGOE) of the OECD/NEA Committee for the Safety of Nuclear Installations (CSNI), and the international incident reporting system (IAEA and OECD/NEA IRS).

Borssele reports any incident to the WANO and the VGB. Operational measures obtained from WANO (Good Practices and Performance Objectives & Criteria) are implemented by Borssele NPP. Information is regularly exchanged on a bilateral basis with neighbouring countries, plus a number of other countries. Personnel of Borssele actively participate with WANO-, OSART-, AMAT- and other missions at foreign nuclear power plants. There are frequent regulatory contacts with many European countries and the USA. Within the framework of the NEA, the Netherlands participates in a working group dealing on a regular basis with operational events.

However, it is possible to improve operating experience feedback activities in order to avoid the recurrence of operating events, and to maintain or improve safety in a changing world. Implementation of recommendations based on international work on operating experience in the nuclear and non-nuclear industries is essential.

#### **19.(viii) Generation and storage of radioactive waste**

The licences for the NPPs state that the provisions of the NVRs must be satisfied. On the issue of radioactive waste management, the Safety Code for Nuclear Power Plant Design (NVR 1.1) requires adequate systems to be in place for handling radioactive solid or concentrated waste and for storing this for a reasonable period of time on the site. The licensee has such systems at its disposal and keeps records of all radioactive waste materials, specifying the type of material and the form of packaging.

The Dodewaard NPP has sent all fuel for reprocessing at Sellafield and has sent all easy removable waste to COVRA. The plant has been transformed into a safe enclosure. This building will contain the remaining materials for 40 years (until 2046) in order to minimise both the activity and the volume of the waste eventually to be transported to COVRA.

The licensee of the Borssele NPP has adopted a written policy of keeping the generation of radioactive waste to the minimum practicable. One of the measures taken to this end is ensuring that the chemistry of the primary system is adequate, in order to reduce the generation of corrosion particles which may be activated. Internal procedures are used to achieve optimum water quality.

Solid waste from the site is transported in accordance with conditions set by the regulatory body. Under these conditions, the licensees have to draw up a timetable for the transportation of radioactive waste to the COVRA interim storage facility for all radioactive waste produced in the Netherlands. The licensees must send a list to the regulatory body at the beginning of each year, stating how much radioactive waste is in storage on-site and how much waste has been transported to COVRA over the previous year.

The NPP's waste management programmes stipulate that general internal radiation protection procedures must be observed so as to satisfy the radiation protection principles, as well as NVR safety guide 2.2.11 (Operational management of radioactive effluents and wastes arising in NPPs), which includes the treatment and storage of spent fuel and waste directly related to operation (taking conditioning and disposal into account). The regulatory body is informed, as described in the section on Article 15.1.



## **RESPONSES TO REMARKS MADE AT THE FOURTH CNS REVIEW MEETING**

During the last CNS review meeting, several challenges facing the Dutch regulatory body were identified. In this section these challenges are addressed.

### **Maintain & enhance knowledge and capacity of Regulatory Body including ensuring adequate financial and human resources of regulatory body with respect to article 8.1 of the convention**

Some of the challenges facing the Regulatory Body have been addressed in the Summary of this report and in the texts of this report on articles 6 and 8 of the Convention. The challenges seem to be the same as or in fact even greater than identified in the previous report to the Convention. The ministry of VROM therefore in 2010 decided to recruit about an additional 22 new staff members for nuclear issues. About ten of these are to support the KFD, the others are to support the Directorate 'Risicobeleid (RB)'.

Since the nature of the work of the KFD requires in-depth knowledge of many technical issues, the recruitment process poses some challenges, maybe even more than for the RB directorate. New KFD and RB staff will have to take part in an extensive training programme, meanwhile taking part in tasks of RB and KFD for necessary training-on-the-job.

Both RB and KFD face the upcoming retirement of several experienced staff members who have a few centuries of combined experience. Not much time is left to ensure that the knowledge of the experienced workers is passed to other employees as part of some kind of succession plan.

Additional information can be found in the text on Article 8 and in Annex 4 'Education and staffing issues at RB and KFD'.

### **Maintain and improve safety/operational reliability in Borssele NPP for Long Term Operation (LTO)**

Upon the invitation of the nuclear inspectorate of the ministry of VROM (the KFD), a peer review mission on safe long term operation (SALTO) was provided by the IAEA to review programmes and activities of the Borssele Nuclear Power Plant (NPP) related to LTO and ageing management of systems, structures and components (SSCs) important to safety. The mission was conducted through meetings and discussions of the IAEA Review Team with counterpart specialists from the plant and technical support organizations (NRG, AREVA NP). The mission team overall was content with its findings, some of the identified good practices could serve other ageing plants as an example for performing comprehensive analyses.

The upcoming third 10-yearly Periodic Safety Review (PSR) is coupled to (among others) the LTO programme of the Borssele NPP. Refer for further information to the text of Article 14.

### **Effective implementation of risk informed regulation**

An integrated requirements and guidance document has been drafted by KFD. This document will be discussed soon with both the licensee and the RB Directorate, responsible for legislation and policy development. As long there is no political decision on future NPPs, this document is only valid for the existing NPP Borssele. Apart from the numerical differences with US-NRC regulatory guide 1.174, this document also differs in providing a criterium for considering economic benefits. When on basis of a justifiable benefit a small risk increase ( $\Delta\text{TCDF} < 1.10^{-6}/\text{year}$ ) is requested by the licensee it is proposed in the document that the licensee has done a large effort to minimize the risks as far as

reasonable possible. An amount equal to 10% of the expected economic benefit during the remaining lifetime of the plant is considered as a reasonable amount. In case a decision is made that new NPPs are allowed to be build in The Netherlands this document can easily be expanded to new NPPs as well.

**Benchmarking criteria to be developed by independent commission for safety comparison**

An important criterion is that Borssele should be in the top 25 % of the safest water-moderated NPPs in Western Europe, US and Canada.

In 2006, the Dutch government signed an agreement (Covenant) with the owners of the Borssele NPP. The NPP is allowed to operate until the end of 2033, if requirements of the operating licence and the Covenant keep being met. The requirement specified in the Covenant with respect to the ranking in terms of safety is an important one. The benchmarking criteria are still being developed. A ‘Borssele Benchmark Committee has been appointed which meets on a regular basis to discuss nuclear safety issues regarding Borssele NPP. The committee plans to have conducted the first benchmark exercise and to have reported on it in 2013. In addition the parties involved in the Covenant twice a year meet in the Steering Group Benchmark NPP to evaluate the progress.

For more information refer to Annex 2 ‘Borssele Covenant’.



## **Appendix 1 SAFETY POLICY AND SAFETY OBJECTIVES IN THE NETHERLANDS**

### **a. Safety objectives**

The IAEA has established standards for safety to protect health and minimize danger to life and property. Many Member States have adopted these as the global reference, to achieve a high level of protection for people and the environment. The IAEA has produced and is continuously updating its Safety Standards Series.

In the Netherlands, safety policy in the nuclear field is based on the following overarching fundamental safety objectives that have been derived from IAEA safety standards.

The general nuclear safety objective:

*To protect individuals, society and the environment from harm by establishing and maintaining in nuclear installations effective defences against radiological hazards.*

The general nuclear safety objective is supported by two complementary safety objectives:

The technical safety objective:

*To take all reasonably practicable measures to prevent accidents in nuclear installations and to mitigate their consequences should they occur; to ensure with a high level of confidence that, for all possible accidents taken into account in the design of the installation, including those of very low probability, any radiological consequences would be minor and below prescribed limits; and to ensure that the likelihood of accidents with serious radiological consequences is extremely low.*

The radiological safety objective:

*To ensure that in all operational states radiation exposure within the installation or due to any planned release of radioactive material from the installation is kept below prescribed limits and as low as reasonably achievable, and to ensure mitigation of the radiological consequences of any accidents.*

These objectives have been adopted from the IAEA NUSSAG report entitled ‘The Safety of Nuclear Installations – Safety Fundamentals’, Safety Series No 110. The regulatory body is well aware that since 2006, this document has been superseded by SF-1, ‘Fundamental Safety Principles’ of the IAEA Safety Standards Series. However the current set of ‘Nuclear Safety Rules’ (NVRs) referred to in the licence conditions, still is based on the previous series<sup>17</sup>.

### **b. the technical safety objective**

As discussed in the sections on the various articles of the Convention, extensive rules and regulations, derived from the IAEA NUSS Safety Codes and Guides, have been defined and formally established. No licence is issued unless the applicant satisfies the regulations. Inspections are carried out to monitor compliance with the rules. Priority is given to safety, and the licensee is aware of its responsibility for safety. Periodical safety reviews are conducted, to ensure that account is taken of new safety insights.

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<sup>17</sup> The various Nuclear Safety Rules (NVRs) are referenced in the licences of the Dutch nuclear facilities as part of the licence conditions. Also refer to the text on Article 7, section 7.2. (i). Among others, that section addresses the use and the ongoing modernization of the NVRs.

The Dutch regulatory body therefore believes that all echelons of the defence-in-depth principle have been preserved, so that there is a low probability of accidents and, should accidents occur, the probability of radiological releases is very low. Even in the case of accidents beyond the design basis – those that might lead to serious radiological releases – measures have been taken to further reduce their probability and to mitigate the consequences should they occur.

In the light of these measures, the technical safety objective has been fulfilled.

### **c. The radiological safety objective**

Under the radiological safety objective, the formal legal limit for the radiation levels to which members of the public are exposed is based on the Euratom 1996 Basic Safety Standards. The government has also formulated an environmental risk policy, which has to be taken into account.

### **d. Dutch environmental risk policy**

The concept of risk management and risk assessment was first introduced into Dutch environmental policy in the 1986-1990 Long-Term Programme for Environmental Management. The concept was reassessed following debates in Parliament. As part of the Dutch National Environmental Policy Plan<sup>18</sup>, the Minister of Housing, Spatial Planning and the Environment, the Minister of Economic Affairs, the Minister of Agriculture, Nature and Food Quality, and the Minister of Transport, Public Works and Water Management set out a revised risk management policy in a document called ‘Premises for Risk Management; Risk Limits in the Context of Environmental Policy’<sup>19</sup>. In the following year, a separate document was issued dealing with the risk associated with radiation: ‘Radiation Protection and Risk Management; Dutch Policy on the Protection of the Public and Workers against Ionising Radiation’<sup>20</sup>. These documents still form the basis for government policy on risk management.

The Nuclear Installations, Fissionable Materials and Ores Decree (Bkse) has recently been amended to incorporate this risk policy in the licensing process for nuclear installations. Risk criteria are explicitly included as assessment principles for licences to be granted to nuclear power plants. The outcomes of a level-3 PSA must be compared with these risk criteria and objectives.

This concept of environmental risk management incorporates the following objectives and steps:

- verifying that pre-set criteria and objectives for individual and societal risk have been met. This includes identifying, quantifying and assessing the risk;
- reducing the risk, where feasible, until an optimum level is reached (i.e. based on the ALARA principle);
- maintaining the risk at this optimum level.

#### *Normal operation*

The dose limit due to normal operation of installations consists of a maximum total individual dose of 1 mSv in any given year for the consequences of all anthropogenic sources of ionising radiation (i.e. NPPs, isotope laboratories, sealed sources, X-ray machines, etc). For a single source, the maximum individual dose has been set at 0.1 mSv per annum. In addition, as a first step in the ALARA process, a general dose constraint for any single source has been prescribed at 0.04 mSv per annum.

#### *Design-basis accidents*

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<sup>18</sup> Lower House of the States General, 1988-1989 session, 21137, Nos. 1-2, The Hague 1989

<sup>19</sup> Lower House of the States General, 1988-1989 session, 21137, No. 5, The Hague 1989

<sup>20</sup> Lower House of the States General, 1989-1990 session, 21483, No. 1, The Hague 1990

The public health risks due to incidents or accidents in the design-basis area are also bound to the criteria of the individual risk concept. However, a conservative deterministic analysis of the respective design-basis accidents is more effective than a PSA, which is based on a probabilistic approach, for the purpose of ensuring that the engineered safety features of a particular NPP are adequate. There are a number of reasons why a conservative, deterministic approach has certain advantages over a probabilistic approach:

Design-basis accidents are postulated to encompass a whole range of related possible initiating events that can challenge the plant in a similar way. These individual related initiating events do not therefore need to be analysed separately.

It is much easier to introduce the required conservatism. With a probabilistic approach, uncertainty analyses need to be performed to calculate confidence levels.

By definition, design-basis accidents are events that are controlled successfully by the engineered safety features. Hence, they do not result in core melt scenarios, and are considered in a PSA as being 'success sequences'. The related radioactive releases are negligible compared with the uncontrolled large releases associated with some of the beyond-design-basis accidents. In other words, a general 'state-of-the-art' PSA, which focuses primarily on core melt scenarios and associated large off-site releases, does not take account of the consequences of design-basis accidents.

Clearly, the above dose and risk criteria are not suitable for use as rigid criteria in the conservative and deterministic approach used in traditional accident analyses. A separate set of safety criteria has therefore been formulated, as prescribed by NVR 1.1, § 1201. This set, which is part of the amended Nuclear Installations, Fissionable Materials and Ores Decree, reads as follows:

Frequency of event F per annum	Effective dose ( $H_{\text{eff}}$ , 50 years) in mSv	
	Adult	Child
$F \geq 10^{-1}$	0.1	0.04
$10^{-1} > F \geq 10^{-2}$	1	0.4
$10^{-2} > F \geq 10^{-4}$	10	4
$F < 10^{-4}$	100	40

An additional limit of 500 mSv thyroid dose ( $H_{\text{th}}$ ) must be observed in all cases.

Correspondingly the provisions concerning the dose related to normal operation as a first step in the ALARA process, a general dose constraint has been prescribed at values of 40% of the above mentioned.

#### *Major accidents*

For the prevention of major accidents, the maximum permissible level for the individual mortality risk (i.e. acute and/or late death) has been set at  $10^{-5}$  per annum for all sources together and  $10^{-6}$  per annum for a single source.

As far as major accidents are concerned, both the individual mortality risk and the group risk (= societal risk) must be taken into account. In order to avoid large-scale disruptions to society, the probability of an accident in which at least 10 people suffer acute death is restricted to a level of  $10^{-5}$  per annum. If the number of fatalities increases by a factor of  $n$ , the probability should decrease by a factor of  $n^2$ . Acute death means death within a few weeks; long-term effects are not included in the group risk.

In demonstrating compliance with the risk criteria, it has to be assumed that only the usual forms of preventive action (i.e. fire brigades, hospitals, etc.) are taken. Evacuation, iodine prophylaxis and sheltering may not, therefore, be included in these measures.

This risk management concept is used in licensing procedures for nuclear installations and all other applications of radiation sources. Guidelines for the calculation of the various risk levels have been drafted for all sources and situations. In principle, the calculations must be as realistic as possible (i.e. they should be 'best estimates').

For NPPs, this means that the level-3 PSA plays a leading role in the verification process. Specific procedural guidelines have therefore been drafted in the Netherlands for the conduct of full-scope PSAs. The level-1 PSA guide is an amended version of IAEA Safety Practice: 'Procedures for conducting level-1 PSAs' (Safety Series No. 50-P-4) and the level-2 guide is based on IAEA Safety Practice: 'Procedures for conducting level-2 PSAs (Safety Series No. 50-P-8).

The procedural guide for level-3 PSAs is a specifically Dutch initiative, in which the COSYMA code for atmospheric dispersion and deposition is used. It gives instructions on the pathways which should be considered, the individuals (i.e. critical groups) for whom the risks should be assessed and the type of calculations which should be performed. It also describes how the results should be presented.

Since it has been recognised that PSAs produce figures that can be used as a yardstick in safety decisions, a number of countries have developed probabilistic safety criteria. The regulatory body in the Netherlands has taken note of the INSAG-3 safety objective, i.e. the maximum acceptable frequency for core damage is  $10^{-5}$  per annum for new NPPs and  $10^{-4}$  per annum for existing NPPs.

In addition, the objective of accident management strategies should be that the majority of potential accident releases will not require any immediate off-site action, such as sheltering, iodine prophylaxis or evacuation. This means that the dose to which members of the public are exposed in the first 48 hours after the start of the release should not exceed 10 mSv. The PSA can help in fixing these figures.

### *Minimisation of residual risk*

The Rasmussen study (WASH-1400) showed that risk was not dominated by design-basis accidents, as was made very clear by the TMI-2 incident and the Chernobyl accident. For this reason, the regulatory body felt it would be useful to enhance the reactor safety concept, which had to that date been based mainly on deterministically defined events such as a large-break LOCA, by incorporating certain risk elements. In addition to the radiological hazard criteria already mentioned, it was decided to make various changes to the Code of Practice on Design that would define the required safety level more clearly and require the licensee to make a reasonable effort to minimise the risk. The following text was added under the heading 'Postulated Initiating Events (PIEs)':

*The nuclear power plant shall be designed to cope with PIEs in such a way that it can be demonstrated in a probabilistic safety assessment that the probability of a large release is no greater than  $10^{-6}$  per reactor-year. These PIEs may be of internal or external origin, or a combination of the two.*

*Large releases are releases that could lead to doses outside the plant exceeding the acceptable limits for accident conditions (see paragraphs 315 and 1003 of the Code of Practice on Design). They might necessitate the consideration of external measures (i.e. off-site countermeasures). Evidence must be provided that there is no sharp increase in risk just below the probability of  $10^{-6}$  per reactor-year.*

In the section on ‘Severe Accidents’, a more stringent form of wording was chosen in paragraph 317 (i.e. ‘shall’ instead of ‘should’):

*Although the probability of severe accidents occurring is very low, these accidents shall be considered in the design so as to further reduce risks wherever these risks can be reduced by reasonable means.*



## Appendix 2 POLICY DOCUMENT ON BACKFITTING

### a. Introduction

This section presents a summary of the current policy on back fitting in the Netherlands. This policy was established in 1989. It was not formally adopted in regulations, but it is used by the regulatory body as guidance and has been accepted by the licensee of Borssele NPP. It is being considered to introduce more formalised guidance on this subject in the near future. The formalised guidance will be based on internationally identified good practices.

### b. What is back-fitting?

The nuclear power plants at Dodewaard and Borssele became operational in 1968 and 1973 respectively. Various developments have influenced views on safety in the intervening period. These developments include the vast increase in experience with nuclear power plants, not only during normal operation but also during incidents and accidents, up to and including severe accidents as occurred at TMI and Chernobyl. In addition, systematic probabilistic risk assessment, of which the WASH-1400 (Rasmussen) report in 1975 was the first example, has led to significant changes, in particular concerning the balance between the various safety measures. Finally, significant progress has been made in the design of computer programmes for performing complex calculations and for use in scientific research. As a result of these factors, there is a tremendous difference between the design characteristics of plants that have recently been put into operation and those of older plants.

When a nuclear power plant is modified in the course of time, on the basis of new views on safety, this is termed 'back-fitting'. The same term is used to describe the situation when the power plant or the operational or maintenance procedures are modified with the aim of improving compliance with the original safety standards. The initiative for such modifications may come from various sources: the regulatory body, the company operating the plant or the manufacturer.

### c. Types of back-fitting

Back-fitting as defined above relates to systems, components, facility design, procedures, and organisational structures. These can be modified for two reasons, detailed below.

1. The rectification of failures to meet the original safety standards (i.e. the standards at the time when the operational licence was granted). These fall into the following categories:

- a) Incidental changes in systems, components or procedures should always be evaluated in order to assess their effects on safety. An integrated analysis may reveal certain undesired interactions.
- b) The recognition of accidents or combinations of accidents that may, as shown by experience or a safety analysis, lead to a situation that is not included in the list of design-basis accidents that formed the basis for the licence. A classic example is a large LOCA, which does not cover a smaller one.
- c) Control of the ageing aspects of the facility. Adaptations must at least be consistent with the level of safety considered to have been originally present. Their objective must be the continuation of the reliability of systems and components in the long term.

2. The rectification of deviations from new safety standards. The safety level of the facility is thus raised in comparison with the level that was assumed to exist during the licensing procedure. This includes:

- a) measures aimed at controlling additional beyond-design-basis accidents;
- b) the enlargement of safety margins;

- c) the prohibition of previously admitted materials;
- d) the introduction of more severe tests that may necessitate changes in construction.

The following subdivision can be made:

- 1) measures based on current, formalised principles and guidelines;
- 2) improvement of the original safety standards by adaptation to recognise safety considerations that have not yet been formalised, for instance by adopting ‘good practices’ developed elsewhere. This also comprises systematic evaluation, including potential measures, based on in-house experience or experience at other facilities.

The two above categories of back-fitting require different approaches, not only because of the varying importance attached to safety, but also for formal reasons. If there is a failure, whether actual or alleged, to attain the safety level imposed by the licence, immediate back-fitting may be ordered. This applies to categories 1a, 1b and, depending on the findings, 1c.

Category 2 usually requires a process of analysis, the object of which is to show what adaptations are possible, taking account of the desired improvement in the level of safety on the one hand and the cost on the other. Because of the improvement in the safety level that may be achieved, a category 2 activity may be given priority in practice. It should be noted, however, that there is a subtle distinction between 2a and 2b, in that 2a-type back-fitting can be enforced more easily.

There is also a difference with respect to the licensing procedure. Category 2 adaptations may necessitate changes in the licence, but this should in no way hamper the adaptations.

#### **d. Basis for back-fitting**

Back-fitting regulations can be imposed through any of a number of channels:

- by statutory means;
- by means of safety regulations imposed by law;
- through licensing requirements for the power plant in question.

A change in the regulations for power plant licensing is currently the fastest way of obtaining results. Studies could be performed to reveal whether back-fitting could be included directly in the law or in law-based regulations.

#### **e. Implementation of back-fitting**

##### *Continuous versus periodic back-fitting*

A distinction should be drawn between back-fitting as a semi-continuous process and back-fitting performed in the context of a special, integrated study. The latter can be carried out, as is done in an increasing number of countries, after periods not exceeding 10 years. The semi-continuous type of back-fitting is a direct response to events and accidents from which lessons can be learned, and also to all types of developments in safety technology that are reflected in modern practice, insights and rules.

