CONVENTION ON NUCLEAR SAFETY

FOURTH REVIEW MEETING, APRIL 2008

Ministerie van VROM →
staat voor ruimte, wonen,
milieu en rijksgebouwen.
Beleid maken, uitvoeren
en handhaven.
Nederland is klein.
Denk groot.

CONVENTION ON NUCLEAR SAFETY

National Report of
The Kingdom of the Netherlands

Fourth Review Meeting (April 2008)

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

The Hague, September 2007

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FIGURES

LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Full term	Translation or explanation (in brackets)
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)

Abbreviation	Full term	Translation or explanation (in brackets)
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	
EOP	Emergency Operating Procedure	
EPZ	NV Elektriciteits-Productiemaatschappij Zuid-Nederland	(Operator of Borssele NPP)
ESFAS	Engineered Safety Features Activation System	
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 = 10^9)
GKN	Gemeenschappelijke Kernenergiecentrale Nederland	(Operator of Dodewaard NPP)
GRS	Gesellschaft für Anlagen- und Reaktorsicherheit	(Nuclear safety experts organisation, Germany)
H_{eff}	Effective dose equivalent	

Abbreviation	Full term	Translation or explanation (in brackets)
HEU	High Enriched Uranium	
HFR	High Flux Reactor	Research reactor (in Petten, of the tank in pool type, 45 MW_{th})
HOR	Hoger Onderwijs Reactor	Research reactor (Delft Technical University)
HSK	Hauptabteilung für die Sicherheit der Kernanlagen	Swiss nuclear regulatory body
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	
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	

Abbreviation	**Full term**	**Translation or explanation (in brackets)**
LOCA	Loss of coolant accident	
LPSA	Living PSA	
MBq	MegaBecquerel	(Mega = 10^6)
MER	Milieu-effect rapport	Environmental Impact Assessment (EIA)
mSv	milliSievert	(Milli = 10^{-3})
µSv	microSievert	(Micro = 10^{-6})
MMI	Man Machine Interface	
MW_e	Megawatt electrical	
MW_{th}	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	
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	
OSART	Operational Safety Review Team	(IAEA)

Abbreviation	Full term	Translation or explanation (in brackets)
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	
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)
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	
SAS	Stoffen, Afvalstoffen, Straling	Chemicals, Waste and Radiation Protection Directorate (Dutch policy department)
SG	Steam Generator	
SGTR	Steam Generator Tube Rupture	
SSCs	Structures, Systems and Components	

Abbreviation	Full term	Translation or explanation (in brackets)
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)
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 a short report on recent developments and 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 fourth in its series. It shows how the Netherlands meets the obligations of each of the articles established by the Convention.

Short history and recent developments

The Netherlands has a small nuclear programme. The country currently has only one nuclear power plant (NPP) plus three research reactors in operation. The technical details of the NPP are provided in Annex 1. Nuclear supervision is exercised by several (mainly governmental) organisations. These are staffed by only a very small number of people: a reflection of the small scale of the country's nuclear programme. Plants operate under licence, awarded after a safety assessment has been carried out. This is based on the Safety Requirements and Safety Guides[1] in IAEA Safety Series 50, as amended for application in the Netherlands. The licence is granted under the Nuclear Energy Act.

The nuclear programme started with the construction of a research reactor in 1955, the High Flux Reactor at 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_e) was put into operation in 1968, and in 1973 this was followed by the first commercial reactor (Borssele NPP, 450 MW_e).

Although plans were made to expand nuclear power by 3000 MW_e, these were shelved following the accident at Chernobyl in 1986. Instead, the government ordered a thorough screening of the safety of both 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 Dodewaard reactor was shut down in 1997.

Since 2005 there have been major political developments in the Netherlands: there have been elections and the Dutch government, in office until the end of 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 Covenant is included in Annex 2 of this report.
Also in 2006, the Minister for Housing, Spatial Planning and the Environment (VROM) published, also on behalf of the Minister of Economic Affairs (EZ), a memorandum on the preconditions for the

[1] 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.

acceptability of new nuclear power plants in the Netherlands. According to the memorandum, any new reactor must be at least a Generation III model with levels of safety being equivalent to those of Areva's EPR. It should be located at a coastal site. Before its operation the government must decide on a disposal strategy for existing high-level waste. Used fuel should be stored until 2025, when a choice will have to be made between different back-end routes: direct disposal, reprocessing, or partitioning and transmutation.

The current government, in office since the start of 2007, has decided that during their term of office, no (additional) nuclear power plants will be built.

Apart from these political and legal developments, there are technical issues requiring attention. Since the only nuclear power plant still in operation was modernised in the mid-nineties, no major safety issues are currently outstanding but, of course, other issues remain. Because the Borssele NPP is a relatively old plant, ageing is an issue requiring serious attention. But less technical issues, such as the effects of the liberalisation of the electricity market on safety, also demand and receive regulatory attention. In addition, the Borssele NPP was granted a licence at the end of 2004 for the use of fuel with a 4.4% instead of 4.0% enrichment.

Over the last few years, more emphasis has been placed on the safety of the High Flux Reactor (HFR). The HFR is a 45 MW_{th} research reactor in Petten in ownership by the Joint Research Centre of the European Commission. The key issues are the finished first 10-yearly periodic safety review and associated back-fitting, follow-up of the investigation in 2002 of the safety culture and the finished licensing procedure for the conversion from high enriched uranium (HEU) to low enriched uranium (LEU). 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 HFR and, where applicable, discussions on the HFR in relation to the various articles. During the third review meeting in April 2005, several Contracting Parties showed an interest in this research reactor and the particular issues surrounding it.

In recent years, the Dutch regulatory authorities have also paid attention to the COVRA interim storage facility in the municipality of Borsele[2] and to the uranium enrichment facility operated by URENCO Nederland BV in Almelo, to which a licence for enlarged capacity has been granted. These facilities are not subject to the Convention and are therefore not given any further consideration here. Apart from these installations, there are also two other smaller research reactors in the Netherlands. These are only briefly mentioned where necessary.

Structure of the report

This updated report follows the format of the previous national report for the Convention on Nuclear Safety, submitted in 2004. It is designed to be a ‘stand alone’ document to facilitate peer review. Some information from the 2004 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. The numbering of its chapters and sections corresponds to that of the articles in the Convention.

[2] Borsele (with one ‘s’) is the name of the municipality in which the village of Borssele (with a double ‘s’) is located.

Chapter 2(a) of the Convention 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).

The report goes on to describe plans for improving safety on the basis of the safety issues referred to earlier. Another chapter is devoted to the main remarks made during the third review meeting of the Contracting Parties to the Convention on Nuclear Safety in 2005. Although emphasis is given to the remarks made specifically in relation to the Dutch situation, responses to several general remarks are also detailed in this chapter.

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

CHAPTER 2(A) GENERAL PROVISIONS

ARTICLE 6.EXISTING NUCLEAR INSTALLATIONS

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.

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 2005.

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 is already at an advanced stage of decommissioning (safe enclosure): the Dodewaard NPP (a BWR, GE design, 60 MW_e). In addition there are three research reactors, the largest of which has a thermal power of 45 MW. The latter is the so-called 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 450 MW_e but a recent turbine upgrade has boosted its net electrical output to 485 MW_e.
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.

The current owner of the Dodewaard NPP (GKN) has no other activities than to maintain the safe enclosure for a period of 40 years. It has been decided to transfer ownership of the remainder of the NPP and its assets to an organisation that may be better equipped to perform this task over a very long period. The state-owned organisation COVRA is considered to be the appropriate organisation. COVRA is the central organisation for waste management in the Netherlands. Its installations are designed to store all types of radioactive waste for at least a 100 years, until a final solution for disposal has been agreed. The financial and other conditions for the possible transfer of ownership of the NPP are being investigated.

6.1.c High Flux Reactor

Although research reactors are not formally subject to the Convention, in this report information is included about the High Flux Reactor (HFR), a relatively ‘large’ 45 MW_{th} research reactor. The reason for this is twofold: firstly, the first 10-yearly periodic safety review resulted in a back-fitting program for the reactor; secondly, in the past problems with the safety culture of the reactor were detected which called for corrective action.

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. Further details of the HFR and the latest developments surrounding it are given in Annex 4.

6.2 Overview of safety assessments and other evaluations

At the time when the Convention took effect on 13 January 1997, it had already been decided to shut down the Dodewaard NPP. The Borssele plant 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 are given in the next section and 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. Surveys showed that legally enforcing the closure would lead to the State having to pay considerable damages. In connection with agreements on keeping Borssele NPP open for longer, owners 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 the owners shall jointly achieve agreed CO_2 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 started at the beginning of 2001 and was completed at the end of 2004. 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.

CHAPTER 2(B) LEGISLATION AND REGULATION

ARTICLE 7.LEGISLATIVE AND REGULATORY FRAMEWORK

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 Description of the legislative and regulatory framework

7.1.a Overview of the legal framework

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);
- General Administrative Act (Algemene wet bestuursrecht, Awb).

The basic legislation governing nuclear activities is contained in the Nuclear Energy Act. The Nuclear Energy Act was designed to do two things at once: to regulate the use of nuclear energy and radioactive techniques, and 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. It sets out the basic rules on nuclear energy, makes provision for radiation protection, designates the various competent authorities and outlines their responsibilities.

Licences for nuclear power plants are granted jointly by the Minister of Housing, Spatial Planning and the Environment, the Minister of Economic Affairs, and the Minister of Social Affairs and Employment, plus where relevant, some other ministers whose departments may be involved. Together, these ministers constitute the competent authorities as defined by the Nuclear Energy Act and are jointly responsible for assessing licence applications and granting licences. The Minister of Housing, Spatial Planning and the Environment acts as the coordinator in this respect. The powers and responsibilities of the various ministers are described in more detail in the section on Article 7.2 (ii).

With regard to nuclear energy, the purpose of the Act is to serve the following interests (Article 15b):
- the protection of people, animals, plants and property;
- the security of the State;
- the storage and safeguarding of fissionable materials and ores;
- the supply of energy;
- the payment of compensation for any damage or injury caused to third parties;

- the observance of international obligations.

A number of Decrees have also been issued containing additional regulations and these continue to be updated in the light of ongoing developments. The most important 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 Nuclear Installations, Fissionable Materials and Ores Decree regulates all activities involving fissionable materials and nuclear installations (including licensing). The Radiation Protection Decree regulates the protection of the public 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 use. The Transport of Fissionable Materials, Ores and Radioactive Substances Decree deals with the import, export and inland 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 Protection Act, in conjunction with the Environmental Impact Assessment Decree, stipulates that any licence application for a nuclear installation must be accompanied by an environmental impact assessment. This complies with EU Council Directive 97/11/EC; see also the section on Article 17 (iv).

In the case of non-nuclear installations, 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.
The General Administrative Act sets out the procedure for obtaining a licence and describes the role played by the general public in this procedure (i.e. objections and appeals).
Annex 3 contains some key sections of the Nuclear Energy Act.

7.1.b Main elements of the Acts and Decrees

Nuclear Energy Act (Kew)
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 purposes of fission or breeding. All other materials are defined as radioactive materials.

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

(a) 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.

(b) 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.

(c) 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.

Under item (c), the Nuclear Energy Act distinguishes between construction licences and operating licences. In theory, a licence to build a plant may be issued separately from any licence to actually operate it. However, the construction of a nuclear power plant involves much more than simply building work. Account must be taken of all activities to be conducted in the plant. This means that the government needs to decide whether the location, design and construction of the plant are such as to afford sufficient protection from any danger, damage or nuisance associated with the activities that are to be conducted there. In practice, therefore, the procedure for issuing a licence to operate a nuclear power plant will be of limited scope, unless major differences have arisen between the beginning and the completion of 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 intermediate period.

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

The decommissioning of nuclear installations is regarded as a special form of modification and is treated in a similar way. In 2002 the Nuclear Installations, Fissionable Materials and Ores Decree (Bkse) was amended to meet the requirements set by Council Directive 96/29/Euratom with regard to the protection of workers and members of the public from the hazards of ionising radiation. The Directive had introduced a new licence requirement for the shutdown and decommissioning of nuclear installations. The amendment of Bkse had the effect of incorporating these regulations in Dutch legislation.

Where modifications are only minor, the licensee may make use of a special provision in the Act (Section 18) that allows such modifications to be made without amendment to the licence. In such cases, the licensee need only submit a notification describing the planned modification.
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 force.

Licences for nuclear installations are issued under the joint responsibility of the Minister of Housing, Spatial Planning and the Environment, the Minister of Economic Affairs and the Minister of Social Affairs and Employment (plus other ministers, where relevant).
Bkse sets out additional regulations in relation to a number of areas, including the licence application procedure and associated requirements. Applicants are required to supply the following information:

- a description of the site where the plant is to be located, including a statement of all relevant geographical, geological, climatological and other conditions;

- a description of the plant, including the equipment to be used in it, the mode of operation of the plant 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 plant'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 plant, specifying the maximum quantities of the various fissionable materials that will be present in the plant at any one time;
- a description of the way in which the applicant intends to dispose of 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 plant 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);
- a global description of plans for eventual decommissioning and its funding.

In addition to these regulations 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 compliance with this Act and the Environmental Impact Assessment Decree, the licensing procedure for the construction of a nuclear plant includes a requirement to draft an environmental impact assessment. In certain circumstances, an environmental impact assessment 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 Impact Assessments must be established and its advice must be sought whenever it is decided that an environmental impact assessment needs to be submitted by a person or body applying for a licence. The regulations based on this Act stipulate the type of activities for which such assessments are required.

The general public and interest groups often use environmental impact assessments as a means of commenting on and raising objections to decisions on nuclear activities. This clearly demonstrates the value of these documents in facilitating public debate and involvement.

General Administrative Act (Awb)
Notice must be given, both in the Government Gazette and in the national and local press, of the publication of a draft decision to award a licence to a plant as defined by the Convention. 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 to be held under the terms of the General

Administrative Act. Any 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. If the appellant asks the court at the same time for provisional relief (i.e. a suspension of the licence), the Decree (i.e. the licence) will not take effect until the court has reached a decision on the request for suspension.

7.2 Provisions in the legislative and regulatory framework

7.2. (i) Safety requirements and regulations

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 regulations are referred to as the Nuclear Safety Rules (NVRs = Nucleaire VeiligheidsRegels) and have been developed under the responsibility of the Minister of Housing, Spatial Planning and the Environment and the Minister of Social Affairs and Employment.

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).

The regulatory body reviewed these draft NVRs and the utilities and other relevant organisations were then given a formal opportunity to comment on the text of the final draft. The regulatory body decided the final content and wording of the NVRs. The regulations were then formally adopted, at the Requirements level by the Ministers and at the Safety Guides level by the Directors-General of the relevant ministries.