10-yearly back-fitting is based on an integrated safety analysis of the as-operated facility on the basis of current views on safety. The analysis must take account of any modifications that have been made in the intermediate period. ‘Current views on safety’ include safety principles and guidelines currently in force. The 10-yearly back-fitting should also deal with the ageing of the facility. The situation as regards ageing must be investigated and described and adaptations must be aimed at renewed, long-term operation.

An integrated study includes a probabilistic safety assessment, which may also suggest certain topics for future investigation.

The distinction between ‘semi-continuous’ and 10-yearly back-fitting may easily become fairly blurred in practice. This is because foreseeable back-fitting will, for practical reasons, be spread over



time and will consequently take place (at least partially) simultaneously with other maintenance activities. In this respect, a 10-yearly integrated evaluation is to be considered primarily as an additional, systematic check on the more continuous type of back-fitting.

#### *Structure of back-fitting projects*

Back-fitting projects consist, roughly, of five functional stages:

1. an investigation of the state of the facility (or parts of it) and a comparison of this state with the requirements;
2. an evaluation of the results of the investigation of the state of the facility, including decisions on whether action is needed to deal with any deviations from the desirable state;
3. a search for practical measures that should lead to improved safety, if the evaluation indicates a need for this;
4. weighing up the costs of back-fitting measures against improvements in the level of safety likely to result from them (this does not apply where safety is to be restored to its original level);
5. the implementation of measures, provided the anticipated benefits are reasonably proportionate to the costs.

The cost-benefit analysis should preferably not be performed using formal criteria in terms of attaching monetary values to the radiation doses that the measures are intended to prevent. A more pragmatic approach is to be preferred, based on an evaluation, for each individual case, of what should be considered a reasonable effort in view of the expected improvement in safety. In cases where a significant improvement in the safety level is beyond doubt and where the costs are relatively low, back-fitting should certainly be carried out.

Decisions on the implementation of back-fitting measures should take sufficient account of the compatibility of the proposed measures with the existing design. The potential negative effects of back-fitting measures should be analysed before any existing design or procedure is adapted, as the existing design or procedure may have resulted from a consistent package of requirements or concepts regarding design or procedures. Priority should be given to measures that will undoubtedly improve overall safety.

#### *Nature of a 10-yearly review*

The two-yearly operational safety review is a condition of licence for the Borssele NPP. The justification for this safety review can best be derived from Guide 102 in NUSS Safety Series No 50-SG-O12 'Periodic Safety Review of Operational Nuclear Power Plants'.

Routine reviews of nuclear power plant operation (including hardware and procedural modifications, significant events, operating experience, plant management and personnel competence) and special reviews following major events of safety significance are the primary means of safety verification. In addition, some Member States have initiated systematic safety reassessments, termed periodic safety reviews (PSRs), to deal with the cumulative effects of plant ageing, modifications, operating experience and technical developments. These reviews are aimed at ensuring a high level of safety throughout plant service life. They are complementary to the routine and special safety reviews and do not replace them. The self-assessment is carried out in accordance with the methodology of this document.

The existing licence is used as the reference for the two-yearly assessment, whereas the reference for the 10-yearly review is 'up-to-date insights on nuclear safety'; hence the licence itself is part of the assessment.

The 10-yearly safety review should include:

- an analysis of the facility and the operating procedures in the context of the safety requirements and safety concepts which are in force;

- an evaluation of the plant's own operational experience, in particular if this has not yet led to immediate action;
- an evaluation of operational experience elsewhere (if this has not yet led to immediate action), in particular of comparable facilities (taking into account back-fitting measures taken in, or scheduled for, them);
- an evaluation of the reliability of systems and components, in view of ageing that has taken place, or is expected to take place, in the medium term;
- a probabilistic safety assessment of the as-operated facility as referred to above, including to a sufficient degree:
  - o the specific operational procedures, with staff qualifications and training;
  - o the programme of tests performed on a regular basis,
  - o the maintenance schedule.
- a check to determine whether the description of the facility and the operational and safety systems still reflects the actual situation;
- a check to determine whether the description of the current operating procedures for normal operation, failure, and accident conditions still reflects the current situation;
- based on the outcomes of the safety review: a description and analysis of the back-fitting measures, stating reasons for the choices made.

Decisions on the implementation of specific measures will be taken after evaluation by the regulatory authorities and after consultation with the parties involved. The descriptions and analyses should be updated again after the various measures have been implemented.

## Appendix 3 THE ROLE OF PSAs IN ASSESSING SAFETY

### a. History of the role of PSAs in the Netherlands

The background to the introduction of Probabilistic Safety Assessments (PSAs) in the Netherlands was political. At the time of their introduction, PSAs were primarily meant for use in relation to site-related issues in the chemical industry and the transport of dangerous substances. The subsequent decision to extend the use of PSAs to NPPs was also politically based.

As long as a PSA is comprehensive in its scope (including shut-down states, internal and external events, etc.) and is state-of-the-art, it will be an instrument that can be used to roughly demonstrate compliance with safety criteria, thereby recognising the uncertainty and imponderability of a large number of relevant matters. In that way it can be used as a decision-making tool, without the need for an absolute belief in the numbers yielded.

Both the Dutch nuclear power plants (of which one ceased operation in 1997) launched their PSA programmes in 1989. The main objective was to identify and assess relatively weak points in the design and operation of the power plants, and thus to facilitate the design of accident management measures and to support back-fitting. An assessment of source terms, public health risks, etc., was regarded as unnecessary at that time.

The licensees translated the regulatory requirements as well as their own wishes regarding the objectives of the PSAs into their original bid specifications:

- To identify and analyse accident sequences, initiated by internal and area events, that may contribute to core damage and to quantify the frequency of core damage.
- To identify those components or plant systems whose absence most significantly contributes to core damage and to isolate the underlying causes of their significance.
- To identify weaknesses in the operating, test, maintenance and emergency procedures that contribute significantly to the core damage frequency.
- To identify any functional, spatial and human-induced dependencies within the plant configuration that contribute significantly to the core damage frequency.
- To rank the weaknesses according to their relative importance and to easily determine the effectiveness of potential plant modifications (both back-fitting and accident management). See Annex 1 for a more detailed description of the PSA-based back-fitting and modifications at the Borssele NPP.
- To provide a computerised level-1 PSA to support other Living PSA activities such as the optimisation of Technical Specifications, maintenance planning, etc.
- To transfer technology and expertise to the licensee to allow it to evaluate future changes in system design and operating procedures, and to incorporate these changes in a Living PSA.

Major modification and back-fitting programmes were announced at around the same time, partly as a result of the accident at Chernobyl. A back-fitting requirement or 'rule' was formulated for the existing NPPs. The requirement addresses the design-basis area, but also the beyond-design-basis area and associated severe accident issues. The 'back-fitting rule' also requires 10-yearly safety reviews. This requirement was included in the operating licences issued for both plants. At that time an important part of these 10-yearly safety reviews was a level-1 'plus' PSA (level 1+).

When the level-3 outcomes are close to (or even above) a limit value, the PSA can be used to identify those 'weaknesses' which are the main contributors to the risk. In this way they can be used as a tool to identify potential back-fitting measures. In that respect, a level-2 or 3 PSA will in most cases be more valuable than a level-1 PSA. An improved level-1 risk (quantified as Total Core Damage

Frequency, TCDF) will not in all cases automatically lead to an improved level-3 risk (mortality risk). To optimise level-3 outcomes, therefore, the main focus should be on the prevention and mitigation of the larger source terms and not on reducing the TCDF.

At a later stage it became clear that the plants needed to have new licences in order to put the major modification programmes into effect. As part of the licensing procedure, both plants were required to submit an Environmental Impact Assessment (EIA). A substantial part of this was taken up by a 'full-scope' level-3 PSA, including an assessment of the influence of the proposed modifications. This meant expanding the scope of the ongoing studies. These studies were completed early in 1994. Their findings were also communicated to the Dutch Parliament.

The scope of the PSAs was also extended in the light of review processes, interim findings of the PSA, changes in the state of the art (e.g. assessment of the risks associated with low-power and shut-down states) and the broadening of the objectives.

In the early 1990s, these level-1+ PSAs were expanded to full-scope level-3 PSAs, including internal and external events, power and non-power plant operating states, and human errors of omission and commission. The PSAs were expanded partly in order to comply with the requirement that the studies should be 'state-of-the-art' (i.e. including non-power plant operating states and human errors of commission), and partly because of the licensing requirements associated with the ongoing modification programmes (i.e. an environmental impact assessment had to include a level-3 PSA).

Because at that time the PSAs were intended primarily to identify weaknesses in the operation and design of the two Dutch NPPs, they were used to support the modification programmes.

#### **b. Guidance for and review of the PSAs**

##### *Establishing guidelines for PSA*

At the start of the Dutch PSA programmes in 1988/1989, there were no national PSA guidelines. In addition, both the licensees and the regulatory body had very little experience in developing a complete PSA for a nuclear power plant. For this reason, both the licensees asked foreign contractors to develop their PSAs.

In 1988, at the first round of talks between the licensee of the Borssele NPP and the regulatory body, discussion was confined to general requirements and the scope and objectives of the PSA. One of the key elements in these talks was the need for technology transfer from the contractor to the plant staff. Before, much of the available knowledge came from studying the literature, such as NUREG reports, rather than from any hands-on experience. It is fair to say that the ongoing regulatory guidance and assessment benefited greatly from this technology transfer, as well as from the peer reviews that were held later. This was equally true of the licensees.

The regulatory requirements set and instructions given, concerned the scope, the level of detail, whether or not best-estimate techniques could be used for modelling purposes, etc. As far as more detailed technical matters were concerned, the USNRC PRA Procedures Guide (NUREG/CR-2300) and the PSA Procedures Guide (NUREG/CR-2815) were considered to be acceptable at that time.

##### *IAEA-missions – peer review of PSAs*

Because the Dutch authorities and their traditional technical support organisations had only limited experience of nuclear PSA programmes, and also because the regulatory body had very limited staff resources, the IAEA was asked to provide support. This support took the form of peer reviews of the PSAs (IAEA-IPSART missions, formerly known as IPERS missions), and training courses in PSA techniques and PSA review techniques. The PSAs of both plants were scrutinised by IPERS reviews at various stages of their performance. For example, the first stage of a peer review of the Borssele PSA by the IAEA took place at the start of the PSA programme. This review involved looking at the agreed scope of the PSA and assessing how this had been translated into a project proposal by the contractor.

Another example was a limited IPERS mission which took place with the aim of checking whether all the issues raised in previous IPERS missions had been adequately resolved in the final report. This review showed that all the issues raised in previous IPERS missions had indeed been adequately resolved, and that the PSA was of high quality.

### **c. Living PSA applications**

After the PSA relating to the modification project had been completed, the focus shifted towards Living PSA (LPSA) applications. The new licence for the modified Borssele plant required the licensee to have an operational Living PSA, but gave no further details of the concept or of the applicability of such an LPSA. Both the licensee and the regulatory body are in the process of defining the boundary conditions for possible applications.

The current ongoing LPSA applications are among others: support for back-fitting measures, support for periodic safety reviews, support for licensing activities, retrospective use of the risk monitor, optimisation of test and maintenance strategies, incipience of reliability-centred maintenance, etc. These applications will be continued or intensified. However, the number of applications may need to be increased in order to make maximum use of the LPSA. Potential applications are the use of PSAs for configuration control, the optimisation of Technical Specifications, or event analysis.

The PSA for the Borssele NPP is updated yearly. This means that both plant modifications and updated failure data are included in the PSA model. The operator, EPZ, is using the Living PSA for many applications:

- Evaluation of modification proposals (design review)
- Technical Specification optimisation
- Optimisation of the maintenance programme
- Optimisation of periodic testing
- Shut-down period configuration optimisation
- Day-to-day configuration evaluation
- Development of Severe Accident Management Guidelines (SAMGs)
- Use of PSA source terms for emergency planning & preparedness

Below a number of the applications are explained to some detail.

#### *Evaluation of modification proposals (design review)*

In 1993 the first 10-yearly Periodic Safety Review (PSR) took place. The PSR resulted in a major modification program. At that time the PSA was not yet finalised. Therefore, the new safety concept was mainly derived from a deterministic safety concept of the German Convoy plants. However it was felt that the PSA could play a large role in the optimisation and evaluation of the deterministic safety concept, the study of alternative solutions and in the licence renewal (Environmental Impact Assessment). Examples of the use of PSA to study alternative solutions were:

- second grid connection, and
- turbo against electrical driven auxiliary feed pump.

The established modifications reduced the TCDF from  $5.6 \cdot 10^{-5}$ /year to  $2.8 \cdot 10^{-6}$ /year.

In 2003 the second PSR took place. The PSA played an important role in this PSR. All issues were weighed against deterministic criteria (Low, Medium and High impact) and the risk significance (TCDF and Individual Risk (IR)). As a result the licensee presented an improvement plan. In it, measures were suggested for each level of the defence-in-depth concept:

- Installation of igniters at site boundary to counteract external gas clouds. Reduction of TCDF by 6% and IR by 54%;
- Increase of DG oil supply in the bunkered systems from 24 hrs to 72 hrs leads to a reduction of TCDF by 20% and IR by 7%;
- Improved seals of the low pressure Emergency Core Cooling System (ECCS) pumps lead to a reduction of TCDF by 20%;
- Improvement of Emergency Operating Procedures (EOPs) with regard to avoiding boron dilution of the primary circuit after start-up of the main coolant pumps.
- Implementation of SAMGs for low power and shutdown Plant Operational States (POS).

### *Technical Specification optimisation*

Recently Borssele NPP has finished a project where the Allowed Outage Times (AOTs) have been optimised. US-NRC Regulatory Guide 1.177 was used as the base for the application, amended to reflect the situation in the Netherlands. The Borssele NPP has modified the acceptance criteria from this guide by lowering them with a factor of 10.

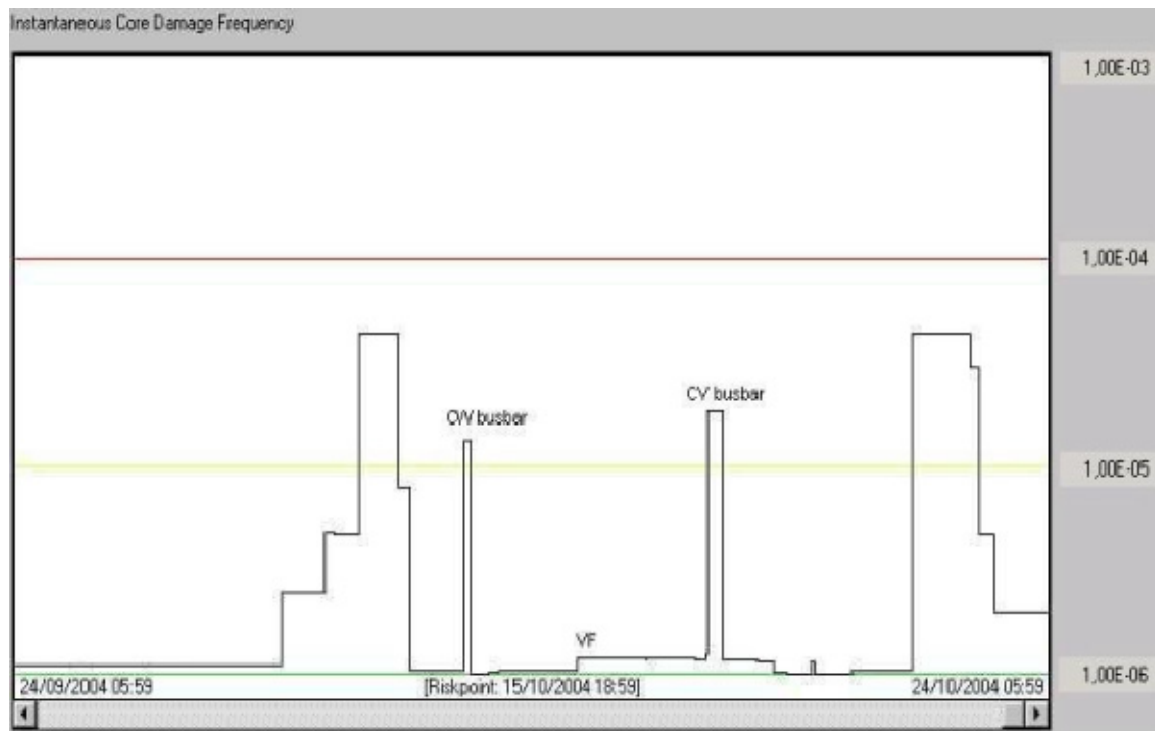
Other boundary values that have been used in the application include:

- For optimisation of AOTs the licensee has adopted a value of  $5 \cdot 10^{-8}$  for  $\Delta\text{TCDF} \times \text{AOT}$
- TCDF shall always  $< 1 \cdot 10^{-4}/\text{year}$ .

Apart from the PSA an expert team participated in the project to address deterministic views, like preservation of defence in depth and safety margins. The team also took into account items like necessary maintenance and repair times, adequacy of spare parts, availability and duration of supply of components on the market.

### *Shut-down period configuration optimisation*

In the figure below an example is given of the result of the outage planning for the refuelling outage in 2004.



**Figure 3 Result of outage planning in 2004**

One of the main objectives for the use of the risk monitor for configuration control is to minimise the TCDF increase as a result from planned component outages by:

- Mastering simultaneous component outages
- Rescheduling component outages with high TCDF impact in a certain plant operating state to an operating state where the component outage has a lower impact,
- Reduction of duration of the refuelling outage.

As a decision yardstick several numerical criteria have been developed by the licensee:

- Cumulative TCDF increase caused by planned and unplanned component outages < 5%
- Cumulative TCDF increase caused by planned component outages < 2 %.
- Instantaneous TCDF shall never exceed the value of  $1 \cdot 10^{-4}$  / year.

#### *Day-to-day configuration evaluation*

This application of LPSA must be stressed. The Borssele NPP is equipped with a high redundancy level. In many cases where a component is taken out of service, the technical specification AOT is not entered. In this area, the use of PSA is very useful. The cumulative delta-TCDF is used as a special performance indicator for this. EPZ aims to keep this indicator below 2% per annum in the case of scheduled maintenance (planned outages) and 5% for planned and unplanned outages combined.

#### *Development of Severe Accident Management Guidelines (SAMGs)*

The level-2 PSA demonstrated that SGTR events with a dry secondary side of the SG could cause the largest source terms and thereby, a large contributor to the public health risk (Source Terms up to 50% Cs and I). The most promising strategy was the scrubbing of the source term through the water inventory in the SGs. By installing extra pathways to keep the SGs filled with water (including flexible hose connection with the fire-fighting system) a factor 14 reduction in the magnitude of the source term (CsI and CsOH) could be achieved. A closer look at the MAAP4 results showed that the

major effect was not the scrubbing effect, but by deposition of fission products on the primary side of the SG tubes. This deposition effect plays also a large role in other core melt scenarios such as ISLOCA.

When core damage in ATWS scenarios cannot be prevented, opening of the PORVs is suggested. Loss of primary inventory is much faster, but creation of steam bubbles will stop the fission process. Also induced SGTR is less probable because of lower primary pressure. In case induced SGTR cannot be prevented lower pressure still helps. Opening of the secondary relief valves is less probable in that case.

*Use of PSA source terms for emergency planning & preparedness*

In the unlikely event that a severe event occurs at the plant with a serious threat for an off-site emergency, the 16 defined source terms in the PSA of Borssele are used as input for the prognosis. These source terms are already included as default input data in the computer codes being used for forecasting the consequences.

For the definition of the planning zones for evacuation, iodine prophylaxis and sheltering, originally the PWR-5 source term from WASH-1400 (Rasmussen Study) was taken as a conservative reference source term. Because the dose criteria for evacuation, iodine prophylaxis and sheltering were lowered, a re-evaluation of the reference source term was done by RB together with the KFD. Doing nothing would have resulted in (emergency) planning zones becoming significant larger than before and also larger than actually needed. Therefore, a more realistic and Borssele NPP specific source term was developed, matching the existing planning zone.

So far, risk assessment data have not been used by the regulator in planning inspections or the development of inspection procedures. Recently a study has been started to investigate whether the USNRC's 'corner stone' approach would be useful in the Dutch situation.

In 1999 the IAEA was asked to produce a Peer Advisory Report on LPSA applications tailored to the specific conditions in the Netherlands. Because the regulatory authorities expressed a wish to make greater use of LPSA insights and to move to a more risk-informed kind of regulation, the IAEA was also asked to include these aspects in its report. The resulting recommendation of most relevance to the KFD was that the authority should develop an appropriate framework for the formal and predictable use of risk information in regulatory decisions. Section d. of this Appendix, outlines the conclusions and recommendations of the IAEA report and describes follow-up action with respect to risk-informed regulation.

**d. Transition towards a more Risk-informed Regulation**

The regulatory body increasingly is confronted with design or operational changes which originate directly from, or are supported by arguments stemming from LPSA-applications at Borssele, and which require approval of the KFD. Therefore the IAEA was asked to advise the KFD in order to support this process. The focal points of this review are illustrated by questions like:

*“Are the LPSA-applications at the Borssele NPP state-of-the-art and sufficient, or should the operator do more?”*, *“How should the KFD respond to these applications, given a small regulatory staff and possible short remaining lifetime of the Borssele NPP?”*.

The main conclusions and recommendations were:

- Complete the implementation of the risk monitor with high priority in order for it to be used for maintenance scheduling, operating decisions and risk follow-up.



- Select those applications that can provide benefit to the plant in the near term<sup>21</sup>. This selection could be based on criteria such as dose reduction, regulatory requirements, maintenance costs, refuelling outage duration, etc. Examples of such applications are risk-informed improvement of technical specifications, risk-informed increment of on-line maintenance activities.
- KFD was suggested to develop a framework for the use of risk information in regulatory decisions. This should include the identification of objectives, description of the decision-making process and acceptance criteria, and clarification of how risk-informed decision-making is to be incorporated in the existing regulations. Since developing such a framework may take considerable effort, they were suggested to review existing risk-informed frameworks, bearing in mind that acceptance criteria need to be developed for the specific situation in The Netherlands.
- The resources required for accomplishing risk-informed regulation depend on how much use will be made of this approach, however, the IAEA team suggested that, as a minimum, KFD should continue to allocate one person, having in-depth knowledge of the Borssele PSA, for PSA-related activities, and that all decision-makers should have some training in PSA.
- The IAEA team felt that if applications are requested by the KFD to the Borssele NPP, these should be discussed with the plant to maximise mutual benefit. Also, the discussions raised the idea that perhaps the KFD and the Borssele NPP could develop a consensus document to conduct and assess PSA applications.
- Finally, IAEA suggested the KFD to use the PSA to focus the regulatory inspection program on the more significant systems, components, and plant practices.

As a follow-up of this advice, the KFD cautiously defined a follow-up program/feasibility study in order to proceed towards a more risk-informed regulation. It was decided to take a step-by-step approach. The first step is to familiarise with risk-informed regulatory approaches in Western countries, whilst the next steps are centred on a particular application, such as Technical Specification optimisation.

#### **e. Follow-up program**

The objective of this program was to arrive at a situation in which regulatory attention is more consistent with the risk importance of the equipment, events, and procedures to which the requirements apply, so that regulatory and licensee resources can be used in a more efficient way when making decisions with respect to ensuring the health and safety of the public. This objective implies that the regulatory requirements be commensurate with the risk contributions (i.e., regulations should be more stringent for risk important contributors, and less stringent for risk unimportant contributors). Therefore, provided risk informed regulatory criteria are appropriately developed, a systematic and efficient expenditure of resources are to be expected, while, simultaneously, a balance in overall plant safety can be achieved.

Examples of typical regulatory actions where risk-informed methods and requirements are thought to be helpful and therefore being investigated in the project, include:

- performance of periodic safety reviews;
- assessment of changes to the licensing basis, e.g. Technical Specification optimisation: surveillance test intervals, allowed outage times, limiting conditions of operation;
- assessment of operational practices or strategies on safety such as: plant systems configuration management, preventive and corrective maintenance prioritisation;
- prioritisation of regulatory inspection activities;
- the need for regulatory action in response to an event at a plant;
- one-time exemptions from Technical Specifications and other licensing requirements; and

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<sup>21</sup> The near term benefit was stressed due to the - at that time expected - closure of the NPP at the end of 2003

- assessment of utility proposals for modifications of the design or operational practices.

The development of Risk-informed Regulation in the Netherlands is bounded by the present limited nuclear power programme: one NPP (Borssele) in operation, and shutdown of this NPP eventually foreseen by the end of 2033.

Currently the focus of future activities/events for Borssele NPP is governed by licence requirements or external circumstances. It concerns initiation/continuation of:

- 10-yearly periodic safety reviews,
- 2-yearly operational safety reviews;
- monitoring of the plant safety culture during the expected plant staff reduction;
- deregulation of the electricity market;
- ageing and long term operation.

Under these boundary conditions, emphasis of the development of risk-informed regulation will be in the operational and not in the design area. Also QA is assumed to focus on operational items, in this respect. The design area, however, cannot be ignored, as the plant configuration determines much of the plant safety characteristics.

As the application domain is limited, and the available manpower within the KFD is also limited, the development of Risk-informed Regulation (RiR) should be based on existing approaches elsewhere; no separate ‘Dutch’ RiR development is to be foreseen. At this moment the main input comes from the USNRC developments. ‘Deregulation’ is meant as a support to the utility to operate and remain competitive on the electricity market. In practice, it means that active support will be given to activities aimed to decrease costs, as long as they do not compromise safety.

The main objectives of the RiR are therefore:

- support the above mentioned (bulleted) activities;
- focus KFD and plant resources on items relevant for risk; and
- eliminate unnecessary ‘regulatory burden’.

It is not the intention of the proposed RiR-project to generate formal revisions of the NVR-series Design, Operation and Quality Assurance. However, RiR-products will be documented and reviewed with the industry.

Overall, the RiR products will be application-oriented. In some areas, fundamental aspects may be touched, where no written guidance can yet be formulated. In those cases, a conclusion must be reached how to proceed on a more ad-hoc basis.

A special aspect of this project is feasibility if the current oversight process can be transformed into a more risk-informed oversight process. This includes the eventual use of safety significant performance indicators.

As a more formal start of this project, the adaptation of US-NRC Regulatory Guide 1.174 with regard to the Dutch Safety Criteria, is now underway. The results will be formalised as a Dutch Nuclear Safety Guide. Also the criteria proposed by the licensee for optimising Tech Specs will be included in this document.

### **f. Numerical Safety Criteria used by the licensee for operational decisions, AOT optimisation, configuration control etc.**

The licensee of the Borssele plant has defined several numerical safety criteria as Performance Indicators (PIs). Evaluation of historic output of the Risk Monitor was used as a basis for these PIs. The licensee has done so in order:

- to master simultaneous component outages;
- being able to reschedule component outages with high TCDF impact in a certain Plant Operating State to another refuelling operating state where the component outage has a lower impact;
- to reduce the component outage duration during the refuelling outage by shifting to on-line maintenance.

The KFD has welcomed these criteria and will incorporate them in its policy plan on Risk-informed Regulation.

*The PI for power operation:*

Total cumulative TCDF increase caused by planned as well as unplanned component outages should be < 5%. The cumulative TCDF increase caused by planned component outages shall be < 2%.

*The PIs for all operating states:*

Instantaneous TCDF (point in time risk) shall never exceed the value of  $1 \cdot 10^{-4}$ /year.

For optimisation of AOTs the licensee has adopted a value of  $5 \cdot 10^{-8}$  for DTCDF x AOT and TCDF always <  $1 \cdot 10^{-4}$ /year.



## Appendix 4 THE SAFETY CULTURE AT BORSSELE NPP

### a. Introduction

Reference is made to the Borssele NPP policy document 2001-0914 rev.4 of 2004:

*EPZ supports the intention in respect to safety culture as defined in the IAEA reports 75-INSAG-4, INSAG-12 and INSAG-15. The definition of the term safety culture reflects the way that the organisation is using people, resources and methods. It is the opinion of EPZ that the attitude, way of thinking, professionalism and alertness of every employee is of great importance to safety. EPZ shall take measures to maintain and promote these attitudes.*

The policy document links up with descriptions of the organisation's 'main processes', as laid down in the Operating Instructions and defined as:

- management and organisation,
- personnel and organisation,
- configuration management,
- operations,
- maintenance.

The main processes form the basis on which the annual departmental plans are drawn up. The policy document is linked to the business plan, which also discusses financial aspects.

### b. Introduction of safety culture programme

In 1996 EPZ launched a safety culture programme for the Borssele NPP. This is an ongoing programme in which new activities are defined every year to improve the safety culture of the personnel of the NPP. These include, for example:

- Introduction of the STAR principle to all employees, where STAR means 'Stop, Think, Act and Review'.
- Introduction of the topic of safety culture into toolbox meetings,
- Introduction of work practices sessions into operations and maintenance refresher courses,
- Introduction of the principle of management on the floor and regular management rounds,
- Management training on safety culture,
- Special focus on safety culture when performing root-cause event analyses,
- Involvement of staff in peer reviews of international nuclear power plants,
- Production of 'work practices' training films for contractors and NPP staff.

Below the above mentioned activities are explained to some detail.

#### *Introduction of the STAR principle to all employees*

All Borssele NPP staff members have attended a 2-hour training session explaining the STAR principle using day-to-day examples. The STAR principle has been developed to improve normal work practices.

#### *Introduction of the topic of safety culture into toolbox meetings*

All operations and maintenance employees are required to attend monthly toolbox meetings at which industrial and radiological safety issues are discussed. Safety culture issues have now also been introduced. These include the STAR principle, the system of work licences, the nuclear safety tagging system, etc.

*Introduction of work practices sessions into operations and maintenance refresher courses*

Refresher courses now include a full-day training session at which work practices are discussed on the basis of undesired events in the past year. There is a special focus on how to handle safety when attention seems to be totally absorbed by time issues. The main message here is: (nuclear) safety first; when there is any doubt, immediately inform management about the issue, so that no unnecessary time will be lost.

*Introduction of principle of management on the floor and regular management rounds*

An important aspect of safety culture is the communication of 'management expectations'. The best way to communicate these expectations is by the presence of management on the floor, e.g. workers must be in close contact with management in normal working situations, to avoid interpretation problems. This is difficult to do because managers tend to lead busy lives, and their presence on the floor does not have top priority. Special programmes and requirements are needed to force them to make time for it.

At the Borssele NPP, the advancement of the management-on-the-floor approach is being combined with the introduction of regular management rounds for all managers. The management rounds focus on the installation. During them, all deficiencies in the plant are noted. Priority is given to remedying the deficiencies in the right order. The management rounds are scheduled in such a way that management visits every area at least twice a year.

*Management training on safety culture*

In 1999, Borssele management attended a special training programme on safety culture. Special attention was paid to safety culture aspects in performing root-cause event analyses. Work practices and safety culture can be important root causes of undesired events. To handle this aspect in a systematic way in the root-cause analysis, the HPES methodology developed by WANO has been introduced at Borssele.

*Involvement of staff in peer reviews of international nuclear power plants*

There is a tendency to drift into accepting small deficiencies in a plant. After a while, things are taken as normal. By involving the staff of the NPP in international peer reviews, it is possible to re-establish the 'normal standard'. On average, five employees of the Borssele NPP are involved in international peer reviews (INPO (HPES), OSART) every year.

*Production of 'work practices' training films for contractors and NPP staff*

The Borssele NPP has produced a one-hour training film showing examples of good and bad practice in normal working situations. All NPP staff and staff of most of the main contractors must watch it. Because the film is highly realistic and field workers recognise the situations shown in it, it is highly effective in improving work practices. The film is updated every year on the basis of the yearly event analysis. In 2001, showings of the film were preceded by a presentation by maintenance managers. This proved an effective way of communicating management expectations.

**c. Evaluation of safety culture programme**

In the years 2004-2006 it was concluded that the safety culture programme should have an extra effort. This was based on the increasing number of small incidents and reported incidents to the regulator, but also on the results of evaluations that came to the conclusion that root causes of incidents are mainly work practices, non-compliance with procedures and communication, and that this has been the case for years without improvement. At the same time the international organisations like WANO and IAEA warned about complacency. Several international documents were stressing the importance of safety management and safety culture. Also the KFD requested to look into the international

developments in its assessment report (2005) of the 10-yearly safety evaluation. In 2006, the Covenant was agreed, that allowed for 20 years extra for operation, if certain conditions are met. This offered a new horizon and perspective for the operating organisation and added to the importance of a safety culture program.

In reaction to this the Borssele NPP has started amongst others to introduce the following steps:

- Introduction in 2005 of the function 'Safety culture officer' who has the duty to establish and follow-up the overall safety culture and human performance plan;
- Using the WANO Performance Objectives and Criteria and the WANO good practises;
- Using WANO support and trainings to introduce for instance Operational Decision Making, Pre- and Post- job briefing;
- Increasing the frequency of WANO peer reviews;
- Company culture improvement plan 2007-2008;
- From 2008 onwards, a Human Performance & Safety Culture (HP&SC) improvement plan introducing INSAG-15 and WANO guidelines for Human Performance.

Important recent results in 2009-2010 are:

- Improvement plan from a WANO Peer review in 2008 (follow-up in 2010)
- Documented and visible Safety Policy Statement (policy level commitment)
- Management Expectations pocket booklets per main department (management commitment)
- Human Performance Techniques (individual commitment) using INPO 06-002, as translated in Dutch (training includes contractors)
- Management Expectations and HP&SC will become an element of the Quality Management System.

The Borssele NPP and the KFD will evaluate each year what the results are of this new approach. The evaluation meetings will also focus on developments regarding performance indicators and regular independent review of safety culture.





## Appendix 5 REQUIREMENTS AND SAFETY GUIDES

### Requirements

- NVR 1.1. Safety Code for Nuclear Power Plant Design.  
Adaptation of IAEA Code Safety Series 50-C-D (Rev. 1)
- NVR 1.2. Safety Code for Nuclear Power Plant Operation.  
Adaptation of IAEA Code Safety Series 50-C-O (Rev. 1)
- NVR 1.3. Code for Quality Assurance for the Safety in Nuclear Power Plants and other Nuclear Installations.  
Adaptation of IAEA Code Safety Series No. 50-C-Q
- NVR 3.2.1 Requirements for the training of operating personnel of NPPs (only in Dutch)

### Safety Guides on Design

- NVR 2.1.1 Safety functions and component classification for BWR, PWR and PTR  
Adaptation of IAEA Safety Guide Series No. 50-SG-D1
- NVR 2.1.2 Fire protection in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D2
- NVR 2.1.3 Protection System and related features in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D3
- NVR 2.1.4 Protection against internally generated missiles and their secondary effects in nuclear power plants. Adaptation of IAEA Safety Guide Series No. 50-SG-D4
- NVR 2.1.5 External man-induced events in relation to nuclear power plant design  
Adaptation of IAEA Safety Guide Series No. 50-SG-D5
- NVR 2.1.6 Ultimate heat sink and directly associated heat transport systems for nuclear power plants. Adaptation of IAEA Safety Guide Series No. 50-SG-D6
- NVR 2.1.7 Emergency power systems at nuclear power plants  
Adaptation of IAEA Safety Guide Series No. 50-SG-D7
- NVR 2.1.8 Safety-related instrumentation and control systems at nuclear power plants  
Adaptation of IAEA Safety Guide Series No. 50-SG-D8
- NVR 2.1.9 Design aspects of radiation protection for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D9
- NVR 2.1.10 Fuel handling and storage systems in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D10
- NVR 2.1.11 General design safety principles for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D11
- NVR 2.1.12 Design of reactor containment systems in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D12
- NVR 2.1.13 Reactor coolant and associated systems in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D13
- NVR 2.1.14 Design for reactor core safety in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-D14
- NVR 2.1.15 Seismic design and qualification for nuclear power plants.

Adaptation of IAEA Safety Guide Series No. 50-SG-D15

**Safety Guides on Operation**

- NVR 2.2.1 Staffing of nuclear power plants and recruitment, training and authorisation of operating personnel. Adaptation of IAEA Safety Guide Series No. 50-SG-O1 (Rev.1)
- NVR 2.2.2 In-service inspection for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O2
- NVR 2.2.3 Operational limits and conditions for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O3
- NVR 2.2.4 Commissioning procedures for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O4
- NVR 2.2.5 Radiation protection during operation of nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O5
- NVR 2.2.6 Preparedness of the operating organisation (licensee) for emergencies at nuclear power plants. Adaptation of IAEA Safety Guide Series No. 50-SG-O6
- NVR 2.2.7 Maintenance of nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O7 (Rev. 1)
- NVR 2.2.8 Surveillance of items important to safety in nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O8 (Rev. 1)
- NVR 2.2.9 Management of nuclear power plants for safe operation.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O9
- NVR 2.2.10 Core management and fuel handling for nuclear power plants.  
Adaptation of IAEA Safety Guide Series No. 50-SG-O10
- NVR 2.2.11 Operational management of radioactive effluents and wastes arising in nuclear power plants. Adaptation of IAEA Safety Guide Series No. 50-SG-O11

**Safety Guides on Quality Assurance**

- NVR 2.3.1 Establishing and implementing a quality assurance programme.  
Adaptation of IAEA Safety Series No. 50-SG-Q1
- NVR 2.3.2 Non-conformance control and corrective actions.  
Adaptation of IAEA Safety Series No. 50-SG-Q2
- NVR 2.3.3 Document control and records.  
Adaptation of IAEA Safety Series No. 50-SG-Q3
- NVR 2.3.4 Inspection and Testing for Acceptance.  
Adaptation of IAEA Safety Series No. 50-SG-Q4
- NVR 2.3.5 Assessment of the implementation of the Quality Assurance Programme.  
Adaptation of IAEA Safety Series No. 50-SG-Q5
- NVR 2.3.6 Quality Assurance in procurement of items and services.  
Adaptation of IAEA Safety Series No. 50-SG-Q6
- NVR 2.3.7 Quality Assurance in Manufacturing.  
Adaptation of IAEA Safety Series No. 50-SG-Q7
- NVR 2.3.10 Quality Assurance in Design.  
Adaptation of IAEA Safety Series No. 50-SG-Q10
- NVR 2.3.11 Quality Assurance in Construction.  
Adaptation of IAEA Safety Series No. 50-SG-Q11
- NVR 2.3.12 Quality Assurance in Commissioning

NVR 2.3.13	Adaptation of IAEA Safety Series No. 50-SG-Q12 Quality Assurance in Operation
NVR 2.3.14	Adaptation of IAEA Safety Series No. 50-SG-Q13 Quality Assurance in Decommissioning Adaptation of IAEA Safety Series No. 50-SG-Q14



## Annex 1: TECHNICAL DETAILS OF BORSSELE NPP

### a. Technical specifications

The Borssele nuclear power plant is a light water PWR with a thermal power of 1366 MW and a net electrical output of approximately 490 MW. The installation is a two-loop plant designed by Siemens/KWU. The plant has been in operation since 1973. The reactor and the primary system, including steam generators, are in a spherical steel containment. This steel containment is enveloped by a secondary concrete enclosure.

The Borssele NPP has the following characteristics:

#### Overall plant

Net electrical output	485 MW
Gross electrical output	510 MW
Rated thermal power	1365.6 MW

#### Reactor

Number of fuel elements	121
Number of control elements	28
Type of fuel elements	15 x 15 - 20
Active length of fuel pins	2650 mm
Outside diameter of fuel pins	10.75 mm
Average power density of reactor core	90.2 MW/m <sup>3</sup>
Average linear heat rating	20.27 kW/m
Average heat flux	599 kW/m <sup>2</sup>
Fuel	UO <sub>2</sub>
Enrichment	4,4%

#### Reactor coolant system

Design pressure	176 bar
Normal (operating) pressure	155 bar
Internal diameter of RPV	3726 mm
Height of RPV	9825 mm
Basic construction material	22 Minor 37
Core outlet temperature	317.5 °C
Core inlet temperature	292.5 °C

#### Main coolant pumps

Number of pumps	2
Rated flow rate	18000 m <sup>3</sup> /h
Speed	25 s <sup>-1</sup>
Electrical power (hot conditions)	5100 kW

#### Steam generators

Number of steam generators	2
Design pressure, primary side	176 bar

Design pressure, secondary side	88 bar
Volume primary side per SG	27.2 m <sup>3</sup>
Volume secondary side per SG	123.6 m <sup>3</sup>
Height	17200 mm
Surface SG exhaust (smallest)	0.362 m <sup>2</sup>
Design temperature	350 °C
Material of U-tubes	Incoloy 800
Number of U-tubes per SG	4234
Total heat transfer area	3600 m <sup>2</sup>

#### Pressuriser

Overall volume	40 m <sup>3</sup>
Water volume (at full power)	24 m <sup>3</sup>
Steam volume (at full power)	16 m <sup>3</sup>
Total power heaters	2000 kW

#### Primary pressure relief

Number and type Details:	Three tandem PORV/Safety Valves (SEBIM); One tandem valve has a motor driven pilot valve and its activation pressure is controlled by the RPS/ESFAS. The other valves open and close at fixed pressure settings. All valves can be opened and closed manually to bleed the primary system in certain accident conditions.
Relief pressure (safety valve)	172 bar/ 176 bar/ 180 bar

#### Pressuriser relief tank

Total capacity	40 m <sup>3</sup>
Water volume (normal operation)	25 m <sup>3</sup>
Gas volume (normal operation)	15 m <sup>3</sup>
Temperature (normal operation)	50 °C

#### Safety systems

##### High-pressure core injection system

Number of high head pumps	4
Capacity	190 m <sup>3</sup> /h at 65 bar
Maximum discharge head	110 bar
Type	Centrifugal pump

##### Low-pressure core injection & RHR system

Number of low-pressure pumps	4
Capacity	465 m <sup>3</sup> /h at 8.1 bar
Maximum discharge head	9 bar
Type	Single-stage centrifugal pump

##### RHR heat exchanger

Number of Heat Exchangers	2
Design pressure, tube side	44.1 bar
Design pressure, shell side	9.8 bar

Borated water storage tanks for core injection systems (inundation tanks)

Number of tanks	4
Capacity per tank	178 m <sup>3</sup> of borated water
Boron concentration (H <sub>3</sub> BO <sub>3</sub> )	2300 ppm B
Pressure	1 bar

Medium-pressure core inundation buffer tanks

Number of tanks	4
Capacity per tank	21.5 m <sup>3</sup> of borated water
Boron concentration (H <sub>3</sub> BO <sub>3</sub> )	2300 ppm B
Design pressure	31.5 bar
Operating pressure	25 bar

Containment spray pumps

Number of pumps	2
Capacity	50 m <sup>3</sup> /h at 13 bar
Maximum discharge head	14 bar

Bunkered primary side reserve supple ion system (reserve injection system)

Number of pumps	2
Capacity	18.8 m <sup>3</sup> /h
Maximum discharge head	185 bar
Type	Piston pump
Number of borated water storage basins	2
Capacity	243 m <sup>3</sup> / 262 m <sup>3</sup> of borated water
Boron concentration (H <sub>3</sub> BO <sub>3</sub> )	2300 ppm B

Bunkered secondary side reserve supple ion system (reserve feed water system)

Number of pumps	2
Capacity	14 kg/s at 900 m
Maximum discharge head	1040 m
Type	Centrifugal pump
Number of demon water storage basins	2
Capacity	496 m <sup>3</sup> / 469 m <sup>3</sup>

Reserve core cooling/ RHR system

Number of pumps	2
Capacity	61.1 kg/s
Maximum discharge head	90 m
Number of Heat Exchangers	1 plate Heat Exchanger (titanium)

Emergency power

Number of diesel generators	5
Rated Power	3 x 4.343 MW and 2 x 0.845 MW

Spent fuel storage

Maximum capacity in inside-containment

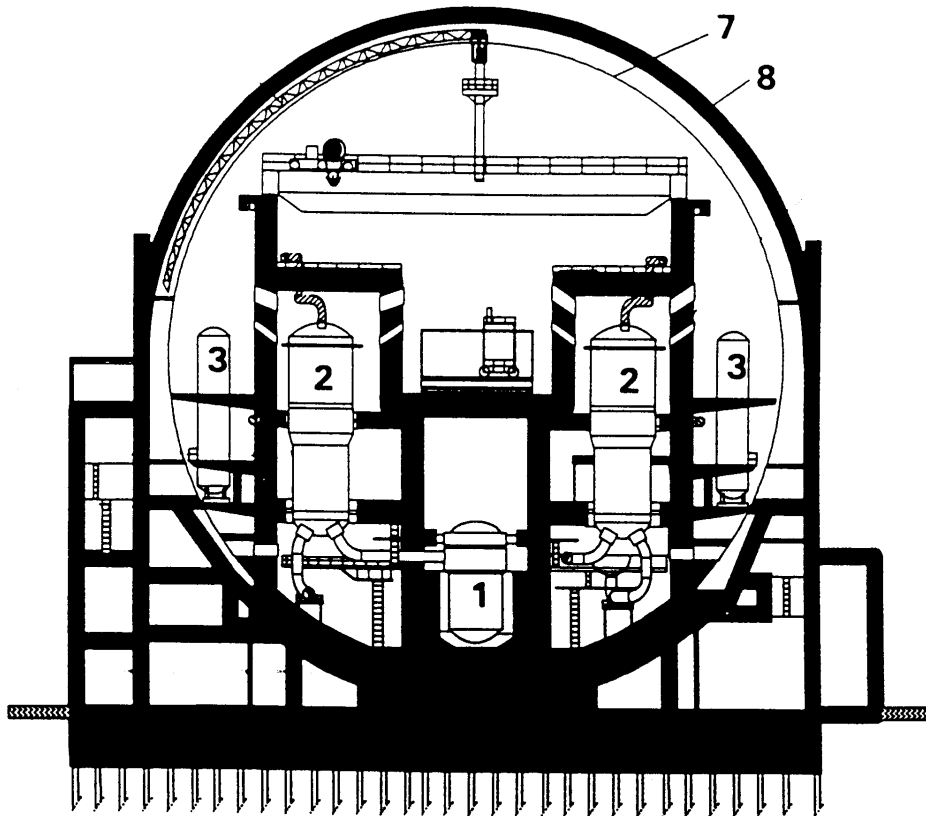
Storage Pool

Actual storage

500 elements in high density racks

298 elements (July 2004)

The end of this Annex shows graphs of the overall plant availability over the years, the number of incident reports from 1990 onwards and the number of unwanted automatic scrams over the years.