The licence granted to the nuclear power plant includes specific conditions under which the NPP has to comply with the NVRs. 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, may also be necessary. Moreover, there will generally be special aspects that need to be assessed by experts on a case-by-case basis.

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 can and must be taken by government even where the complete agreement of operating organisations has not been obtained.

The process for developing NVRs can be summarised as follows:
- Initiative to adopt an IAEA standard;
- Study of the IAEA standard by regulatory body;
- Proposal of amendments;
- Internal review of proposed amendments;
- Presentation of first draft NVR to relevant external organisations;
- Discussion of the draft;
- Second draft NVR;
- Discussion of second draft;
- Final NVR;
- Formal establishment of standard via approval by the Minister;
- Publication in the Government Gazette.

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 national 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.

Revision of NVRs
It should be noted that 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. When this political expectation was not realised in the end a gradual change in politics took place leading to a limited extension of operation and later on even a fixed life time extension until 2034 (for further description see Annex 2). When these changes took place it became obvious that there was a big need of revision of the NVRs.

This revision process is ongoing since the beginning of 2006 and it is planned that by the end of 2008 the project will be close to completion. Not only the existing NVRs will be revised but also others like those about siting will be added as well as some others. An important aspect will also be the adoption of the WENRA Reference Levels as far as they are not already included in the IAEA standards.

In addition to the system of NVRs, the Ministry of Housing, Spatial Planning and the Environment has formulated a policy on tolerance of the risks posed by nuclear power stations. This policy has been formulated independently of the NVRs and is incorporated in the Nuclear Installations, Fissionable Materials and Ores Decree (Bkse).

The basis and application of the regulations are discussed in more detail in Appendix 1, which includes 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.

Dose criteria for normal operation
The dose limit for members of the public is a maximum total individual dose of 1 mSv 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.

Risk criteria for incidents and accidents
In accordance with the probabilistic acceptance criteria for individual mortality risk and societal risk as laid down in the Nuclear Installations, Fissionable Materials and Ores Decree (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 analysis. In the Dutch view, it is unreasonable to assume that any countermeasure will be 100% effective. On the contrary, 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 NPPs show both situations: with and without credit being given for countermeasures.

See Appendix 1 for a more comprehensive discussion of these criteria and their background.

Other 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.

The safety of pressure retaining equipment in the Dutch nuclear installations is regulated by both the Nuclear Energy Act and the Steam Act in combination with the Steam Decree. Under a contract with the government on the basis of the two last mentioned legal documents, Lloyds Register Nederland BV (the former 'Stoomwezen BV', privatised in 1995) is the single Notified Body performing design assessments, fabrication appraisals and inspections (including in-service inspections) on pressure equipment in the Dutch nuclear installations. Enforcement of the Steam Act is the responsibility of the Ministry of Social Affairs and Employment.

Some important changes in this area are expected by the end of the year 2007. The legal basis for oversight on nuclear pressure equipment is to be transferred from the Steam Act to the Nuclear Energy Act. Consequently the prime responsibility for its enforcement will then be with the Ministry of VROM and its department of Nuclear Safety, Security and Safeguards (KFD).
Notified Bodies under the European Pressure Equipment Rule 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.

Periodic Safety Reviews
NVR 1.2 stipulates that periodic safety reviews must be carried out; further guidance is given in the IAEA Safety Guide Series No. 50-SG-O12, 'Periodic Safety Review of operational NPPs'. The requirement is condensed into an explicit licence condition, which states that 10-yearly integrated safety reviews must be performed to compare the performance of the plant with the requirements of the latest regulation and state-of-the-art safety practices. The principle is that the plant should comply as far as is reasonably feasible, i.e. all practicable back-fitting measures should be proposed to ensure that any discrepancy is kept to a minimum, as it is recognised that existing nuclear power plants cannot always conform to the latest regulations. In addition, reviews of operational safety aspects must be conducted every two years. See the section on Article 10 for further details.

7.2. (ii) Licensing procedure

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) for the preparation, transport, possession, import or disposal of radioactive material.

Article 15a of the Act lists the ministers responsible for licensing. As already mentioned in the section on Article 7.1 of the Convention, responsibility for nuclear activities is not centralised, but is divided principally between three ministers, who consult each other in accordance with their areas of competence. The division of responsibilities is as follows:

- the Minister of Housing, Spatial Planning and the Environment (VROM) is responsible, together with the Minister of Economic Affairs (EZ) and the Minister of Social Affairs and Employment (SZW), for licensing nuclear installations and activities;
- the Minister of Housing, Spatial Planning and the Environment is responsible, together with the Minister of Social Affairs and Employment, for licensing the use of radioactive materials and radiation-emitting devices;
- With regard to nuclear installations the Minister of Housing, Spatial Planning and the Environment is responsible for all public health and safety aspects, including radiation protection for workers and members of the public; the Minister of Economic Affairs is responsible for energy supply policy; and the Minister of Social Affairs and Employment is responsible for regulations concerning the protection of workers.

Other ministers may be consulted on nuclear activities which fall within their particular spheres of competence. For instance, discharges of radioactive material in air and water involve the Minister of Agriculture, Nature and Food Quality (LNV) and the Minister of Transport, Public Works and Water Management (V&W), while the subject of emergency response involves these two Ministers plus the Minister of the Interior and Kingdom relations (BZK) and the Minister of Health, Welfare and Sport (VWS). See the table below for an overview.

	LNV	V&W	BZK	VWS
Discharges in air	X			
Discharges in water	X	X		
Transport		X		
Emergency provisions	X	X	X	X
Medical applications				X

A move is now being made to reduce the number of authorities involved in order to streamline the licensing procedures and reduce the administrative burden. To this purpose a proposal to change the Nuclear Energy Act has been drafted which is currently under review by the Parliament.

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.

The first three ministers mentioned above are also the competent ministers for the suspension or withdrawal of a licence.

Article 15b of the Nuclear Energy Act enumerates the interests for the protection of which a licence may be refused (these are listed above in the section on Article 7.1, sub 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 competent regulatory body in relation to the subject of a licence condition.
As already stated (see section on Article 7.1, sub b), in the case of very minor modifications, the licensee may make use of a special provision in the Act (Article 18) that allows such modifications to be made without a licence change. The licensee need only submit a report describing the intended

modification. This reporting system 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, which the licensee is required to perform.

In addition to the Nuclear Energy Act and the Environmental Protection Act, the Steam Act also includes some provisions relevant to nuclear safety: it prescribes a licence per individual pressure-retaining component. More about the Steam Act can be found in sections 7.2. (i) and 7.2. (iii).

7.2. (iii) Regulatory assessment and inspections

General

Article 58 of the Nuclear Energy Act states that the Ministers 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 several entities. The most important two are the directorate of Chemicals, Waste & Radiation Protection (SAS), and the department of Nuclear Safety, Security & Safeguards (the KFD, KernFysische Dienst). Refer to section 8.1.b for a detailed description of these departments and their position within the organisational structure of the Ministry of Housing, Spatial Planning and the Environment (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 Chemicals, Waste and Radiation Protection Directorate (SAS) 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 policymaking 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 information is 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. This task is subcontracted to a Notified Body, 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 Directive for pressurized equipment. 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 report and the safety report 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. SAS assesses the radiological consequences associated with postulated transients and accidents in the various plant categories. SAS 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, SAS lays down the guidelines for the required calculations (data for food consumption, dispersion, etc). The KFD is involved in these activities, especially as concerns 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.

The KFD is participating in relevant working groups of NEA/CNRA and NEA/CSNI (including its subgroups) and in working groups of other international bodies as WENRA, IAEA and EU. WENRA has become an important body for harmonization of nuclear safety that has the clear support of KFD and the Ministry.

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. However, there is a need for inspections also 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 now introduced a systematic self-assessment programme too.

7.2. (iv) Enforcement

As indicated in the section on Article 7.2 (iii), 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) and the Minister of Social Affairs and Employment (SZW) are empowered under Article 37b of the Nuclear Energy Act to take all such measures as they deem necessary, including shutting down the nuclear installation in question. 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 15aa 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.

ARTICLE 8.REGULATORY BODY

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.

8.1.a General

As discussed in the section on Article 7, several ministers are jointly responsible for the licensing, assessment and inspection of nuclear installations. The various organizations within the ministries which are charged with these tasks, and the legal basis on which they operate, have already been discussed in the section on Article 7.2 (ii and iii):

- Ministry of Housing, Spatial Planning and the Environment (VROM) (see also Figure 1)
  - Directorate-General for the Environment (DGM)
    - Directorate for Chemicals, Waste, Radiation Protection (SAS)
  - Inspectorate-General (VI)
    - Department for Nuclear Safety, Security and Safeguards (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

The Ministry of Housing, Spatial Planning and the Environment has overall responsibility for legislation concerning the Nuclear Energy Act, for licensing and for ensuring that the current legislation is being adequately enforced. It is also responsible for the technical safety considerations on which the decision to grant or reject an application for a licence is based. These considerations are mainly based on assessments and inspections by the KFD, which advises the licensing body (SAS) on licensing conditions and requirements, including those relating to effluent discharge, environmental protection and security & safeguards.

After the transfer from the Ministry of Social Affairs and Employment to the Ministry of Housing, Spatial Planning and the Environment in 2001, the KFD kept the supervision over the radiological safety of workers in nuclear installations. Policymaking and the regulation for the protection of workers remained the responsibility of Ministry of Social Affairs and Employment.

As a result, the various bodies within the Ministry of Housing, Spatial Planning and the Environment, together with the Ministry of Social Affairs and Employment, are responsible for formulating the conditions attached to the licence concerning the safety and the (radiation) protection of the workers and the public and the environment.

On January 1st 2002 all inspection bodies of the Ministry of Housing, Spatial Planning and the Environment were merged into a single unified Inspectorate-General (VROM-Inspectie or VI). The main goal of this merger was to separate inspection and enforcement more sharply from legislation activities, policymaking and licensing. The newly formed Inspectorate is divided into five regions within the country. In addition to these regional organisations the VI consists of the VROM-IOD (Investigation Service) and the KFD.

Since March 1st 2004 all supervision tasks for the nuclear installations in the Netherlands have been integrated in the KFD, including those for nuclear security and safeguards. 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. At the same time KFD was reorganized according to the organizational structure of the Inspectorate. Figure 1 illustrates the current organisation of the regulatory body within VROM.

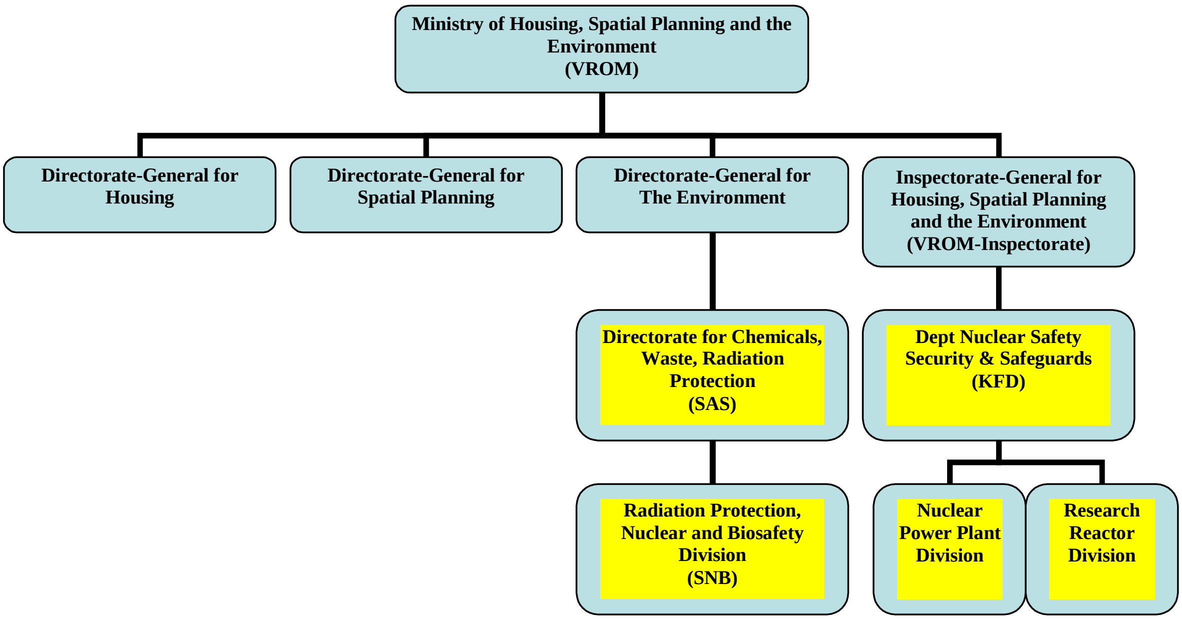

Figure 1 **Nuclear safety and radiation protection within the Ministry of the Environment**

8.1.b Regulatory body

The nuclear regulatory body in the Netherlands is formed by several entities, of which the most important are SAS and KFD, both from the Ministry of Housing, Spatial Planning and the Environment. An organization chart has been presented in Figure 1. SAS and KFD together are the regulatory authority for nuclear safety, security and safeguards. Although there are day-to-day contacts there is also a periodic bilateral meeting. Also the Inspector-General and Director-General of VROM in their regular meetings discuss amongst other things nuclear matters. The organisations KFD and SAS will be described in more detail in this section.

According to the Nuclear Energy Act, the Ministry of Social Affairs and Employment and the Ministry of Economic Affairs are also part of the regulatory body.

The Directorate Health and Safety at Work within the Ministry of Social Affairs is responsible for the legal aspects of radiation protection of workers. Less than one man-year is allocated to this work annually.

The Directorate-General for Energy and Telecommunications (Ministry of Economic Affairs) is responsible for aspects concerning energy demand and energy supply. Annually, less than one man-year is devoted to Nuclear Energy Act matters.

Directorate for Chemicals, Waste, Radiation Protection (SAS)

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 quite recently.

Recent examples of policy making are the conditions and requirements for a new nuclear power plant (2006) and the inclusion of WENRA harmonisation levels in the regulatory requirements. In the nuclear safety and security area these policies are established in close cooperation with the KFD. The Directorate is also responsible for regulatory body activities such as licensing nuclear installations and nuclear transports in general (all procedural aspects, technical aspects are covered by KFD), as well as for all aspects of radiation protection and external safety. It has the following disciplines at its disposal: radiation protection, nuclear safety, risk assessment, security and safeguards, and legal and licensing matters. These disciplines are grouped together in the Radiation Protection, Nuclear and Biosafety Division (SNB). There has been a certain build-up of capacity (two formation units) and expertise in the fields of security and safeguards. The duties mentioned above do not require any specific budget, apart from resources to cover research and staffing costs and SAS's annual contribution to support the work of the National Institute for Public Health and the Environment (RIVM). SAS also takes part in some international undertakings like TRANSSC, WASSC, and RASSC.