**Figure 4** Cross-section of reactor building of Borssele NPP

1. Reactor pressure vessel
2. Steam generator
3. Medium-pressure core inundation buffer tank
7. Steel containment
8. Secondary concrete enclosure (shield building)



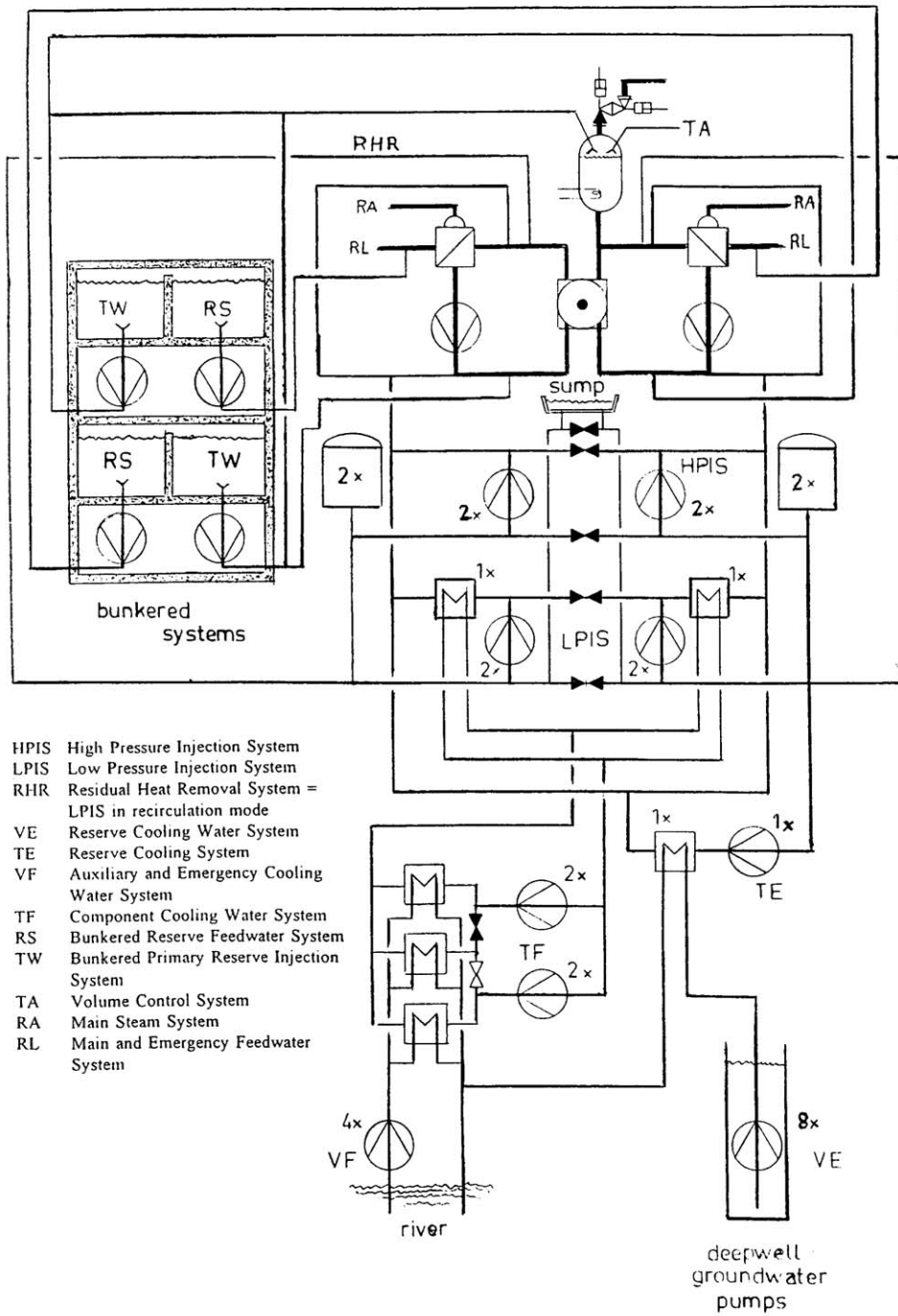


Figure 5 Safety features of core injection & RHR systems at Borssele NPP

**b. Safety improvements from the first 10-yearly Periodic Safety Review**

In the late 1980s, mainly as a result of the Chernobyl accident, the Dutch government formulated an accident management and back-fitting policy for the two NPPs that were in operation at the time. Both utilities were asked to upgrade the safety of their plants by incorporating state-of-the-art features, and hence to guarantee safe operation in the next decade. With the aid of the respective reactor suppliers, the two utilities developed a new safety concept for their plants in the early 1990s. In October 1996, the utility operating the Dodewaard NPP decided to close down the plant on economic grounds, and the ongoing modification programme was therefore halted. However, the utility operating the Borssele NPP (which was 20 years old at the time) embarked on a € 200 million modification programme.

The new safety concept was largely based on a comparison of the plant's current design basis with national and international deterministic nuclear safety rules; deterministic studies of the plant; insights gained from similar designs; operating experience and, last but not least, insights derived from the German Risk Study (DRS-B). Because a plant-specific PSA had not been completed at the start of the conceptual stage of the modification programme, the only PSA influences in the safety concept originated from the German Risk Study (DRS-B). However, a plant-specific PSA was performed in parallel with the activities for the conceptual design. This PSA played a major role in later stages of the modification programme. Once the safety concept had been finalised, it was translated into a 'safety plan', consisting of a package of modification proposals for the plant systems, structures and components.

The following list of features illustrates the impact of these modifications on the design of the Borssele NPP, especially the third, fourth and fifth echelons of defence:

- Functional and physical separation of redundant ECCS trains.
- Addition of a single train reserve cooling water system (RHR) to strengthen the decay heat removal capability. This system consists of a reserve decay heat removal system and a reserve emergency cooling water system including deep-well groundwater pumps.
- Functional separation of the closed component cooling water system trains and the addition of a fourth pump to this system.
- Increase in the discharge head of the pumps of the bunkered primary side reserve suppletion system (reserve injection system) to 168 bars.
- Connection of the bunkered primary reserve suppletion system (reserve injection system) to the pressuriser (spray) to make it easier to decrease pressure in the event of an SGTR.
- Functional separation of the auxiliary and emergency cooling water system trains.
- Replacement of emergency power diesel generators to increase the electrical output.
- Replacement of the existing main steam and feed water lines inside the containment and annular space (between the inner and outer containment) and partially in the turbine hall by qualified 'leak before break' piping; steam flow limiter at the containment penetration location and guard pipes around steam and feed water lines in the auxiliary building.
- Replacement of the primary power-operated relief valves (PORVs) on top of the pressuriser to improve the Bleed & Feed capability and to improve reliability in the event of ATWS situations (tandem principle). The number of PORVs has also been reduced, thereby reducing the LOCA frequency due to spurious PORV opening (although the reduction in the PORV LOCA frequency is due mainly to the revised staggered pressure set points for opening the valves).
- Complete renewal of the control room.
- Installation of a filtered containment venting system.
- Installation of a catalytic hydrogen recombiner to enhance the capacity for preventing or mitigating hydrogen burn, deflagration or detonation.

- Installation of a new reactor protection system and second control room in a new external events hardened building.
- Automation of the cooling-down of the primary system by means of SGs in the event of incidents or accidents such as minor break LOCAs (100 K/hour).
- Replacement of one of the two turbine-driven emergency feed water pumps by a motor-driven pump, to increase the reliability of the emergency feed water system.
- Installation of check valves on inundation tank lines (low-pressure ECCS) to eliminate a failure mode in sump operation.

**c. Modifications due to the second 10-yearly Periodic Safety Review**

The Borssele NPP in 2003 finalised its second 10-yearly periodic safety review. The evaluation process was started by the definition by licensee and regulator of the scope of the evaluation, and after discussions agreed upon. The first phase of the evaluation has resulted in a list of concrete items to be addressed in the evaluation.

Next, coherent evaluation items were clustered into improvement-issues. The safety-interests of the improvement-issues have been estimated, from a nuclear safety point of view as well as from a radiation protection point of view. The safety interests were characterized according to a method whereby both deterministic and probabilistic considerations were used. Additionally, expert judgement was part of this method.

The probabilistic safety interest of an improvement issue is based upon the maximum possible decrease of the core damage frequency (TCDF PSA level 1) and the decrease of the individual risk (IR PSA level 3). The safety benefit of the characterized improvement issues leads to a concept of structured measures, the integral improvement plan.

In 2004 the licensee presented a preliminary version of her improvement-plan as the final result of the evaluation process, to be implemented in the next coming years. For each echelon of the defence in depth concept modifications have been suggested. In the period 2005-2007, the majority of the modifications has been implemented.

To mention are:

*Technical measures:*

- Installation of detectors and igniters at site boundary counteract external gas clouds;
- Increasing the supply of diesel oil in the bunker systems from 24 hours to 72 hours;
- Installation of improved seals for the pumps in the low pressure injection system;
- Installation of a second reserve cooling water (TE) pump;
- Automatic starting of the bunkered primary reserve injection system if the level in the RPV becomes too low during midloop operation;
- Duplicating the control panel of the fire extinguishing system for the main coolant pumps to an area outside the containment.

*Organisational, personal and administrative measures:*

- Securing the competence and the experience in the organisation in the light of the future outflow of older employees;
- Establishing a risk analysis for safety relevant tests;
- Supplementary study of the radiation induced embrittlement of the reactor vessel internals;
- Updating the fire-PSA model;
- Possible extension of PSA application areas;

- Optimising the alarm plan; organisation, available means, instrumentation, further differentiation of source terms;
- Updating the fire hazard analysis;
- Improving instruction and training of fire protection;
- Relocating the control stand of the fire extinguishing system for the main coolant pumps.
- Improvement of the emergency Operating Procedures (EOPs) with regard to avoiding dilution of the primary coolant after start-up of a main coolant pump;
- Implementation of Severe Accident Management Guidelines for low-power and shut-down modes of operation;
- Implementation of an E-0 optimal recovery guideline for low-power and shut-down modes of operation (E-0 = reactor trip and safety injection, diagnostics).

**d. Man-machine interface (MMI)**

MMI was an important topic in the Borssele back-fitting programme that was implemented in 1997. It encompassed:

- enlargement and complete retrofit of the main control room,
- addition of a secondary (emergency) control room in a new external events hardened building,
- a full-scope replica simulator, including main and secondary control room,
- an emergency response and communication facility in the cellar under the office building.

The design of the latest MMI is a plant-specific solution applying modern techniques in a rather old plant. It is based on the following principles:

- The computerised process presentation system (PPS) is used by the operator only for obtaining information from the plant and guidance on accident management. The PPS information is also available outside the control room, in particular in the Emergency Support Centre.
- Safety significant plant information is also presented by panel instrumentation. Manual actuation of components can only be executed from control panels.
- The design of the control room follows a strict and consistent 4-quadrant system: shift supervisor, deputy shift supervisor, reactor operator and balance-of-plant operator.
- Operation of main control room and backup control room is mutually interlocked. To transfer control to the backup control room, the reactor must be scrammed before transfer of control can be performed.
- Control of components by the reactor protection system (RPS) or ESFAS has priority over manual control or control by non-safety classified automation. Where EOPs require an exemption for manual control (to optimise the events sequence), a key code is required.
- An Integrated Plant Status Overview panel (IPSO) is readable from any place in the main control room. Depending on deviations from normal operation, the mimics and set of parameters presented by the IPSO will automatically be adapted.
- Aforementioned PPS provides real time information like:
  - process conditions and parameters;
  - process mimics able to zoom in;
  - p, T diagrams presenting safe-unsafe limits and actual working points;
  - a critical safety function monitoring system (CSFMS), which indicates the status of the critical safety functions by colour codes with the possibility to instantaneously zoom in on status trees which lead to the use of the appropriate Function Restoration Guide, see below.

The critical safety status monitor presents six so-called Critical Safety Functions (CSF):

1. Sub-criticality
2. Core Cooling
3. Heat Sink
4. Vessel Integrity
5. Containment Integrity
6. RCS Inventory

These Critical Safety Functions (CSFs) are depicted on the IPSO panel in the control room by a small rectangle of six squares arranged in a 2 x 3 matrix. The same matrix is also depicted on all the computer screens in the control room. In addition a hard-wired classified panel depicting the same Critical Safety Functions is located in the control room. Each square representing a CSF can be depicted in four colours:

Green:	function is satisfied
Yellow:	function is abnormal
Orange:	function is endangered
Red:	function is violated

By clicking on one of the rectangular blocks in the little matrix on the CRT, the appropriate status tree is opened. The aforementioned measurements form the junctions in the status trees. Each junction answers a question if a certain threshold is passed which leads to the routings through the status trees, applicable to the actual situation. The routings end in the AM procedures prescribed for the current status of the plant. These procedures are executed from paper. The dominance in applying the procedures is indicated by the colours of the rectangular blocks, the routing in the status trees and the sequence in the listing of the six Critical Safety Functions.

Although the availability of the PPS is high, the system is not safety qualified. Therefore the CSMFS can act as a trigger, but the CFSs have to be verified on the hard wired information.

At the Borssele NPP, an integrated Event-Based and Symptom-Based package of Emergency Operating Procedures (EOPs) is used:

- The Optimal Recovery Guidelines (ORGs); ‘Event’-based procedures for LOCA, Secondary Line Break, SGTR and combinations of these.
- The Function Restoration Guidelines (FRGs); ‘Symptom’-based procedures for the overall safety of the plant.

The entry to this package is through the E-0 after Reactor Trip (RT) and/or Safety Injection (SI) procedure, to diagnose the event and to decide on the appropriate event based procedure, based on the event’s symptoms. There are three levels of diagnosis in the set of EOPs: an early diagnosis via E-0, a continuous diagnosis based on symptoms through the CSFs, and re-diagnosis via ES-0.0.

If a CSF is shown in any colour other than green on the computer screens, the addressed signals of the reactor protection system are also depicted on the screen, together with the necessary FRG. The combination of reactor protection signals and CSF uniquely defines the necessary FRG. The FRGs are selected on the basis of the status of the challenge and the ranking of the challenge as depicted by the CSF status board. 1st rule – colours; red, orange, etc., and 2nd rule – ranking of the CSF; Subcriticality, Core Cooling, etc.

As long as the Critical Safety Functions are satisfied (green) the event is dealt with by the event-based ORGs. The moment a Critical Safety Function is jeopardised, the operator has to use status trees to

select the appropriate FRG. The operator remains in that FRG until the CSF is shown in green again or another CSF takes higher priority.

**e. Data on radiation protection and exposure**

There has been a downward trend in the average effective individual dose at the Borssele plant ever since 1983. This is true both of plant personnel and of externally hired personnel. In the early eighties, the average effective individual dose was 4 mSv per annum for Borssele personnel and 5 mSv per annum for externally hired personnel. By the end of the nineties, the figures had decreased to 1 mSv and 1.5 mSv respectively. The trend of low doses seems to continue past the millennium.

The trend in the collective dose has been very similar to that in the individual doses. The total collective dose amounted to 4 manSv per annum in the early eighties. By the end of the nineties it had decreased to 1.0 manSv per annum. The trend of low doses seems to continue past the millennium.

Apart from the regular activities, the modification activities carried out in 1997 resulted in an additional collective dose of 1.8 manSv. The highest individual dose received in 1997 was 14.0 mSv.

The legal dose limits for members of the public are as follows:

- dose limit for any one source is 0.1 mSv per annum;
- dose limit for all sources together is 1 mSv per annum.

See Appendix 1 for the background to and justification of these figures.

The discharge limits in the licence for the Borssele NPP are as follows:

*Allowed releases in air per annum:*

Noble gases	500	TBq	
Halogens	50	GBq	, ...of which a maximum of 5 GBq J-131
Aerosols	500	MBq	
Tritium	2	TBq	
Carbon-14	300	GBq	

*Allowed releases in water per annum:*

Alpha emitters	200	MBq
Beta/gamma emitters (excl. 3H)	200	GBq
Tritium	30	TBq

The dose consequences to members of the public due to releases in amounts equal to the aforementioned limits are estimated to be:

- maximal individual dose from releases in air: about 0.7 microSv per annum;
- maximal individual dose from releases in water: about 0.01 microSv per annum.

Actual releases from 1973 onwards are shown on the following pages. As the actual releases are normally less than 5% of these discharge limits, the actual doses are also less than 5% of the aforementioned maximum doses.

The (actual) collective dose to the public from the releases in air is estimated at  $1 \cdot 10^{-3}$  manSv per annum.