Manpower situation

SAS devotes about eight man-years per annum to nuclear licensing and safety, security and safeguards issues relating to all nuclear facilities and transports. KFD supports SAS with technical safety assessments and safety status information. Most other licensing activities (radiation protection) are outsourced to the SenterNovem organisation.

Within the next three years four very experienced staff members will retire. Their replacement will be a challenge, because their expertise and experience is mostly limited to the single person.

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 technical advising and support of SAS (SNB) in the framework of licensing and the establishment of regulations. KFD has a formal nuclear inspection strategy, which is based on two pillars: prevention of degradation and continuous improvement of safety. The Inspector General has adopted 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, e.g. in the framework of plant or organisational modifications and periodic safety review. Furthermore

KFD conducts technical assessments in the context of licensing/rulemaking, work that is requested by SAS. Three professional (tertiary vocational college-level) members of staff are available full-time to conduct routine installation inspections (field inspectors). One of these is dedicated to the inspection of Borssele NPP.

Current organisation
The organisation has been changed from a matrix to a line organisation with two divisions of about equal size; one for Research Reactors (RRs) and one for Nuclear Power Plants (NPPs). The divisions share an administration bureau. The new organisational structure creates a focus on a limited number of licensees per division, and it provides for a ‘one-stop shop’ of regulation for the licensee.

To prevent loss of knowledge and too tight relationships with the licensees, a policy of regular rotation of staff between the divisions has been established, which takes account of the yearly work programme. In addition, the two department heads will rotate every three years. The first rotation plan will be implemented from 2008. During the execution of the daily tasks, the divisions support each other when and where necessary.

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

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
The KFD encompasses 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 outside specialists. This annual budget is sufficient for about 3 man-years of work. This is an example of 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 safety organisations.

More about the available disciplines, and associated training, can be found in Annex 5.

Cooperation with other inspection organisations
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, there will be established a so-called Domain Nuclear Industry. Main task is to coordinate inspection plans and create an ICT platform to exchange information with each other, the licensees and the public.

KFD also seeks to cooperate with other inspectorates in the Netherlands, taking advantage of the knowledge and facilities of those bodies.

In addition there is cooperation with regulatory bodies in other countries. With some organisations like GRS and AVN there are even contracts to fill in the existing and expected gaps in the capacity and fields of expertise of KFD.

Education
The KFD has a policy of allocating between 10 and 15 days each year to training for each staff member. Examples of training courses for new staff are given in Annex 5.

Apart from the regular courses, there is training dedicated to the technical discipline, including international workshops, conferences and visits to other regulatory bodies. 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 KFD that the core experts have sufficient knowledge to specify and assess work done by external experts.

Budgets and fees
As regards budgets for external support, there is a budget of about € 450.000 for contracting external experts or technical safety organisations in the Netherlands and abroad for special issues. In recent years this budget is also increasingly used for security matters and the training expenses of the new staff. The whole KFD budget is part of the Ministerial budget and is not based on payments by the licensees. On the other hand, a Decree in the Nuclear Energy Act requires the licensees to pay a yearly fee for supervisory issues (about € 600.000 for Borssele and about € 15000 for the other licensees). This money goes directly to the Public Treasury. It covers less than 25% of the total budget. As far as the financing is concerned, currently an evaluation of practices in other countries is being carried out.

Manpower situation
The current total KFD professional formation is about 23 man-year equivalents, including three managers. A relatively large number of staff (3) have retired at the end of 2005, but have been replaced with new staff. Before January 2008, one staff member will be recruited to replace a retired staff member. In the next five years, an additional six very experienced employees will retire. The time to transfer their knowledge to their successors proves to be less than anticipated. This is due to a new early retirement plan and some difficulty in attracting new adequately qualified staff.

Other challenges are the anticipated increasing workload, combined with possible future budget and staff cuts.

More on the challenges regarding staffing, and the way KFD tries to meet them, can be found in Annex 5.

8.2 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 to the Minister of Housing, Spatial Planning and the Environment. 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.

ARTICLE 9.RESPONSIBILITY OF THE LICENCE HOLDER

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.

The principle that the ultimate responsibility for safety lies with the licensee is established in the legislation at different 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 of lack of proof of this safety case.

Secondly the Nuclear Energy Act, where 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, three articles of NVR 1.2 (Safety requirements for nuclear power plant operation) 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 also 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. This point is 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.

Compliance with the licence and its terms is monitored by means of an appropriate inspection programme, as already discussed in the section on Article 7. 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.

CHAPTER 2(C) GENERAL SAFETY CONSIDERATIONS

ARTICLE 10. PRIORITY TO SAFETY

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.

10.1 Policy on nuclear safety

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. 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.

The description of the NPP organisation, including specifications of competences and authorities, 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 past several years there was a major cost savings operation (-15%) due to market conditions. At the same time the number of reported incidents has gradually increased. Therefore KFD is supervising these developments very closely. Additional information is presented in the sections on Articles 11 and 14 of the Convention.

Where new safety insights emerge, their relevance to the power plant 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 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 and, particularly, investigations of the relevance of foreign incidents to the Dutch NPP.

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. The decommissioning of the Dodewaard NPP is currently at a stage where all fuel and easily removable liquid and solid waste have been removed. The plant is in a state of safe enclosure and will be finally decommissioned in 2045.

10.2 Safety culture

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 and international practise has led to an increased and strong effort at the NPP to improve safety culture together with KFD. See 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. It included a wide-ranging review of the safety aspects of management, organisation and procedures by means of a top-down approach. The mission confirmed that there was a high standard of technical nuclear safety, but recommended a number of organisational and operational improvements. In response to the OSART findings, the former Reactor Safety Commission recommended that ‘comparable’ assessments or self-assessments should be conducted at regular intervals, e.g. every two years. A number of assessments have been conducted as a consequence of this recommendation.

In 1994 a pilot ASCOT review was conducted as a complement to an ASSET review. One of its specific aims was to look at the safety culture. It was performed by an expert from the IAEA, who interviewed individuals within the senior management structure. It was a novelty for the staff at Borssele to be subjected to an investigation of a regulatory nature that also looked at the social environment. Although the findings were encouraging, some critical remarks were made about the supervision of subcontractors and the conduct of some operational work.

In 1995, Borssele initiated a self-assessment aimed mainly at middle and lower-level management. It was led and managed by a Dutch consultancy firm called GITP Management Focus. The main topics for assessment were effectiveness and safety culture. The assessment team made use of the INSAG-4 checklists. They concluded that, although alertness and safety awareness were high, horizontal communication could be improved. The follow-up to this assessment involved revision of procedures and instructions, extension of pre-job briefings, and use of modern communication and education tools. Organisational changes have been made at the plant in order to improve cooperation between departments.

In 1999, a first WANO peer review was conducted at Borssele. This kind of review is similar to an OSART mission, as the approach is also performance-based; however, the approach is bottom-up instead of top-down. Operational performance was reviewed and current practice was observed. Discussions were held with plant personnel. The team was composed of 20 persons, and the review lasted three weeks. The WANO performance objectives and criteria (which are aimed at excellence in the organisation in the area of nuclear safety) were used in the review. As a result, 14 areas of improvement were suggested.

In 2000, a WANO Peer Review Follow-Up mission took place. All 14 improvements were reviewed by a small team and practically all issues were found to be resolved.

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 there has been conducted a second OSART mission. The team gave 4 recommendations and 23 suggestions for improvement to the plant. Also there were 15 good practises 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. In June 2007 the follow-up was conducted. The result was that practically all issues were found to be resolved or on the right track.

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 safety performance is part of the WANO and OSART missions, a regular additional independent assessment will be performed of which the type is being discussed with KFD.

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

Research Reactor HFR in Petten
In the previous report for the third review conference of the CNS, published in 2004 and reviewed in 2005, mentioning was made of safety culture problems at the research reactor in Petten, as identified in 2001. Due to the actions of a whistle-blower, who alerted the media, these problems attracted political attention. This resulted in a temporarily closure of the reactor (one month) in early 2002. 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.

Annex 4 contains detailed information about the HFR and – among others - the safety culture improvements.

ARTICLE 11. FINANCIAL AND HUMAN RESOURCES

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.

11.1 Adequate financial resources

Social and economic background
In the last 10 years operators of electric power generating systems have had to deal 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.

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 rapidly. As a result of these developments electricity companies consider different alliances and merging options.

Historically the Netherlands has had a stable social structure and a reliable banking system. The liberalisation of the electricity market did not have any direct effect on this, but the extension of integration of national European electric power systems introduces new market dynamics. The interest in commercial and economical aspects has increased. Therefore regulatory attention on the relationship between production and safety is continuously required.

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 still own almost all generators, as well as transmission and/or the distribution networks. 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. It received a tentative green light for some kind of legislative move in the area. According to the recent summit conclusions of the EU meeting of 27 energy ministers on 6 June 2007 the member states are split into two camps on the issue and a majority of the energy ministers are against the European Commission ideas on forcing energy firms to separate production and distribution. The draft legislation on unbundling is currently being drafted by the European Commission and is due to see the light of day in autumn 2007.

In the Netherlands a new law requiring the separation of electricity generation and network activities is already implemented, but (in this law) unbundling is only required when an electricity company wants to merge with a foreign (electricity) company or if an electricity company starts risky ‘adventures’. According to the law, within three years from now, the electricity firms will have to fulfil the separation requirements anyhow.

Nowadays in the Netherlands shareholders of electricity companies are mostly governmental organisations. If this aforementioned separation requirement of electricity companies becomes reality, than a production company will become a fully commercial organisation, without a public (network) function. In that case, the governmental shareholders might sell their share and international merges and acquisitions will become more likely. Due to the fact that electricity networks are an interesting (long term) investment for financers, the separation will probably have a negative influence on the financial position of the company that owns (only) the generation activities.

Liberalisation and separation of activities may lead to the loss of the existing stable national commercial and financial environment and behaviour, possibly with a negative influence on long-term safety practices and culture. Therefore it may be advisable to consider a more specific introduction of (national and international) legal requirements relating to financing and organisation.

Legislative aspects
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.

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. At the present time, 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. Indeed, 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.

Financing of safety improvements
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 approvement. 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 evaluation 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 evaluation, 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.

Rules and regulations on adequate financial resources for safe operation
NVR 2.2.9 (Management of nuclear power plants for safe operation) 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 cost 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. Paragraphs 6.1.1 and 6.1.3 of this NVR read respectively:

Certain services and facilities complementary to the direct operating functions shall be provided for effective implementation of the management programmes and for ensuring safe operation of a nuclear power plant. These are called supporting functions. The services are the expertise and assistance made available to the plant management to support the operation of the nuclear power plant. The facilities are the equipment and systems required by the services….
… the operating organisation shall make arrangements to provide the following services and facilities:
1. Training services
2. Operation services
3. Quality assurance services
4. Radiation protection and emergency preparedness
5. Maintenance and surveillance services.

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).

Rules and regulations on financial resources for waste management activities
The starting point for the radioactive waste policy in the Netherlands is long-term surface storage (at least 100 years) in buildings at COVRA (Central Organisation for Radioactive Waste, located at Borsele). Storage takes place in accordance with the 'isolate, manage and inspect' criterion. This means that the waste is adequately separated form the biosphere by means of a manageable process and that the measurements are used to verify that the storage conditions are also being maintained over a long period.

Originally the radioactive waste storage facility was located at the research establishment at Petten (ECN). This explains why a certain amount of historical radioactive waste is still stored at the Petten site. It is, however, scheduled to be conditioned, repacked and transferred to the present storage facility of COVRA in a period of about 10 years. Some interesting developments are:

- In September 2003 the facility for treatment and storage of high-level radioactive waste (HABOG) of the centralised radioactive waste management organisation (COVRA) was commissioned;
- For the Dodewaard NPP, which was shut down in 1997, the construction of the safe enclosure was finished in April 2005, and the 40 years waiting period officially started on the 1st of June 2005;
- A financing scheme for the treatment and transfer to COVRA of historical radioactive waste at the NRG Waste Storage Facility at Petten was established.

One of the basic principles governing radioactive waste management, which also adheres to the Netherlands, is the polluter pays principle. This principle requires that all costs associated with radioactive waste management are to be borne by the organisations or institutes responsible for the generation of this waste. With regard to the management of Spent Fuel (SF) and High Level Waste (HLW), the utilities and the operators of research reactors have agreed to jointly build a facility for treatment and long-term storage of SF and 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.

In the frame of transfer of ownership of COVRA from the utilities and the Netherlands Energy Research Foundation (ECN) to the State, the utilities decided to discharge themselves from any further responsibility for management of the radioactive waste. They made a down payment to COVRA covering the discounted costs for operation and maintenance of the HABOG during the envisaged operational period (~100 years). The other customers for the HABOG pay their share of operational costs by annual instalments.

For Low and Intermediate Level Waste (LILW) there are fixed tariffs for specified categories of radioactive waste, which take into account all management costs. 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. 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. In the previous period COVRA suffered substantial and structural exploitation losses for the management of LILW, which can be partly attributed to a successful implementation of national waste separation and reduction policies. Financial support as a combination of a subsidy and a loan granted by the government, is aimed to ensure that COVRA will have a neutral financial result over the period up to 2015.

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 was 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 has been decreased, because of the lower volumes of waste to be disposed of. 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.

Rules and regulations on financing decommissioning
When a nuclear power plant reaches the end of its operational life, various administrative and technical measures have to be taken with the aim of making and keeping the facility safe. An important part of this is the nuclear power plant's dismantling, which is the full or partial removal of all the machinery, equipment and buildings, and, if necessary, decontamination of the site, usually with the final aim of leaving only a ‘green field’ behind. The preparations for this have to start at an early stage. According to current views, the plant's operators should draft a decommissioning plan in the design stage of the plant and submit it for approval to the competent authorities. It should primarily be checked against the national dismantling strategy, so that the accumulation of the required funds to pay for decommissioning can be geared to it.

This involves a large sum of money. A rule of thumb is that approximately 15% of the investment costs should be reserved for decommissioning a nuclear power plant, with differences above or below this amount depending on the type of reactor. Accurate methods of estimating the actual dismantling costs have been available for several years. See the publication of NEA/OECD[3] in connection with this, which is based on standardised cost units and was produced in cooperation with the IAEA and the EC.

There should also be sufficient clarity about what costs should be attributed to decommissioning and what costs could be attributed to operating the nuclear power plant. For example, providing financial security also relates to the costs of waste disposal (including the residual nuclear fuel) that is in the nuclear power plant at the time the power plant is decommissioned. This is not necessary for the waste that is generated and removed before that moment. This is sufficient incentive for the power plant's operator to arrange for and bear the costs of this waste's disposal. The provision of financial security for decommissioning and dismantling nuclear power plants will be created with the introduction of a new section 15g in the Nuclear Energy Act. The bill to make various amendments to the Nuclear Energy Act is expected to enter into force next year, but is currently under review by the Parliament. The proposed amendment to the Nuclear Energy Act includes a basis for imposing further rules on decommissioning and dismantling of nuclear facilities.