The (actual) collective dose to the public from the releases in water is estimated at  $5.3 * 10^{-6}$  manSv per annum.

f. Discharges, doses and other relevant diagrams for Borssele NPP

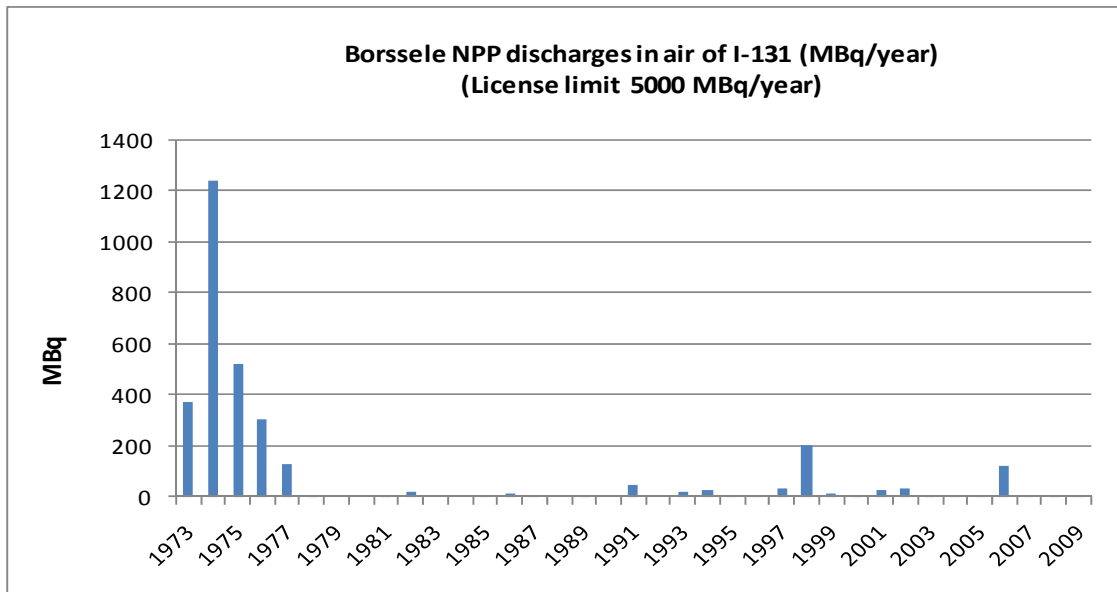


Figure 6 Borssele NPP discharges in air of I-131

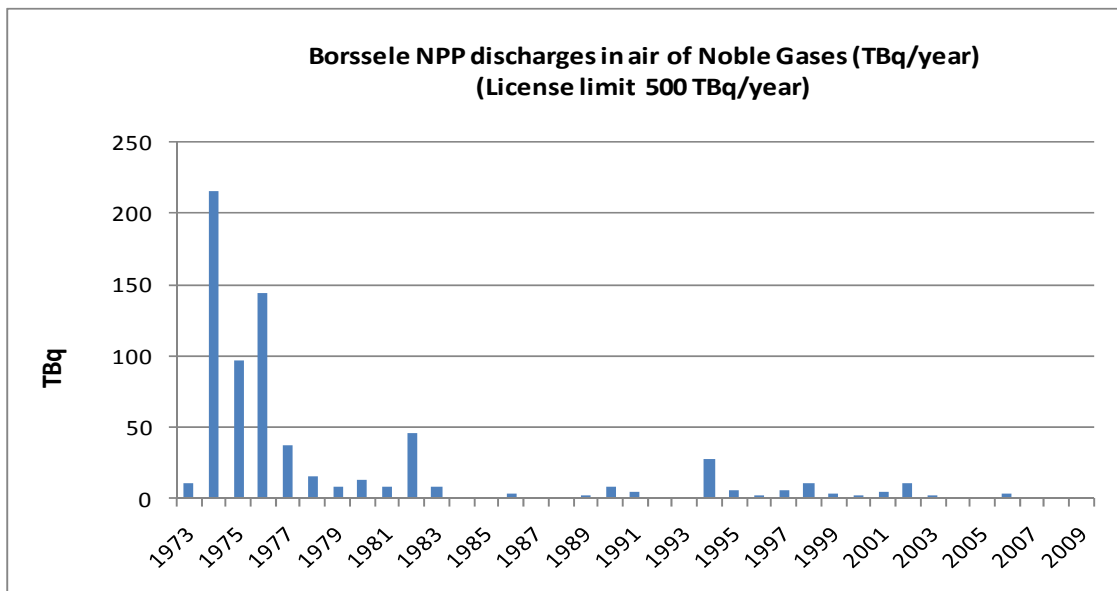
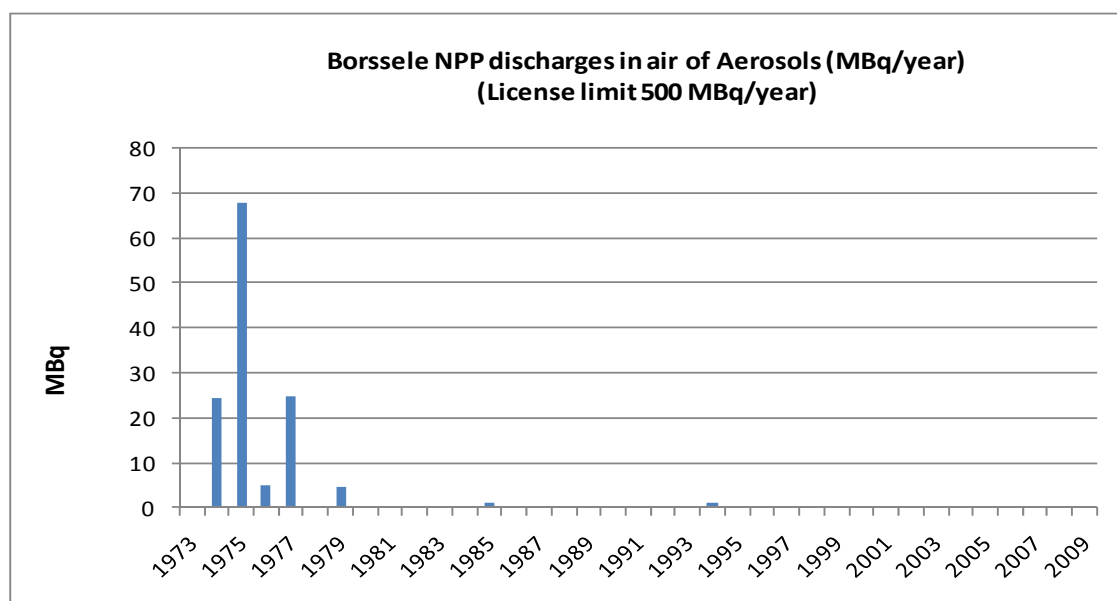
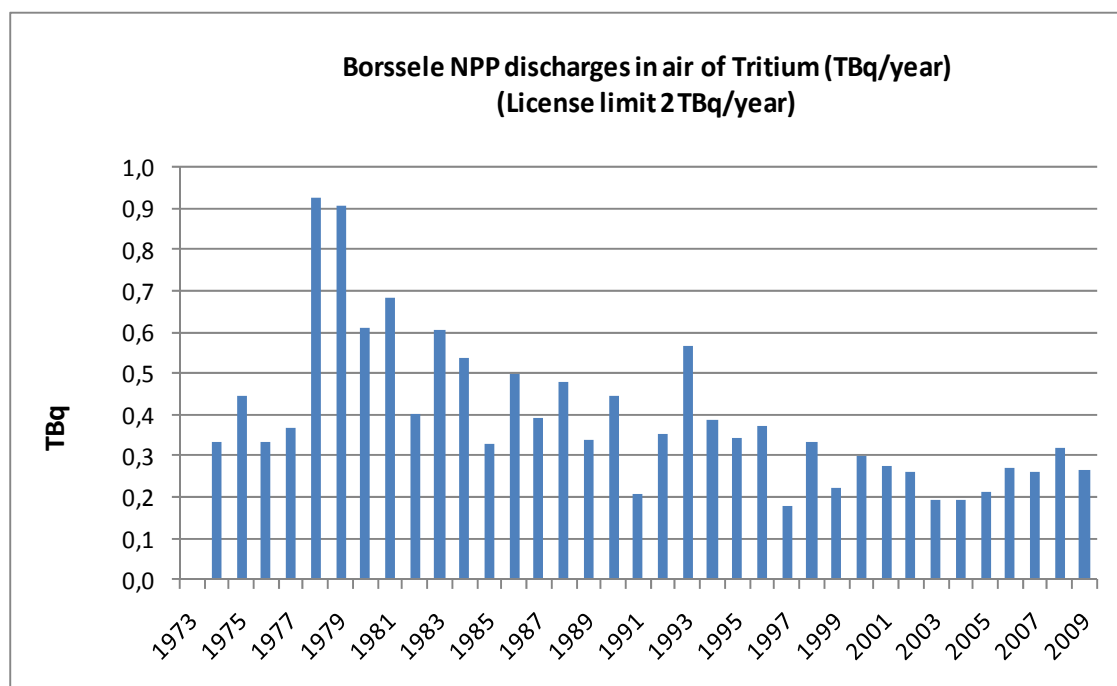


Figure 7 Borssele NNP discharges in air of noble gases





**Figure 8** Borssele NPP discharges in air of aerosols



**Figure 9** Borssele NPP discharges in air of tritium

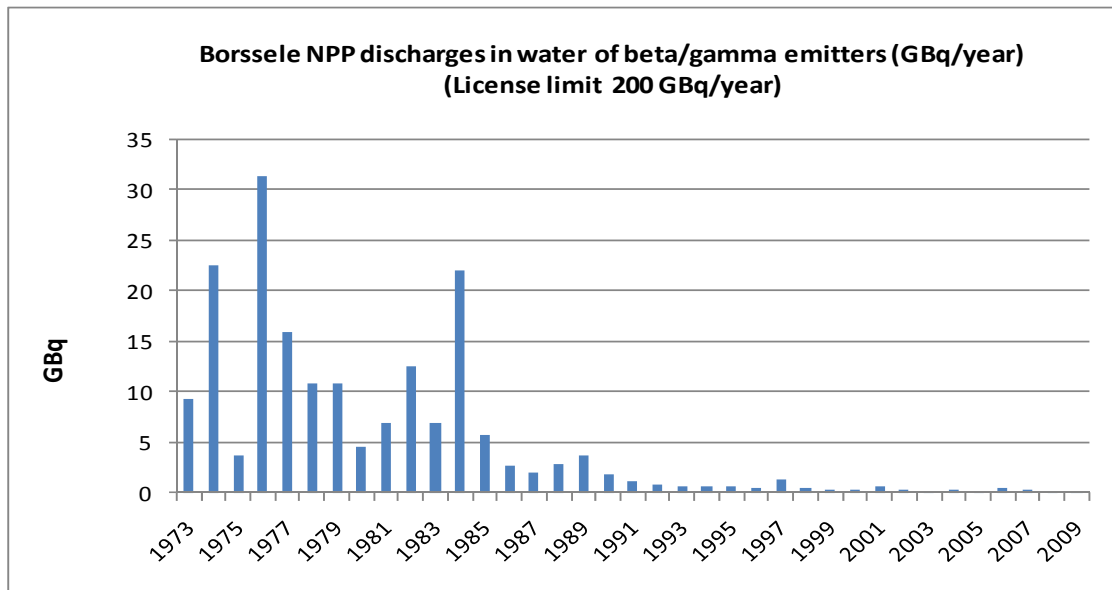


Figure 10 Borssele NPP discharges in water of beta/gamma emitters

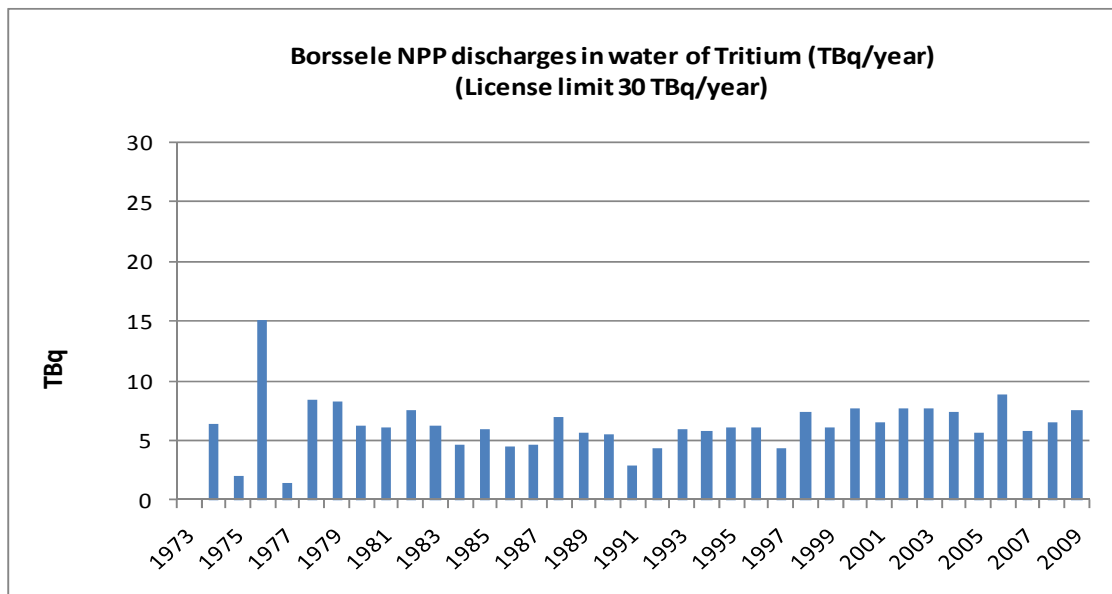


Figure 11 Borssele NPP discharges in water of tritium

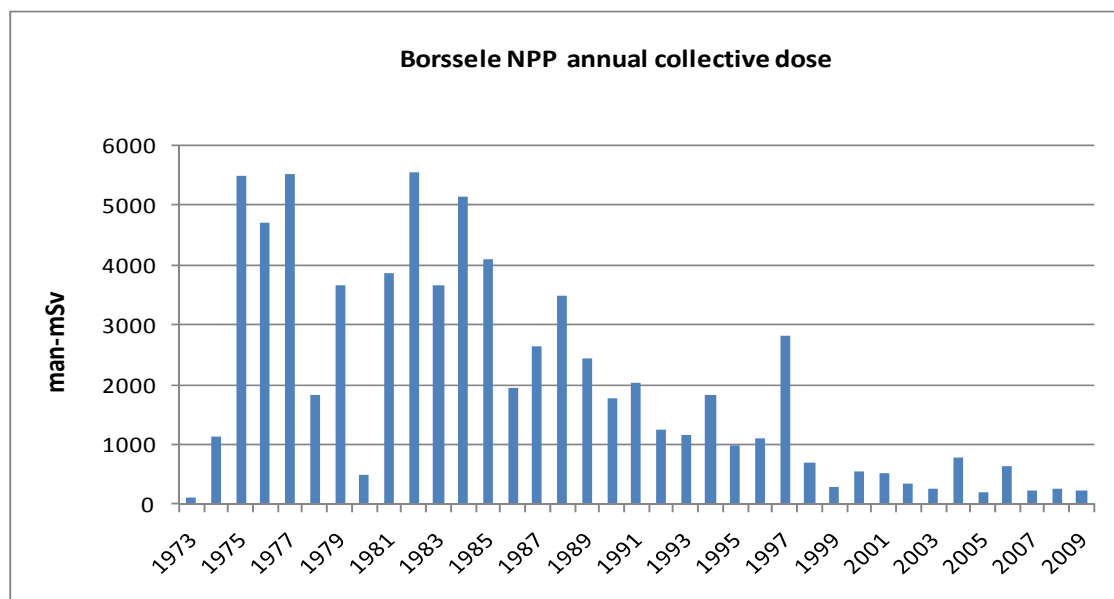


Figure 12 Borssele NPP annual collective occupational dose

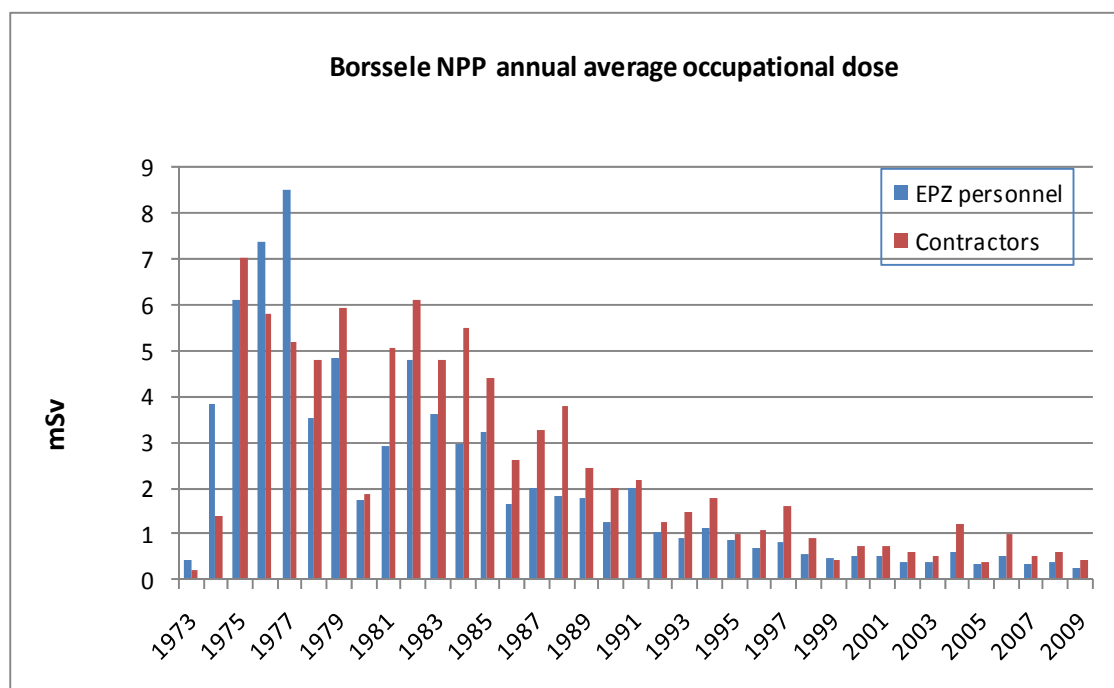


Figure 13 Borssele NPP annual average occupational dose

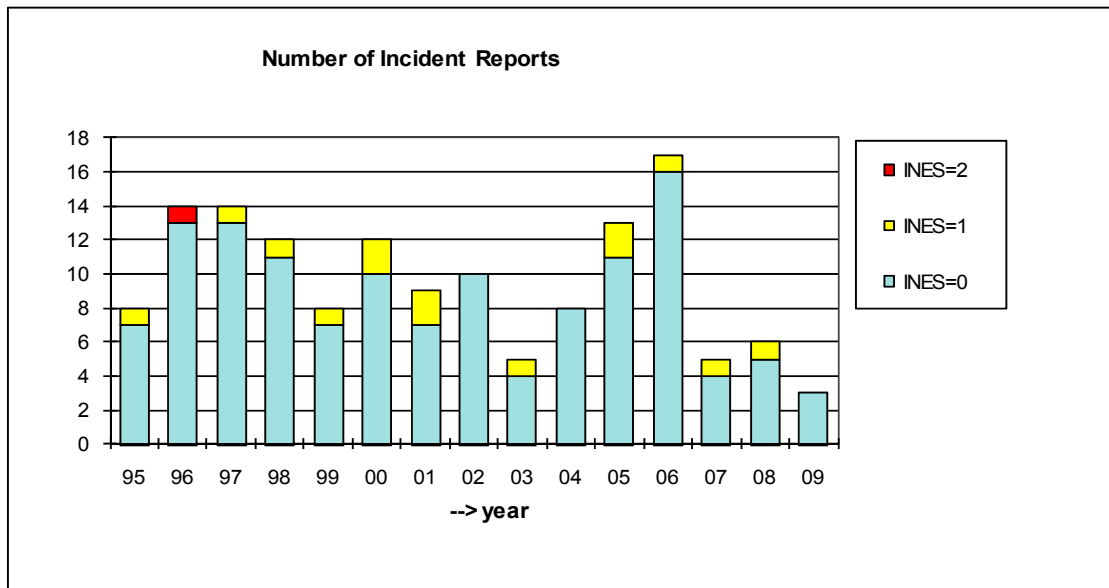


Figure 14 Number of incident reports

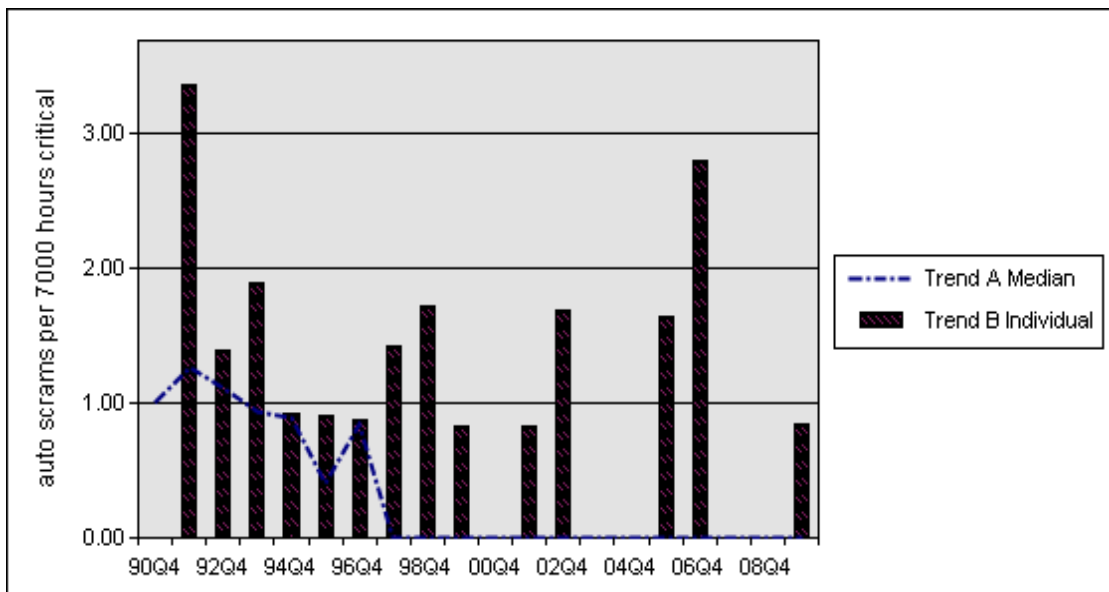


Figure 15 Unplanned automatic scrams.

Trend A Median is the world-wide trend, based on the WANO database, Trend B is the trend of the Borssele NPP.

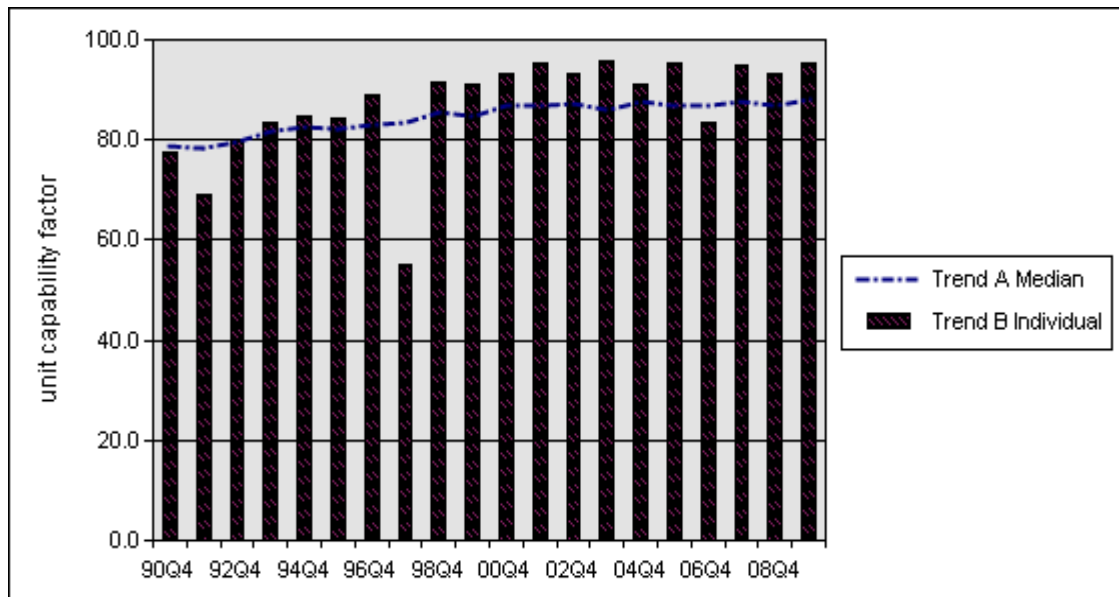


Figure 16 Unit capability factor.

Trend A Median is the world-wide trend, based on the WANO database, Trend B is the trend of the Borssele NPP.



## **Annex 2: BORSSSELE NPP COVENANT**

### **Introduction Covenant**

The operation licence for the Borssele nuclear power plant was issued in 1973 and does not contain a predetermined expiration date. This means that as long as the requirements (as stated in the regulations and the licence) are fulfilled, the plant is allowed to operate. The regulatory body is charged with the monitoring and control of the requirements and will intervene if necessary.

Following political pressure to shut down the plant (first by the end of 2003, later by the end of 2013) and in consideration of the new tasks and responsibilities of the government in the, now liberalized, energy production market, the desirability of a clearly predefined expiration date for the licence was recognized by the government. However, a unilateral decision of the regulatory body to shut down the plant on a short notice (in 2013), even if technically possible, might lead to a considerable damage claim. Also it was recognized that technical possibilities exist for continuing to operate the Borssele NPP safely after 2013 and that continued operation after 2013 could help to reduce greenhouse gas emissions.

An agreement with the owners of the Borssele NPP (EPZ, Essent and Delta) was therefore pursued, by which several issues could be settled and from which both the government and the plant owners could benefit. This resulted in the ‘Borssele Nuclear Power Plant Covenant’ which was signed in June 2006 by the Dutch government and the owners of the plant. In the covenant they agreed upon extending the operating life of the plant to no later than December 31<sup>st</sup> 2033 and the conditions which should be met during the remaining operating life. The agreements in the covenant are in addition to the requirements of the operation licence, which remains in full force.

The main agreements in the Covenant, besides the closing date, regard: 1) a so-called ‘safety-benchmark’; 2) extra incentive for more sustainable energy management in relation to the closing date of the Borssele plant; 3) funding of decommissioning costs.

The (unofficial) English translation of the Covenant is presented in the remainder of this Annex.

### **Borssele Benchmark Committee**

At the end of 2008 the Borssele Benchmark committee was established by the parties of the ‘Borssele Nuclear Power Plant Covenant’. Central government appointed two members of this committee, two others were appointed by the management and the shareholders of the NPP. All parties of the Covenant jointly appointed the chairman of the committee.

#### *Methodology*

The committee is making progress in developing and testing a methodology for assessing the safety performance of the NPP Borssele. The committee should determine if the NPP is among the twenty-five percent safest water-cooled and water-moderated power reactors in the European Union, the US and Canada. This implies ranking the safety of about 250 power stations and establishing whether Borssele is among the safest 25%. The safety analysis should cover the design, operation, maintenance, ageing and safety management.

The committee feels confident that with smart use of the available data combined with expert qualitative assessment it will be possible to conclude with sufficient confidence if KCB is among the safest 25% of power stations or not.

To do so it decided to make a separate safety evaluation of the reactor design and the way reactors are operated. The latter assessment will cover operation, maintenance, ageing and safety management. Considering its task the committee focuses only on safety aspects that are relevant for the surrounding

environment of the plant. Risks that may lead to damage of the plant and/or personnel operating the plant but provide no hazard outside the plant are not taken into account. The economic impact of these risks can be considerable but are solely born by the plant owner.

Separating the safety characteristics of design from the operational safety aspects implies that both aspects should be recombined in the final assessment. The way this will need to be done is under discussion. An important element in this discussion will be to what extent weighting factors attributed to these rather different aspects will influence the outcome.

*Progress (July 2010)*

The committee completed a trial evaluation of the safety characteristics of design using a set of design criteria developed by the committee and the enormous amount of design data publicly available. This evaluation proved that it is possible to make a credible ranking of the design safety aspects of the different power stations and to identify a top 25%. It is the intention of the committee to complete this evaluation by a more detailed analysis of the design safety characteristics of the KCB and a representative sample from this top 25 %. Regarding the operational characteristics the situation is somewhat more complicated. Although there is comparable data available on the operational performance of the power stations concerned, these data focus on the current state of the plant. These data have been used for a preliminary identification of a top 25%. The committee intends to repeat this analysis in the coming years to identify possible trends in relative plant performance. Furthermore the committee is exploring to what extent information on the programmatic approach by the plant operators to ensure safety can be added to this analysis. It feels that the level of forward looking control is an important element in all operational safety aspects so this should be looked into. It appears that IAEA Operational Safety reviews from so called OSART missions can provide a basis for this additional analysis. Further development of the methodology to be followed is now in progress.

*Planning*

The first report of the committee should be available in 2013. To be assured that this date will be met the committee intends to finalize its evaluation in 2012. To this end the discussion on methodology should be completed at the end of 2011 so 2012 can be used for the final data collection and a limited number of plant visits to check its findings and to allow for a more detailed analysis of the safety of Borssele NPP.



## **Borssele Nuclear Power Plant Covenant**

### **Extra incentives for the transition to sustainable energy management in relation to keeping the nuclear power plant in Borssele open for longer**

#### **Parties:**

1. **State Secretary of Housing, Spatial Planning and the Environment**, Mr P.L.B.A. van Geel, and the **Minister of Economic Affairs**, Mr L.J. Brinkhorst, also on behalf of the **State Secretary of Social Affairs and Employment**, Mr H.A.L. van Hoof, acting in their capacity as administrative bodies and in their capacity as representatives of the State of the Netherlands, hereinafter jointly referred to as “Central Government”;

#### **and**

2. **N.V. Elektriciteits Produktiemaatschappij Zuid-Nederland EPZ**, with its registered office in Borssele, legally represented for the present purposes by its director Mr J.W.M. Bongers, hereinafter referred to as “EPZ”;
3. **Essent Energie B.V.**, with its registered office in ‘s-Hertogenbosch, legally represented for the present purposes by its director Essent Nederland B.V., which company is legally represented by the chairman of the board of directors Mr M.A.M. Boersma, hereinafter referred to as “Essent”;
4. **Delta Energy B.V.**, with its registered office in Middelburg, legally represented for the present purposes by its director Delta N.V., which company is legally represented by the chairman of the board of directors Mr P.G. Boerma, hereinafter referred to as “Delta”;

#### **taking into account that:**

1. EPZ has been granted a licence<sup>22</sup> for an indefinite period on the grounds of the Nuclear Energy Act to operate Borssele nuclear power plant;
2. Delta and Essent each hold a fifty percent stake in the shares of EPZ;
3. Delta and Essent are also tollers of Borssele nuclear power plant, which means that they are buyers in equal proportion of the entire electricity production of Borssele nuclear power plant, for which they pay a tolling price;
4. the Outline Agreement of the Balkenende II cabinet (Outline Agreement) stipulates that “Borssele nuclear power plant shall be closed when the end of the technical design life is reached (end of 2013)”;
5. EPZ is not willing to cooperate voluntarily on the Outline Agreement to terminate operations of Borssele nuclear power plant at the end of 2013;
6. the State Secretary of Housing, Spatial Planning and the Environment has considered<sup>23</sup> shutting down Borssele nuclear power plant (by legislation) but has decided against this, owing to:
  - a. the results of the surveys referred to below,

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<sup>22</sup> Licence of 18 June 1973, no. 373/1132/EEK, further established by royal decree of 13 September 1979, no. 46, and amended by decrees of 26 May 1999, no. E/EE/KK/99004680, 22 September 2004, SAS/2004084087 and 13 December 2005, SAS/2005212596.

<sup>23</sup> Parliamentary documents II 2004/05, 30 000, no. 5, p. 2, 5 and 6

- b. the possibility of concluding a covenant with EPZ, Essent and Delta by providing an extra incentive for more sustainable energy management (energy efficiency, the production of renewable energy and clean fossil fuel) in relation to the closing date of Borssele nuclear power plant, and
  - c. the decision of the Lower House on this subject;
7. for the implementation of the Outline Agreement, the State Secretary of Housing, Spatial Planning and the Environment has conducted various surveys of the possibilities for closing Borssele nuclear power plant at the end of 2013 <sup>24</sup>;
  8. the main conclusions to emerge from these surveys <sup>25</sup> were that technical possibilities exist for continuing to operate Borssele nuclear power plant safely after 2013, that the continued operation after 2013 could help reduce greenhouse gas emissions and that legally enforcing the closure would lead to the State having to pay considerable damages;
  9. to give an extra impulse to the transition towards sustainable energy management, a survey was also conducted of the possibilities that exist for an innovative energy policy, thereby placing the problem of the closure of Borssele nuclear power plant in a broader perspective from the point of view of Central Government's aim of making energy management more sustainable;
  10. it was also taken into account that continuing the operations of Borssele nuclear power plant would provide considerable savings in terms of greenhouse gas emissions, such as CO<sub>2</sub> and NO<sub>x</sub>, and that the savings in CO<sub>2</sub> emissions are estimated to be 1.4 million tonnes CO<sub>2</sub> per year;
  11. the parties have held talks about these surveys;
  12. EPZ, Delta and Essent support Central Government's aim of achieving sustainable energy management;
  13. EPZ, Essent and Delta are already active in a wide field of developments concerned with energy efficiency and sustainable energy and intend to continue their activities in this field in the future within the scope of their aim of corporate social responsibility;
  14. in connection with agreements on keeping Borssele nuclear power plant open for longer, until no later than 31 December 2033, the parties are willing to give extra impetus to energy efficiency, the production of sustainable energy and/or projects that avoid or reduce greenhouse gas emissions, whereby Delta and Essent shall jointly achieve CO<sub>2</sub> emission reductions of 0.47 million tonnes per year and Central Government shall achieve CO<sub>2</sub> emission reductions of 0.93 million tonnes per year;
  15. further analysis <sup>26</sup> commissioned by the Ministry of Housing, Spatial Planning and the Environment and conducted by NRG and ECN in 2005 showed that there are no insurmountable objections to Borssele nuclear power plant remaining open until no later than 31 December 2033;
  16. EPZ is willing to undertake that Borssele nuclear power plant shall continue to comply with the safety standard described in article 4.2. EPZ is willing to undertake that Borssele nuclear power plant shall be one of the twenty-five percent safest water-cooled and water-moderated power reactors in the European Union, the United States of America and Canada. This obligation is in addition to the regulations that arise from the Nuclear Energy Act, the regulations based on that

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<sup>24</sup> Parliamentary documents II 2004/05, 30 000, no. 5

<sup>25</sup> Parliamentary documents II 2004/05 30 000, no. 5, appendix

<sup>26</sup> Kerncentrale Borssele na 2013, Gevolgen van beëindiging of voortzetting van de bedrijfsvoering, ECN-C—05-094 (Borssele nuclear power plant after 2013, Consequences of ending or continuing with operations, ECN-C—05-094), November 2005, NRG 21264/05.69766/C, November 2005

Act and EPZ's Nuclear Energy Act licence. These regulations are based on the ALARA (As Low As Reasonably Achievable) principle;

17. Central Government would prefer Borssele nuclear power plant to be dismantled immediately after it has been shut down, because Central Government believes this would remove uncertainties associated with deferred dismantling and make the Borssele nuclear power plant location available for other uses as soon as possible;
18. in a decision of 22 December 2005, the Council of Ministers agreed to the establishment of this covenant;
19. Central Government presented the Lower House with a draft version of this covenant on 10 January 2006 for examination<sup>27</sup>;
20. general consultations were held with the Lower House about the draft covenant on 27 April and 6 June 2006. General consultations continued on 8 June 2006. It emerged from the consultations that the covenant will have the support of the majority of the Lower House.

**Acknowledge having agreed as follows:**

**1. Definitions**

The following definitions apply in this covenant:

- *Borssele nuclear power plant*: the nuclear power plant at Borssele which commenced operations in 1973 and is known locally as BS30;
- *additional innovative projects*: projects of the kind referred to in article 8.2.

**2. Objective**

The aim of this covenant is:

- a. to extend the operating life of Borssele nuclear power plant to no later than 31 December 2033;
- b. for Delta and Essent to make extra efforts to achieve CO<sub>2</sub> emission reductions of 0.47 million tonnes per year;
- c. for Delta and Essent to invest in additional innovative projects to support the transition to more sustainable energy management, to help achieve the CO<sub>2</sub> emission reductions referred to in section b;
- d. the establishment by Essent and Delta of a fund to support innovative projects concerned with the transition to more sustainable energy management;

These objectives will be realised taking into account the following starting points:

- (i) to ensure that Borssele nuclear power plant shall be one of the twenty-five percent safest water-cooled and water-moderated power reactors in the European Union, the United States of America and Canada, to which end a committee of independent experts to be established by the parties shall regularly carry out benchmarking;
- (ii) Borssele nuclear power plant shall be dismantled as soon as possible after

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<sup>27</sup> Parliamentary documents II 2005/06, 30 000, no. 18, appendix

being shut down.

**3. Extending the operating life of Borssele nuclear power plant to no later than 31 December 2033**

3.1 Throughout the term of this covenant, Central Government shall not make a start on national and international legislation and regulations with the intention of closing Borssele nuclear power plant before 31 December 2033. Without detriment to article 10, this shall not affect the powers of the States General in this matter (which include the power to introduce legislation and to use the normal parliamentary powers to supervise the government) and the powers and obligations of Central Government to implement international regulations. Moreover, this shall not affect the powers and obligations of Central Government to implement national and/or international regulations, insofar as they concern the achievement of normal operations at Borssele nuclear power plant.

3.2 EPZ shall shut down Borssele nuclear power plant no later than 31 December 2033, without Central Government owing any form of compensation on account of the plant's shutting down.

3.3 a. The obligation referred to in subsection 2 to shut down Borssele nuclear power plant by 31 December 2033 at the latest, and the obligations described in articles 4.2 and 5, must, in the event of any alienation of the title, renting, leasing, lending or establishment of a real right of enjoyment in respect of the nuclear installations of Borssele nuclear power plant, be imposed on the subsequent acquirer(s) of the title, tenant(s), lessee(s), borrower(s) or owner(s) of real rights, stipulated and adopted on behalf of Central Government and included in any further instrument concerned with transferring the title, renting, leasing, lending or establishing a real right of enjoyment in respect of Borssele nuclear power plant.

b. Prior to the aforementioned alienation of the title, renting, leasing, lending or establishment of a real right of enjoyment, EPZ shall give Central Government at least thirty days' notice of its intention and provide the necessary information to demonstrate compliance with this section.

c. The obligations referred to in subsection a shall, if possible, be imposed as qualitative obligations on the subsequent acquirer(s) of the title, tenant(s), lessee(s), borrower(s) or owner(s) of real rights.

d. If a qualitative obligation is not possible, EPZ and Central Government shall do everything possible to register the provisions referred to in articles 3.2, 4.2 and 5 as a recordable fact by agreement between Central Government, EPZ and the land registry.

e. If neither a qualitative obligation nor the registration as a recordable fact is possible, the obligations referred to in subsection a shall be imposed on the subsequent acquirer(s) of the title, tenant(s), lessee(s), borrower(s) or owner(s) of real rights by means of a perpetual clause.

f. EPZ and Central Government shall endeavour to implement the obligations

referred to in subsections c and d by no later than 31 December 2006.

3.4 Contrary to article 3.1, in the event of new legislation and regulations or their application resulting in it no longer being possible for EPZ to actually deliver irradiated fissionable material to a third party, to enable fissionable materials to be reprocessed for Borssele nuclear power plant, with the result that Borssele nuclear power plant would have to be shut down, the parties shall endeavour to solve the problem jointly. Their attempts shall focus on EPZ, Delta and Essent finding a practical and economic alternative to enable them to continue operating Borssele nuclear power plant without interruption and without this leading to costs for Central Government other than Central Government being obliged to pay EPZ compensation for losses resulting from government decisions, if the competent authorities refuse to issue a reprocessing licence or impose conditions on the licence and EPZ consequently suffers disproportionately.

3.5 The parties shall implement this covenant with due care, bearing in mind their respective interests that are related to and arise from the covenant. They shall refrain from any activity that is contrary to this principle.

#### **4. Nuclear safety policy of EPZ**

- 4.1
- a. The parties shall establish a Committee (the Committee) of experts for benchmarking nuclear safety at Borssele nuclear power plant.
  - b. The Committee shall be composed of five independent members.
  - c. Two members of the Committee shall be appointed by EPZ, Essent and Delta jointly and two by Central Government. The parties shall jointly appoint the Committee's chairman.
  - d. The chairman and Committee members shall be appointed for five years. The chairman and Committee members may be reappointed at the end of an appointment period.
  - e. The Committee shall draft regulations on its performance; the regulations shall require the approval of the parties.
  - f. The Committee shall gear its work to that of, amongst others, the Department of Nuclear Safety, Security and Safeguards.
  - g. Half of the financial resources the Committee requires to perform its work shall be provided by EPZ, Essent and Delta jointly, and half by Central Government.
  - h. Central Government shall place an official secretary at the Committee's disposal.
- 4.2 EPZ shall ensure that Borssele nuclear power plant continues to be among the twenty-five percent safest water cooled and water-moderated power reactors in the European Union, the United States of America and Canada. As far as possible, safety shall be assessed on the basis of quantified performance indicators. If

quantitative comparison is not possible for the design, operation, maintenance, aging and safety management, the comparison shall be made on the basis of a qualitative assessment by the Committee referred to in article 4.1. To this end, external review missions shall be regularly requested, but at least once every five years, to provide an insight into the level of safety at Borssele nuclear power plant. The reports of the external missions shall be public, unless this is not possible on the grounds of agreements between EPZ and third parties or the security of Borssele nuclear power plant. These matters shall not affect Central Government's obligations pursuant to the Government Information (Public Access) Act. The Committee's final opinion shall be made public.

4.3 The regulations of the licence for the operation of Borssele nuclear power plant shall remain in full force. Likewise, the legislation and regulations on nuclear power plants that may apply at any time shall remain in full force for Borssele nuclear power plant.

## **5. Dismantling**

5.1 EPZ shall dismantle Borssele nuclear power plant as soon as possible after the plant has been shut down.

5.2 EPZ shall not place Borssele nuclear power plant in a safe containment building or other form of entombment.

5.3 EPZ shall submit a valid application to the competent authorities to shut down and dismantle Borssele nuclear power plant no later than six months before Borssele nuclear power plant is due to be shut down.

5.4 The parties have agreed that the target capital of the provision that EPZ is to form for the costs of shutting down and dismantling Borssele nuclear power plant only needs to have been achieved in the year 2033.

5.5 If EPZ is subject to a statutory obligation to provide financial security for the provision referred to in article 5.4, Central Government shall not, without EPZ's agreement, require EPZ to provide security in the form of a suretyship or bank guarantee or to participate in a fund set up for that purpose.

## **6. Policy of EPZ, Essent and Delta on sustainable energy management**

Delta and Essent shall each make a total financial contribution of € 125 million to achieving the transition to sustainable energy management. The contribution shall comprise:

- a. investments by Essent and Delta in additional innovative projects, as worked out in greater detail in article 8, and
- b. the establishment of a fund for financing innovative projects, as worked out in greater detail in article 9.

## **7. Additional CO<sub>2</sub> emission reduction of 0.47 million tonnes**

7.1 To achieve the objective stated in article 2, in the opening words and under b,

Delta and Essent shall take measures of the kind referred to in article 8 to achieve an additional CO<sub>2</sub> emission reduction of 0.235 million tonnes each per year. (The aforementioned tonnage is referred to below as the “Tonnage to be Achieved”).

- 7.2 Emission reduction means a reduction in the emission vis-à-vis “business as usual”. If the emission reduction is related to the production of electricity, the average emission of existing power stations in the calendar year preceding the investment decision concerned shall be taken as the starting point for determining the reference, whereby the combined burning of biomass in that calendar year (excluding the biomass agreed on in that calendar year in the Coal Covenant<sup>28</sup>) shall be considered as electricity generation based on fossil fuels that are burned in the power plants concerned.
- 7.3 The allocated emission reduction referred to in article 8.6, subsection a, shall be deducted from the respective Tonnages to be Achieved.
- 7.4 This covenant does not affect the calculation rules for the allocation of emission permits in the national allocation plan, as referred to in chapter 16 of the Environmental Management Act or in similar international allocation plans.

## **8. Investments by Delta and Essent in additional innovative projects**

- 8.1 Also with a view to achieving the CO<sub>2</sub> emission reduction stated in article 7.1, Delta and Essent shall each invest a sum of € 100 million in additional innovative projects. In connection with these investments, they shall attempt:
- a. in the period 2006 to 2008, to survey options for their own projects and make an analysis and provisional choices;
  - b. in the period 2009 to 2011, to work out these projects in more detail and apply for the required licences;
  - c. in the period 2012 to 2014, commit themselves financially to these projects.
- 8.2 A project shall be designated as an additional innovative project if:
- a. the project contributes to achieving sustainable energy management in the Kingdom of the Netherlands, including a structural reduction in the emission of greenhouse gases, and is realised in one or more of the following domains, amongst others:
    - fossil and/or biomass incineration/gasification techniques;
    - "multi-fuel" unit;
    - biomass unit(s);
    - CO<sub>2</sub> capture and storage;
    - CO<sub>2</sub> neutral fuels;
    - storage techniques for imbalance reduction by increasing non-baseload reprocessing;
    - energy-saving options, such as heat pumps, micro-CHP (Combined Heat and

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<sup>28</sup> Agreement of 3 August 2000 on reducing CO<sub>2</sub> emissions from coal-burning power plants

Power ) systems and the application/equipment introduction, and

b. the nature of the project is deemed to be innovative and demonstrates entrepreneurial courage, and

c. with the exception of the technical and economic risks, the project meets the minimum requirements that are normally set in Delta and/or Essent for investments of a comparable size, including profitability requirements and market expectations/assessments. Subsidies shall also be taken into account in this assessment, if the project concerned qualifies under the applicable rules for government subsidies. These matters do not affect the right of Delta, Essent and/or EPZ to apply for any such subsidies.