Operators of Dutch nuclear power plants have created a dismantling fund. In the Netherlands, this has so far been built up through annual deposits. The dismantling funds have thus far been managed by the electricity generating companies.

Article 1801 of NVR 1.2 states:

[3] A proposed Standardised list of items for costing purposes in the decommissioning of nuclear facilities, Interim technical document, NEA/OECD, 1999

The operating organisation is responsible for providing measures for the decommissioning of the nuclear power plant in a safe manner after it has been taken out of operation, and its responsibility can only be terminated with the approval of the regulatory body.

This requirement can be translated into a stipulation that the licensee should have sufficient (financial) resources to ensure proper decommissioning. The Nuclear Installations, Fissionable Materials and Ores Decree (Bkse) specifies that the licensee's application for a decommissioning licence must be accompanied by an indication of the costs of decommissioning and how it proposes to meet them.

The main point is providing sufficient assurances that the funds will be available when required to cover the decommissioning costs. This entails drafting quality requirements for the legal basis of the fund and management of the money it contains. Steps must be taken to ensure the money is not involved in any possible corporate failure/bankruptcy of the licensee. At this moment, further shape is being given to the main features of the decommissioning policy.

JRC owns the research reactor HFR in Petten, and NRG is the licensee. JRC has officially stated in its contract with NRG that the European Communities will bear the entire cost of decommissioning the plant.

11.2 Sufficient number of qualified 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 radiologically 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 licenses 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.

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 in this respect 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 and 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.

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.

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

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.

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 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) – 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, licensees are 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. At the moment the Borssele NPP is preparing a Human Performance and Safety Culture program (HP & SC program) to enhance its performance. Also the licensee and the regulatory body have agreed on having a meeting every year to discuss improvement plans and the progress and developments in this area. Both are considering an adequate method to monitor the safety performance by a set of indicators, periodic external audit or a combination of both.

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.

Licensees in the Netherlands address the subject of Human Factors in their annual reports. Good examples are the licensees of the Borssele NPP and the High Flux Reactor (HFR, European-owned research reactor) in Petten.

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. One of the main reasons of this reorganization was posed by the challenges of the liberalised market which creates a drive to reduce operational and maintenance costs. The cost reduction goal of Borssele NPP in 2003 was set at 15%. The reorganization was also 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 has been completed, although the reduction of personnel (target minus 10%) is not fully realized yet.

This reorganization was monitored by the regulatory body using evaluations, assessments and indicators. Part of the assessment was based on a comparison of the new organisational structure and number of staff with analyses in a German (GRS) report about minimum requirements for staffing made for the German NPPs. The new staffing situation of Borssele NPP was assessed to just satisfy the requirements of comparable (German) NPPs. Although the regulatory body has accepted this, the manpower situation is of some concern and remains an important item to monitor in the future. It is planned that the Borssele NPP will be required to develop a monitoring system to determine the adequacy of the number of and quality of staff frequently and report the findings to the regulatory body.

The reorganization had a negative effect on the relationship between management and employees. The main reason for this was the limited employee involvement. The management is now making effort to improve this relationship.

The Plant Manager has the responsibility on operational safety (Senior Nuclear Executive) since October 2005. The EPZ director is responsible for supplying the resources. Although the managers Human Resources and Finance are headed by the EPZ Director, the Plant Manager has the formal authority to require the necessary resources for safety related activities from them. Yearly objectives are discussed between EPZ Director and Plant Manager in bilateral or in the quarterly meetings with the managers. Safety goals and objectives, based on WANO indicators are regularly reviewed, and the main action plans are followed by the corporate level.

Outsourcing
Outsourcing is another measure seen as a possibility to reduce costs. However, it may lead to over-reliance on external sources of expertise. There is also a danger that management may underestimate the amount of supervision, guidance and oversight that is necessary to maintain a grip on associated safety levels and may therefore fail to meet their licensee obligations. Last but not least, staff in the standing organisation may be reluctant to share know-how and experience with contractors, because of the fear of losing their jobs or positions.
In the Netherlands, there are no explicit legal rules on outsourcing. Because some Member States do have such rules, the introduction of government guidance in this area in the Netherlands in the near future is being considered. The pros and cons of this kind of guidance should be evaluated.

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 is interested in introducing alcohol and drugs test. The implications are investigated.

12.7 Safety management

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.

At the Borssele NPP programs have been implemented to improve the leadership of the managers and promote safety culture:

- 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 tours in the field, 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.

Safety assessment is part of the OSART Missions and WANO Peer Reviews (for example the Cross Functional Factors) which are frequently performed by international groups of experts at the Borssele NPP.
Recently the option to have a separate periodic independent assessment of the safety culture is discussed but not yet decided.

As mentioned before, 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[4] .

[4] 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).

ARTICLE 13. QUALITY ASSURANCE

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.

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.

Throughout the nuclear sectors, there has been a change of policy in the form of a shift from complying with minimum rules towards performance-based Quality Management Systems (QMSs) accompanied by processes of continuous improvement. As mentioned in the section on Article 12, Human Factors, the safety management system and the quality management system are largely part of the same process in the nuclear installations and share the same goal ('safety'); however, the associated approaches and parameters differ.

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).

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' self-assessment activities, they gave the regulatory body a good insight into the current state of affairs. As the only operating nuclear power plant in the Netherlands from 1998 onwards, the Borssele NPP is the main focus of attention in this respect.

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 leading to a process based on more quantitative criteria (one of the essential elements of the new system) has required a different mind-set. The interfaces with safety culture and safety management have added to the complexity of the introduction.

The interface of the QMS with Human Factors (see section on Article 12) is important. 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 criteria, while others have made extensive provisions on this point in general or specific regulations and/or guidelines. International cooperation and exchange of knowledge and experience may lead to a better understanding of these problems in the near future, coupled with a set of criteria and regulations for the Netherlands.
Refer to section 12.5 for more observations on outsourcing.

13.4 The QMS at the regulatory body

As described in the Netherlands' earlier national reports on compliance with the CNS, the regulatory body is also 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 and based on the same principles. The industry-based ISO standard is more appropriate to the work of the regulatory body than the IAEA programme, which is 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.

ARTICLE 14. ASSESSMENT AND VERIFICATION OF SAFETY

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.**

14.(i) Assessment of safety

A licence is only granted if the applicant complies with the NVRs on Design, Operation and Quality Assurance (see Appendix 5) and with the probabilistic safety criteria (including dose-frequency constraints within the design-basis envelope). Appendix 1 gives a detailed overview of the probabilistic safety criteria. To this end, the licensee drafts a Safety report (SR) and a Safety analysis report (SAR), which it submits to the regulatory body. The SAR gives a detailed description of the proposed facility and presents an in-depth analysis of the way in which it complies with the NVRs. An SR is the report that is attached to the licence, and as such a public document. It describes the organisation, the design, the outcomes of the safety analyses, etc. in some detail. A SAR gives a detailed description of the safety analyses, simplified system diagrams, and other supporting documents. To illustrate the difference, the Borssele NPP SR is a two-volume document, whereas its SAR is a twenty-volume document. Both documents are updated in case of later modifications of the installations.

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).