8.3 The investments that Delta and Essent make in additional innovative projects shall also be deemed to include additional innovative projects that are implemented and financed by EPZ. In that case, the investment obligations of Delta and Essent that are referred to in article 8.1 shall each be reduced by half of the sum in investments made by EPZ, unless specifically agreed otherwise.

8.4 If an additional innovative project of Delta and/or Essent also qualifies for a special subsidy that is created by Central Government after this covenant has been signed, with the intention of realising the Central Government Tonnage to be Achieved on the basis of article 7.1, the allocated emission reduction shall be proportionally ascribed to Central Government. The emission reduction ascribed to Central Government shall be based on the proportion of the subsidy amount that is actually allocated to the project on the basis of the arrangement referred to in the preceding sentence vis-à-vis the amount of the total investment of the project.

8.5 a. The parties shall establish a Committee for additional innovative projects (the A.I.P. Committee).

b. The A.I.P. Committee shall be composed of five independent members.

c. Two members of the A.I.P. Committee shall be appointed by EPZ, Essent and Delta jointly and two by Central Government. The parties shall jointly appoint the A.I.P. Committee's chairman.

d. The chairman and the members of the A.I.P. Committee shall be appointed until 1 July 2012.

e. The A.I.P. Committee shall draft regulations on its performance; the regulations shall require the approval of the parties.

f. Half of the financial resources the A.I.P. Committee requires to perform its work shall be provided by EPZ, Essent and Delta jointly, and half by Central Government.

8.6 a. Taking into account article 7.2, the A.I.P. Committee shall determine whether a project will be designated as an additional innovative project, and shall allocate to that project the volume of avoided greenhouse gas emissions vis-à-vis the



“business as usual” situation (“allocated emission reduction”).

b. EPZ, Essent and Delta shall submit their projects to the A.I.P. Committee in good time, so that the A.I.P. Committee has sufficient time to form the opinion referred to in subsection a before 1 January 2009.

c. An opinion or an allocated emission reduction of the kind referred to in subsection a shall be binding for the parties.

8.7 If EPZ carries out additional innovative projects, the allocated emission reduction shall be equally divided by Delta and Essent and deducted from the Tonnes to be Achieved by Delta and Essent respectively, unless specifically agreed otherwise.

**9. Establishment of a fund to support the transition to more sustainable energy management**

9.1 Delta and Essent shall establish a fund (the Fund) by no later than 31 December 2006 and shall maintain it for funding innovative projects that contribute to the aim of achieving sustainable energy management.

9.2 The details of the Fund's establishment shall be worked out by the parties before 31 December 2006 on the basis of the following main lines:

a. The appointment procedure for the managers of the Fund and the corporate governance shall include guarantees to ensure that the management is independent and has no relationship with EPZ, Delta or Essent. Central Government shall specifically check this independence;

b. The Fund shall have a “revolving character”. This means that agreements shall be made to ensure that the yields from the projects financed by the Fund are partially used to reimburse the financial resources provided by the Fund for the projects, plus a reasonable fee;

c. Immediately after the Fund's establishment, Delta and Essent shall each make an initial deposit of € 5 million into the Fund;

d. If and insofar as necessary for the Fund's financing requirements, Delta and Essent shall each make equal deposits into the Fund up to a maximum sum of € 20 million, at the request of the Fund and during the period up to 2033. The dates of the deposits shall be determined in relation to the Fund's financing requirements. Delta and Essent shall not be obliged to make additional deposits if and insofar as the fund's net worth is equal to or greater than € 50 million;

e. The criteria to be used for assessing projects shall be determined at the time that the Fund is established. The following minimum conditions shall apply:

- the projects must make a demonstrable contribution to the aim of achieving sustainable energy management,
- the projects must meet yield requirements that shall be further determined,
- the projects should preferably be carried out in the Netherlands or environmental

credits should in any case be ascribed to the Netherlands;

f. The maximum contribution towards financing a project shall be € 5 million per project.

**10. Indemnification in the event of interventions in the operating life of Borssele nuclear power plant**

10.1 If Central Government attributably fails in the fulfilment of the first sentence of article 3.1, and Borssele nuclear power plant is closed as a result of that, Central Government shall be obliged to pay compensation based on a reasonable assessment of the losses and lost profits suffered by EPZ, Delta and Essent up to 31 December 2033, including the additional costs incurred in connection with the early shutdown of Borssele nuclear power plant.

10.2 If Borssele nuclear power plant is shutdown before the date stated in article 3.2, as a result of initiatives of the States General, Central Government shall be obliged to pay compensation based on a reasonable assessment of the losses and lost profits suffered by EPZ, Delta and Essent up to 31 December 2033, including the additional costs incurred in connection with the early shutdown of Borssele nuclear power plant.

10.3 If Borssele nuclear power plant is shutdown before the date stated in article 3.2, as a result of the implementation of international regulations, Central Government shall be obliged to pay compensation based on a reasonable assessment of the losses and lost profits suffered by EPZ, Delta and Essent up to 31 December 2033 in connection with the investments in additional innovative projects, on condition that the compensation is compatible with Community law.

10.4 If Borssele nuclear power plant is shutdown before the date stated in article 3.1 because EPZ no longer meets the applicable safety requirements, as they arise from the Nuclear Energy Act and regulations based on that Act, Central Government shall not be obliged to pay any form of compensation.

**11. Character of the covenant, applicable law, court with jurisdiction**

11.1 Insofar as this covenant contains civil-law rights and obligations, it may be deemed to be an agreement pursuant to civil law.

11.2 This covenant is subject exclusively to Dutch law.

11.3 Any disputes concerning this covenant or agreements relating to it that are not solved by mutual agreement shall be brought before the competent court with jurisdiction at The Hague for settlement.

**12. Other provisions**

12.1 Neither party is entitled to transfer its rights and obligations arising from this covenant to a third party without the written approval of the other parties. Any such approval shall not be withheld on unreasonable grounds. Grounds for

withholding approval may only relate to this covenant.

- 12.2 This covenant may only be changed or supplemented by means of a statement signed by the parties.
- 12.3 If Delta and/or Essent have effectively demonstrated on 31 December 2008 that the submitted additional innovative projects for which investments on the grounds of article 8.1 will be made will not result in the complete realisation of the agreed CO<sub>2</sub> reduction, the parties, having heard the A.I.P. Committee on this matter, shall hold further discussions as soon as possible. They shall give shape to the obligations that are still outstanding and the manner in which they are to be performed.
- 12.4 If any provision in this covenant is deemed to be invalid and/or impracticable, the validity and practicability of the covenant's remaining provisions shall not be affected and the parties shall mutually agree on the replacement of the invalid or impracticable provision by a valid and/or practicable provision with a nature and purport that are as close as possible to the intention of the invalid and/or impracticable provision.
- 12.5 After signing this covenant, if circumstances, with the exception of the circumstances referred to in articles 3 and 10, change substantially in a way that affects the performance of the parties or entails EPZ, Essent or Delta incurring additional costs, the parties shall hold reasonable discussions with each other about the changes with a view to finding a solution that is acceptable to all parties.
- 12.6 Any notices the parties issue to each other on the grounds of this covenant shall always be served in writing.
- 12.7 During the period from the date of signing this covenant until 31 December 2014, Delta and Essent shall send Central Government a written report every two years outlining the performance of their obligations on the grounds of articles 7 to 9. These reports shall be presented within five months of the end of the period they concern. The first report shall cover the period that ends on 31 December 2006.

### **13. Term**

This covenant shall enter into force on the day after all the parties have signed the covenant and shall end on the completion date of the dismantling of Borssele nuclear power plant, as referred to in article 5.1. As evidence of their agreement the parties shall agree on this date in writing.

### **14. Publication in Government Gazette**

One month after it enters into force the text of this covenant shall be published in the Government Gazette.

**As agreed and signed in quintuplicate.**

The State Secretary of Housing , Spatial  
Planning and the Environment

N.V. Elektriciteits Produktiemaatschappij  
Zuid-Nederland EPZ,

P.L.B.A. van Geel  
(place: Goes                      date: 16 June 2006)

J.W.M. Bongers  
(place: Goes                      date: 16 June 2006)

The Minister of Economic Affairs

Essent Energie B.V.,

L.J. Brinkhorst  
(place: Goes                      date: 7 June 2006)

M.A.M. Boersma  
(place: Arnhem                      date: 9 June 2006)

Delta Energy B.V.,

P.G. Boerma  
(place: Goes                      date: 16 June 2006)

## Annex 3: HIGH FLUX REACTOR (HFR)

### a. General description

The HFR is a relatively large research reactor with a current thermal output of 45 MW<sub>th</sub>. It is a tank in pool type reactor of a design similar to the old Oak Ridge Reactor in the USA (Figure 17, Figure 18, Figure 19 and Figure 20). Comparable reactors are the R2 reactor in Studsvik, Sweden and the Safari reactor in Palindaba, South Africa. The latter is still in operation.

The aluminium reactor vessel with 4.5 cm thick walls (core box) is located at the bottom of a 9 m deep pool (Figure 18 and Figure 20). In 1984 the first reactor vessel was replaced by the current vessel, partly because radiation induced embrittlement of the core box was suspected. Later, it turned out that this embrittlement was far less than anticipated. The reactor vessel and the reactor pool are located inside a gas-tight steel containment with a 25 m diameter and 12 mm thick walls. A closed primary cooling circuit is connected to the reactor vessel. This primary circuit consists of 16" and 24" aluminium piping, a 43 m<sup>3</sup> decay tank, three electrically driven main primary cooling pumps and three heat exchangers (see Figure 19 and Figure 21). The heat is discharged by an open secondary system, pumping water from a canal to the sea. The decay tank, primary pumps and heat exchangers are located in a separate pump building, together with two electrically driven decay heat removal pumps. In addition, decay heat can also be discharged by natural circulation over core and pool.

The HFR was originally designed to operate with over 89% high enriched U.A1x as fuel. In 2005 a new licence was issued to operate the reactor in future using low enriched uranium (LEU) with an enrichment of less than 20%. The conversion from HEU to LEU was completed in the autumn of 2006. Table 1 gives some technical details of the HFR and the fuel.

### b. History and use of HFR

The construction of the facility began in the mid-fifties at the Petten site, a location in the dunes close to the sea. The reactor core achieved criticality for the first time in 1961. In 1962, following a special request by the Dutch government, an agreement between the Dutch government and the European Community for Atomic Energy (Euratom) was signed by which it was decided that Petten would host one of the four Joint Research Centres (JRC). As a consequence of that agreement, ownership of the reactor was transferred to the European Committee for Atomic Energy (Euratom) in 1962.

Although the Joint Research Centre (JRC) Petten became the licensee, the operation and maintenance of the reactor was subcontracted to the founding organisation, Reactor Centre Netherlands. This organisation was later renamed the Energy Research Foundation Netherlands (ECN). In 1998, the nuclear branches of ECN and KEMA (a research institute of the Electric Power Utilities) were merged and the operation of the HFR was consequently transferred to the newly formed organisation NRG (Nuclear Research and consultancy Group). NRG was also granted the right to exploit the HFR commercially.

Although much of the use of the reactor is still in the field of materials research, including new fuel types, the reactor is increasingly being used for medical applications. Notable examples are:

1. the production of radio-isotopes (about 20% of the world production of molybdenum-99 for so-called Technetium generators and about 70% of the world production of Iridium-192 is produced in the HFR), and
2. irradiation of patients with highly malignant brain tumours using Boron Neutron Capture Therapy (BNCT). This is a new therapy still under development.

**c. Modifications**

From 2002 to 2005 a first periodic safety review was executed. References were the existing IAEA rules and regulations for research reactors, complemented with some principles applied in nuclear power reactors. The design basis got newly defined by a complete set of PIE analyses. Ageing and operating experience were investigated and there was a survey of the state of the art, which included visits to other research reactors. A probabilistic risk scoping study complemented the deterministic analyses. The safety review resulted into a list of recommendations and suggestions. This led to a Safety Design and Modification Concept. The most important modifications were described in the aforementioned nuclear licence of 2005.

The new safety concept of the HFR is mainly based on three safety functions: safe shut-down of the reactor, long-term decay-heat removal, and containment. This concept is based on the traditional principles of defence-in-depth and multiple safety barriers for all accident conditions. In addition, a 30-minute autarchy period has been introduced during which no credit for operator intervention is taken. The safety analyses and risk scoping study being conducted within the framework of the 10-yearly periodic safety review, bearing in mind this safety concept, have produced a number of recommendations for improvements, most of which are implemented in the last two years as part of a major modification programme. Due to media and political attention, a measure to overcome the effects of a special large-break LOCA (installation of a vacuum breaker on the reactor vessel head) has been licensed separately and was implemented in late 2003. The major features of the modification programme implemented are:

- installation of additional vacuum breakers on the primary system to prevent uncovering of the core during a large break LOCA;
- installation of Accident Pressure Equalisation lines preventing pressure built up and uncovering of the core in the event of a boiling core;
- controlled use of pool water in case of a primary leak combined with loss of power by installation of pool water injection valves; this enhances the passive safety of the plant;
- replacement of one diesel driven decay heat removal pump by an electrical pump with own battery back-up, increasing the availability of the emergency core cooling;
- modification of Emergency Power System logic;
- limitation of the portal crane movement inhibiting hoisting above the reactor vessel during reactor operation;
- a shock damping structure to prevent pool damage by a falling transport container;
- installation of a manual operated alternative shutdown system for ATWS events;
- jackets around existing siphons in the primary cooling water system providing redundant containment isolation.

The last three topics have not yet been finished because of unsatisfying side effects. From 2008 all attention went to the deformations and the repair of the primary cooling water lines as described in section 6.2. So, progress of the modifications stopped. Re- evaluation is planned after the repair will be finished in August 2010.

A second Periodical Safety Review is planned to be started in 2011.

**d. Licence renewal**

In 2005, with a further addition in 2007, the licence of the HFR was renewed for several reasons.

- The licence existing at that time was obsolete. It was issued before the Nuclear Energy Act entered into force and revisions so far had been fragmentary;

- Due to the first 10-yearly Periodic Safety Review the HFR needed a significant upgrade. A new updated Reference Licensing Basis and a new Safety Analysis Report (SAR) were issued in the process. In order to make the safety upgrade possible, a new licence was needed;
- The HEU-LEU conversion also required a licensing procedure;
- The transfer of the licence from JRC to NRG required a new licence as well.

New licence conditions were issued by the regulatory body, to mention:

- The 10-yearly Periodic Safety Review are mandatory;
- Every 5 years an IAEA-INSARR mission or alike should be held;
- The allowed amount of spent fuel in the fuel storage pool, after a transition period of 3 years, is limited to 500 fuel elements. Spent fuel should be shipped as soon as possible to the waste storage facility COVRA;
- Organisational changes or changes in the mandate of the senior-managers need prior approval of the director of the KFD;
- The reference licensing basis as developed for the 10-yearly Periodic Safety Review is part of the mandatory regulation for the HFR;
- An ageing management system has to be maintained (after having been developed);
- A system for operational feedback is institutionalised.

#### **e. IAEA-INSARR missions**

In 2002 an IAEA-INSARR mission was conducted with emphasis on safety culture (see previous Dutch national report on the Convention on Nuclear Safety for a more detailed description of the safety culture issues at that time).

Prompted by the earlier identified safety culture issues as well as the recommendations of the IAEA-INSARR-mission, the KFD formulated a licence condition for the new licence, which required every 5 years an IAEA-INSARR review or equivalent independent audit to be conducted. This requirement resulted into transformation of the follow-up mission of the 2002 INSARR into a full scope new mission. This second INSARR-mission was held in 2005 and at that time it was the mission with the largest scope and the largest number of experts (10) in the team. It was noted that almost all issues identified in the 2002 INSARR mission were resolved. Special mention was made in the report on the implementation of the Safety Culture Enhancement Plan, that succeeded to resolve most of the pending safety issues and followed the recommendations and suggestions provided by the INSARR mission of 2002. The next independent audit on safety culture is foreseen in 2011.

#### **f. HFR primary system repair**

Since a few years deformations in a component of the primary coolant system of the HFR in Petten are being observed and monitored. In the summer 2008 a pinhole was revealed by a bubble jet at one of the inward deformations of the primary coolant system reducers, which are embedded in the concrete biological shield. The reactor no longer complied with its licence conditions, suggesting repair to be necessary. Therefore the reactor was shut down by NRG.

The government accepted a proposal by NRG to put back the HFR in service on a temporary basis, without the repair. Refer to the section on Article 6, section 6.2 for more information on the background and decision making process by the government regarding this decision.

This section continues with some details about the repair.

A detailed plan for final repair has been worked out and is being executed since 19 February 2010. The repair is expected to be finalized in August 2010.

Apart from an assessment by the Dutch regulatory authority, in January 2010 IAEA conducted a peer review mission on the final repair plan. The IAEA peer review mission was satisfied with the repair

plan and the supervision by the Dutch regulatory authority, provided that some recommendations would be followed.

Currently (July 2010), execution of the final repair proceeds as it should and follows the plan. Holes have been drilled into the concrete to reach both affected aluminium pipes. Affected pipe-parts have been taken out and replaced by welding in new parts. This was completed in June 2010. Thereafter the holes will be filled up with heavy concrete after which recommissioning of the installation will follow. After the repair, the HFR will comply again with the licence conditions. Only after approval by the Dutch regulatory authority, the HFR will restart its operation in August 2010.



**Table 1. Technical Details of the High Flux Reactor**

Maximum thermal power	50 MW <sub>th</sub>
Reactor coolant pressure (absolute)	0.34 Mpa
Maximum flow rate (3 pumps)	> 4150 m <sup>3</sup> /h
Height active fuel	0.6 m
Number of positions inside core	72 (8x9)
Horizontal dimensions	0.73 x 0.62 m
Specific power	310 MW/m <sup>3</sup>
Core inlet temperature	40-56 °C
ΔT over core	9-10 °C
	<u>LEU</u>
Fuel enrichment	19.25-19.95 %
Number of fuel plates per element	20
<sup>235</sup> U-mass per fuel element	550
Uranium density	4.8 g/cm <sup>3</sup>
Material fuel matrix	U <sub>3</sub> Si <sub>2</sub> -Al
Over reactivity	9.25 %
Negative reactivity value of total control rods	23.42 %
Shut-down margin of total control rods	14.02 %
Fuel temperature coefficient	- 2 pcm/K
Moderator temperature coefficient	- 13 pcm/K
Total temperature coefficient	- 15 pcm/K
Depth of reactor basin/fuel storage pool	8.7 m
Height of water above reactor vessel	4.2 m
Volume of reactor basin	151 m <sup>3</sup>
Volume of fuel storage pools	192 m <sup>3</sup>
Volume of containment	11700 m <sup>3</sup>
Normal underpressure	5 mmWC
Maximum overpressure	50 kPa

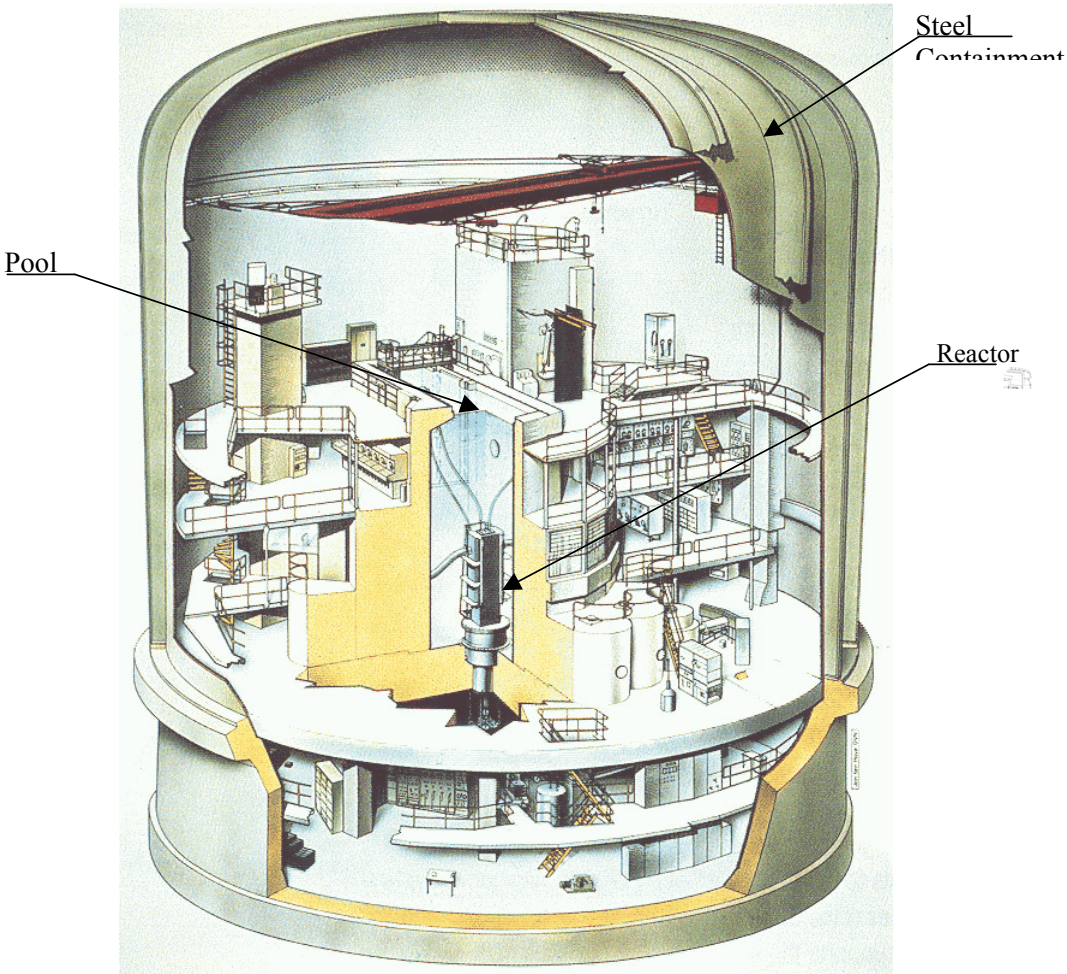


Figure 17 3D Cross section of reactor building of the HFR

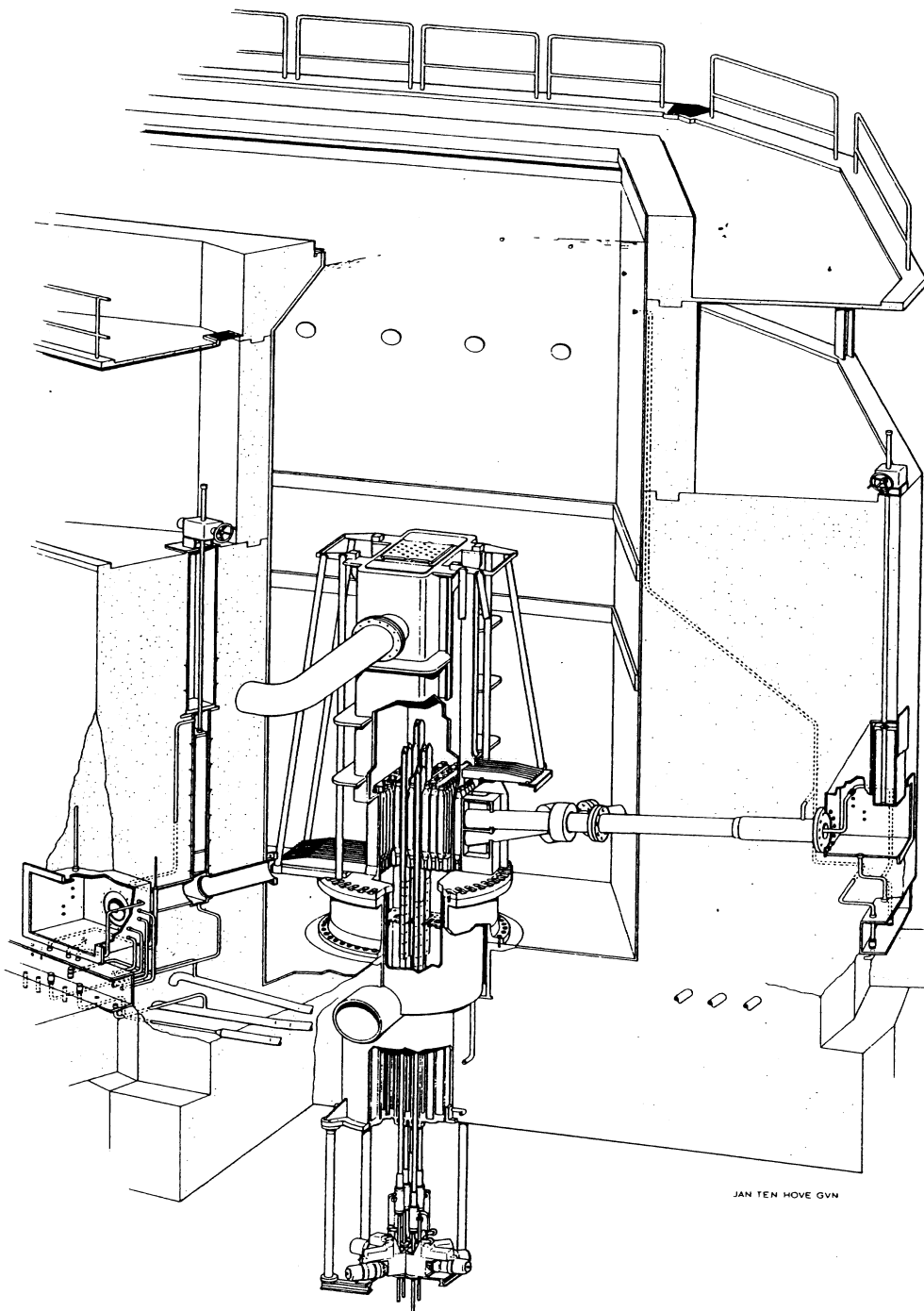
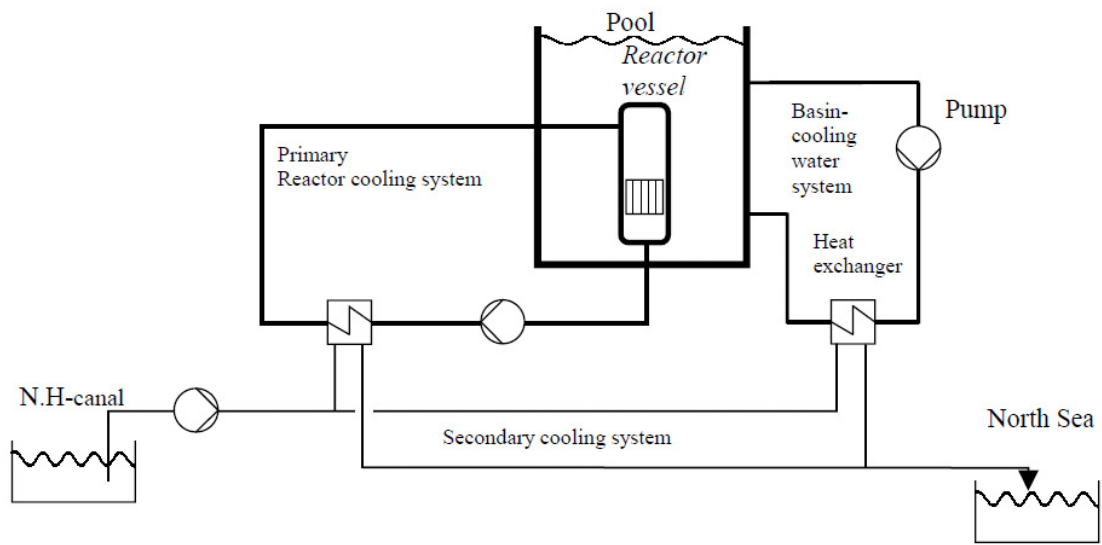


Figure 18 Reactor vessel in reactor pool of the HFR



**Figure 19** Schematic presentation of the primary, secondary en basin cooling system of the HFR

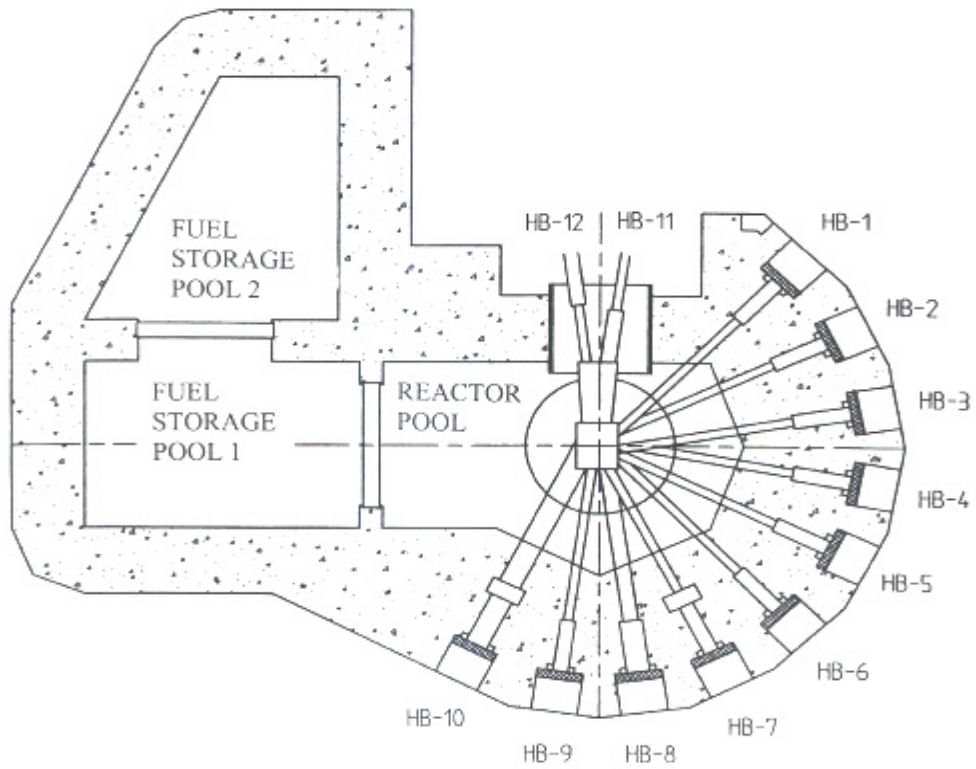
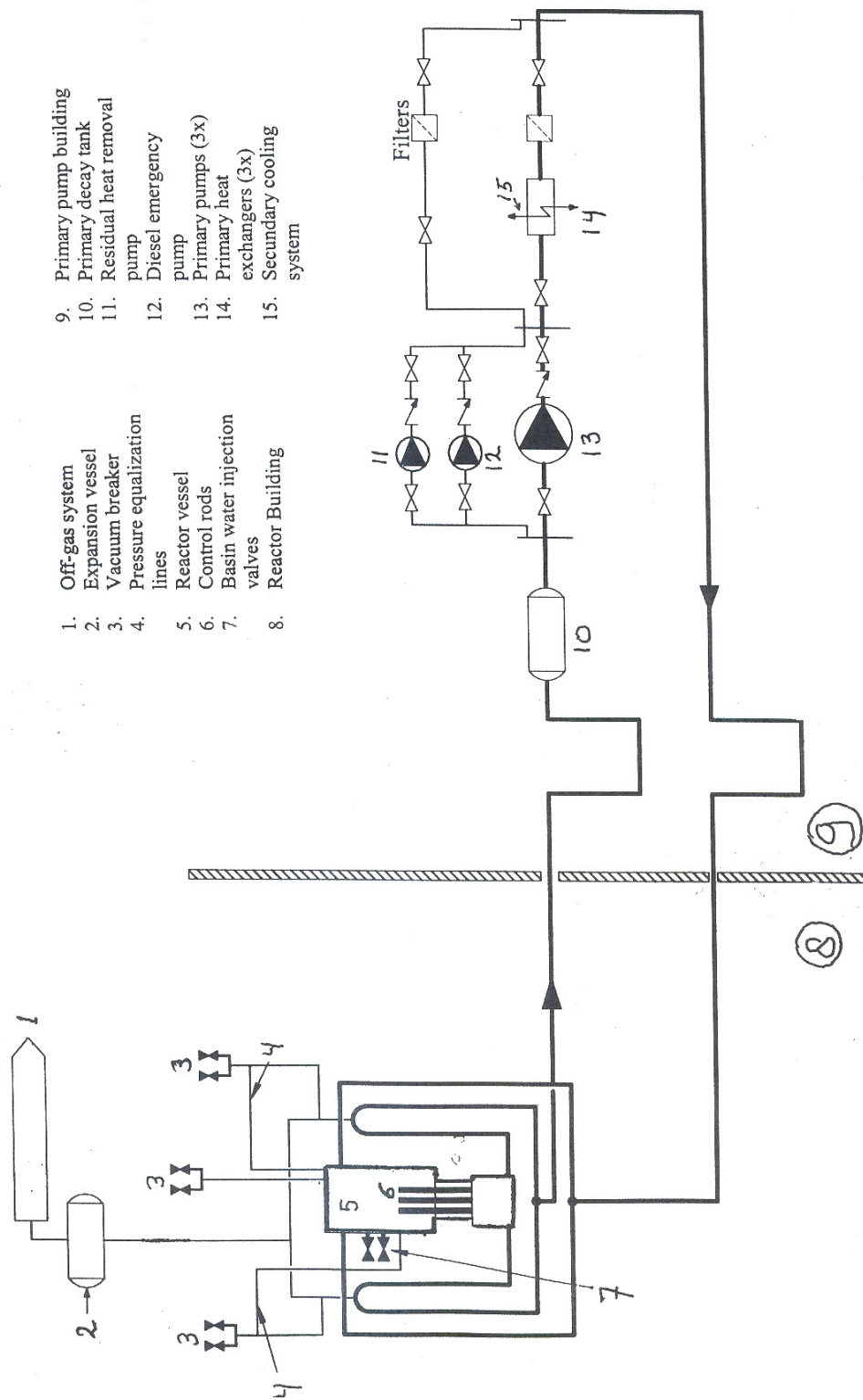


Figure 20 Cross-section of reactor pool and spent fuel storage pools of the HFR



- |                                 |                                  |
|---------------------------------|----------------------------------|
| 1. Off-gas system               | 9. Primary pump building         |
| 2. Expansion vessel             | 10. Primary decay tank           |
| 3. Vacuum breaker               | 11. Residual heat removal pump   |
| 4. Pressure equalization lines  | 12. Diesel emergency pump        |
| 5. Reactor vessel               | 13. Primary pumps (3x)           |
| 6. Control rods                 | 14. Primary heat exchangers (3x) |
| 7. Basin water injection valves | 15. Secondary cooling system     |

Figure 21 Process flow scheme of primary circuit of the HFR (after modifications).

## **Annex 4 EDUCATION AND STAFFING AT RB AND KFD**

### **a. Introduction**

This Annex provides detailed information on available disciplines at the departments of the regulatory body, the education programme and the current staffing issues. This information is complementary to the information provided in the section on Article 8 of the Convention. The regulatory body has two branches; the licensing and policy branch, the RB, and the inspection branch, the KFD. Also refer to the text on Article 8 on the regulatory body.

The regulatory body is faced with challenges regarding staffing, since the activities in the nuclear sectors of the Netherlands are increasing. In 2006 the nuclear power plant Borssele was given the allowance in principle to extend its operating life with another 20 years. Therefore the plant management started to develop an increased amount of major projects to prepare for the future. In addition, in 2009 procedures were started for the future licence application for nuclear new build. This refers to the plans of company NRG to build a new research reactor (Pallas) and plans of utility Delta for new nuclear power in the Netherlands.

Both initiatives have led to requests within the ministry of VROM for the allowance to expand the financial and human resources of KFD en RB. In the first half of 2010 the financial budget for the supervision of the existing installations (mainly Borssele) was increased and budget was reserved to increase the total amount of staff at RB and KFD together with about 22 fte.

In the next paragraphs, for both departments of the regulatory body, RB and KFD, the core disciplines, the education and the staffing issues are discussed.

### **b. Core disciplines at RB (licensing, legislation and policy development)**

The main tasks of this Directorate are related to licensing, legislation, policy development and implementation in the fields of radiation protection, waste management, nuclear safety, security and safeguards in relation to the public and the environment.

The core disciplines are:

- radiation protection;
- nuclear safety;
- risk assessment;
- security & safeguards;
- legislation;
- licensing.

### **c. Core disciplines at the KFD (supervision of nuclear facilities)**

The KFD encompasses the major reactor safety, radiation protection, security and safeguards and emergency preparedness disciplines. For areas in which its competence is not sufficient or where a specific in-depth analysis is needed, the KFD has a budget for contracting outside specialists. This is considered to be one of the basic policies of the KFD: the core disciplines should be available in-house, while the remainder of the work is subcontracted to third parties or Technical Support Organisations (TSOs).

The core disciplines are:

- mechanical engineering;
- metallurgy;
- reactor technology (including reactor physics and thermal hydraulics);

- electrical engineering;
- instrumentation and control;
- radiation protection (workers and members of the public);
- probabilistic safety assessment and severe accidents;
- quality assurance;
- nuclear safety auditing and inspecting;
- process technology;
- security and safeguards,
- human factors and organisation.

Basically, there is one specialist (university-level) member of staff for each discipline (but two for process technology, for metallurgy/materials engineering and radiation protection). Although all these professionals are also inspectors supporting the field inspector (10%), their main job consists of assessing documents submitted by licensees in accordance with licence requirements (80%), e.g. in the framework of plant or organisational modifications and periodic safety review, and conducting technical assessments in the context of licensing/rulemaking (10%), work that is requested by RB. Three professional (tertiary vocational college-level) members of staff are available full-time to conduct routine installation inspections (field inspectors). In the case of security and safeguards, the staff consists of four people.

The supervisory duties of the KFD include the security of nuclear power plants. Scientific and technical support is provided by the RIVM (the National Institute for Public Health and the Environment). Some research into security-related issues is subcontracted to private companies.

### **d. Education of RB staff**

RB has a policy to provide a dedicated education program, tailored to the needs of the staff member regarding her or his tasks. Some professionals are largely occupied with legislative work, while others are focussed on developing policies on nuclear safety, waste management, etc. Many are involved in licensing issues. Each focus requires a different set of abilities and associated trainings. Therefore the background of RB staff varies from a university degree in law to a degree in engineering. Some examples of trainings:

- basic training in radiation protection;
- basic training in nuclear technology and nuclear safety;
- basic trainings on specific (new) reactor types;
- trainings and workshops regarding (the introduction of new) laws or other legislative issues;
- training in advising on policy issues in a political environment.

### **e. Education of KFD staff**

The background of KFD staff mostly is technical. The KFD has a policy of allocating between 10 and 15 days each year to (refresher) training for each staff member. Examples of trainings for new staff are:

- basic training in radiation protection (15 days)
- basic training in nuclear safety (12 days):
  - o reactor physics;
  - o reactor kinetics;
  - o nuclear fission;
  - o global lay-out of reactor and fuel;
  - o fuel cycle;



- o waste management;
- o reactor types;
- o small simulator training;
- university module reactor engineering (10 days);
- reactor systems training (10-15 days);
- transient and accident analyses course (10 days);
- full scope simulator training (5 days);
- several 1-2 day courses organised by a German TSO, GRS;
- basic trainings on (new) reactor types.

**f. Other activities contributing to education and training of RB and KFD staff**

Both RB and KFD staff receive dedicated training on relevant disciplines, including international workshops. Participation in conferences and visits to other regulatory bodies also contribute to the expertise of staff. In addition there is information exchange through the international networks of OECD/NEA, IAEA, EU, etc. Experts have to keep up to date with developments in their discipline and are also responsible for maintaining a network for a number of other disciplines that are not permanently available. It is the policy of the regulatory body that the core experts need to have sufficient knowledge to specify and to assess work done by external experts.

**g. Staffing issues at RB**

RB is in the process of expanding its staff with 11 new employees. This will double the number of staff dedicated to nuclear licensing and safety, security and safeguard issues. The introduction of these people in the existing organisation is a challenging task. Education and training will require careful planning. Staff will be recruited from within the ministry of VROM, so they will be accustomed to the procedures that are custom at RB.

**h. Staffing issues at the KFD**

The staffing of the KFD is an ever-ongoing concern as it is with any comparable organization, which consists of a great variety of highly specialized professionals. This issue has been discussed within the organization almost as long as the KFD exists. In 2008 KFD celebrated its 40 years anniversary.

Build-up of staff started systematically by the mid 70s and continued well into the eighties. An almost complete coverage of disciplines was developed in principle by 1985 when there was an advanced planning for the extension of the nuclear programme in the Netherlands. After the Chernobyl accident the extension of the nuclear energy option was put to a hold and also the continuation of the existing nuclear power plants was debated. As a consequence there was no need to increase the number of staff at the KFD. Until 2009, the situation was essentially still the same.

In the following, first the situation for the existing installations will be discussed and after that the new developments.

*The staffing for the supervision of the existing installations:*

The total professional formation of the KFD, for all existing nuclear facilities is now 21.5 (including the 3 managers) full time equivalents (fte). Currently about 50% of KFD experts are supervising Borssele NPP. In recent years all retired staff has been replaced with new staff. In the next three years (2011-2013) retirement of about 5 experienced staff including one manager will take place. .

At the last CNS review meeting it was communicated that KFD is allowed to start recruiting one year before retirement of a staff member. Due to the budgetary constraints this is no longer the case.

To cope with the increasing amount of work for the existing installations in 2010 there has been concluded the intent for a contract with GRS for 2010-2014. The plan is to increase the hired capacity of GRS from about 1,5 to 5 fte/year.

### *The situation for new build*

The allowance for the expansion in April 2010 led to the execution of a recruitment plan before the summer of 2010. For KFD it means that it will be expanded with 11 fte of staff (roughly +40%). It is expected that this can be completed beginning of 2011. Part of this plan is to attract and educate staff from other VROM-inspection programmes. The rest should be external (national and international)

### *Challenges*

Although these are very positive developments it also creates major challenges for the KFD-management. The challenges are now:

- The ageing of the workforce. There is still a large group to leave within 3 years. This presents the danger of experience disappearing in a short period of time, where many new people have to be introduced and large important projects have to be mastered;
- Introducing 40% more people in an existing organisation with challenging new tasks;
- It takes at least two years before new staff is fully employable, so the effective build-up of capacity is slow. On the other hand the (inter) national possibilities for education and training have much improved in the last three years;
- Governmental budget cuts have been announced for the next years, starting in 2011, because of the savings that have to take place in order to cope with the international financial crisis. It is uncertain what will be the impact of budget cuts. We can probably comment on this during the review meeting in 2011.

In order to cope with these challenges:

- The KFD continuously seeks contacts with colleague regulatory bodies abroad;
- Intensive contacts are established with GRS in Germany;
- In Belgium contacts are explored with the Belgian regulatory authorities BelV and FANC, taking advantage of not having a language barrier;
- Contacts are also build up with the Swiss regulatory body HSK;
- In addition contact will be sought with regulatory bodies also facing increasing workload, like in Sweden, the UK and Finland;
- The memberships of NERS, WENRA and other international bodies are important as a support for the supervising activities in the Netherlands. In the security area KFD has become member of ENSRA (since 2006).