As the NVRs are fairly general and lack the technical detail commonly found in national nuclear regulations in some other countries and the absence of nationally developed nuclear codes and standards in the Netherlands, additional material is needed to define the licensing basis. This includes e.g. the US Code of Federal Regulations, the USNRC Regulatory Guides and the USNRC Standard Review Plan, the ASME code, ANS/ANSI standards, KTA standards, and RSK recommendations. Although 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:

- a chosen set of foreign regulations and industry standards are consistent with the relevant NVRs, and
- there is consistency among the various sets of standards or regulations, if more than one set is to be applied (e.g. when parts of both US and German regulations are to be used).

The SAR is studied in depth, often with the help of external bodies such as GRS, AVN and TÜV, since the KFD is a small organisation. The underlying and supporting documents are also reviewed in depth to ensure that the regulations have been met. Selected items are analysed by computer codes other than the original ones. Often, assessments of similar power plants by a foreign regulatory body are also considered.

The IAEA has been asked to provide support to ensure the proper assessment and review of PSA results. It has done so by undertaking peer reviews of the PSAs (the IPSART missions, formerly known as IPERS missions) and by giving 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 these 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 (ISO 9001).

Periodic Safety Reviews
As stated, 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 basic 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 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 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 and area 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, high 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 CNS Review 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 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. It is evident that, generally speaking, this second

ten-yearly safety review is more a fine-tuning of the safety concept of the plant instead of a major change.

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.

Safety Assessments related to changes of the licence
Significant changes to the installations that imply changes to the design assumptions, as laid down in the safety report, require a licence. To demonstrate that the safety impact of these changes remain within the prescribed limits, new safety analyses have to be performed. An example of such a change 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 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.

Safety assessments initiated by the licensee
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. To mention 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 can be and are used in their assessment work at Borssele NPP.

Internal safety review of technical and organisational modifications at Borssele NPP 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 advice the Plant Manager for authorisation. The last step in the review is an assessment by or on behalf of the regulatory body. In the case of minor modifications likely to have no impact on safety, a more simple 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 expected 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 plant uses a risk monitor, e.g. for configuration control during outages.

Both the licensee and the regulatory body are interested in extending the use of the LPSA. Exactly which application is most relevant to decision-making on operational matters (i.e. safety and economics) has not been decided. To aid the decision process, the IAEA has been asked to provide ‘Peer Advice’ on LPSA applications. Because the regulatory body believes that LPSA insights should be used to a greater extent in its own safety assessments and verifications, and also to enable it to embark on a risk-informed approach to regulation, the IAEA has also been asked to include these aspects in its report. See Appendix 3 for further information on this ‘Peer Advice’ and the first steps towards a more risk-informed approach to regulation.

ARTICLE 15. RADIATION PROTECTION

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.

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 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 mSv 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.

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 requires the Borssele NPP 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) .The more specific requirements are laid down in the Technical Specifications (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 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.

ARTICLE 16. EMERGENCY PREPAREDNESS

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.

16.1 Emergency plans

Introduction
There are no statutory regulations in the Nuclear Energy Act requiring the presence of an on-site emergency preparedness plan. However such a plan is prescribed in the regulatory framework, viz. the Code on Operation, NVR 1.2, Ch. 11. Additional guidance is formulated in NVR 2.2.6 ‘Preparedness of the Operating Organization for Emergencies at Nuclear Power Plants’. The licence also specifically addresses the question of an emergency plan: 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 regular training takes place. The emergency plan and emergency organisation must be consistent with the disaster relief facilities devised to deal with an off-site emergency.

There are certain statutory regulations on off-site emergency planning and the actions that must be taken in the event of an emergency at a nuclear power plant. Central government plays an important role in this.

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:
- 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 for the National Nuclear Emergency Plan ('Nationaal Plan voor de Kernongevallenbestrijding', NPK). This, in turn, corresponds to the IAEA emergency classification system. The various types of emergency procedures, and the emergency plan and organisation are sent to the regulatory body for inspection and assessment.

If an emergency arises, the plant management must inform the relevant authorities immediately, advise them of the classification of the accident, and supply whatever information is required in order to help the KFD to understand the accident, assess the potential for mitigating its effects and make a prognosis of potential radioactive discharges. A computerised data line, giving live process information, is part of the plant information supplied to the KFD during an emergency. The regulatory body maintains a strict on-duty call schedule in order to be prepared for its role 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 draw up a schedule of regular emergency drills and classroom training. 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 an interface with the various government organisations at local, regional and national levels (e.g. the National Crisis Centre or NCC). The last full-scale exercise was in May 2005.

During these drills and exercises, KFD inspectors assess the performance of the plant emergency organisation and observe whether established procedures have been properly followed. These include the provision of information to the local and national authorities and the taking of action in accordance with government regulations, as laid down by the NCC.

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 groups:

- A national alarm and coordination centre to which all nuclear incidents and accidents (and other environmental incidents) are reported. This centre is staffed and accessible 24 hours a day.
- A (nuclear) Planning and Advisory Unit. This unit 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 unit consists of a front-office, where the emergency situation is analysed and advice on measures is drafted, and back-offices for radiological, medical, operational and administrative 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), which operates the national radiological monitoring network and monitoring vans and also collects data from other institutes. Alongside the radiological experts, the nuclear regulatory body (KFD) plays 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 act as extra pairs of eyes and ears for the NPK organisation.

- A policy team at the National Crisis Centre of the Ministry of the Interior and Kingdom relations. This team decides the measures to be taken. 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 Information Centre also 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 role to play in making 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 drawn up emergency contingency plans in consultation with representatives of central government. These plans are obligatory under Article 7 of the Disasters and Major Accidents Act, and encompass all measures that need to be taken at both local and regional levels. Exercises are also held at regular intervals.

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

Measure	Intervention level
Preventive evacuation:	1000 mSv H_{eff} or 5000 mSv H_{th}
First day evacuation:	500-50 mSv H_{eff} or 1500 mSv H_{th}
Late evacuation:	250-50 mSv (first year dose)
Relocation/return:	250-50 mSv (first 50 years after return)
Iodine prophylaxis:	500 mSv (child); 1000 mSv (adult, first day)
Sheltering:	50-5 mSv H_{eff} or 500-50 mSv H_{th} (first day dose)
Grazing prohibition:	5000 Bq I-131 per m^2
Milk (products), drinking water etc:	500 Bq/l I, 1000 Bq/l Cs, 125 Bq/l Sr, 20 Bq/l alpha emitters.

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 national Health Council ('Gezondheidsraad') is currently advising that the intervention level for iodine prophylaxis should be lowered by a factor of ten. 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.

Dimensions of emergency planning zones for Borssele
The organisational zone involves all municipalities within 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 direct measures are defined geographically:
- Evacuation zone: circle with a radius of 5 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 the case of nuclear emergencies.

Criteria for emergency situations
Following consultation with the Ministry of the Environment and particularly with the KFD, Borssele NPP has adopted the four 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. A difficult element 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 as follows:
1. Emergency stand-by: Emission < 10 * permitted daily emissions (noble gases; this means for the Borssele NPP $1.3*10^{15}$ Bq Xe-133 equivalent). No intervention levels are reached.
2. Plant emergency: Emission ≥ 10 * permitted daily emissions (noble gases). No intervention levels are reached.
3. Site emergency: Emission ≥ 0.1 * accident emission (the accident emission for the Borssele NPP is defined as $\geq 3 * 10^{17}$ Bq Xe-133 and $\geq 5 * 10^{13}$ 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_{eff} or 5 mSv H_{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 ≥ accident emission, being the emission that leads to the lowest intervention levels for direct measures. These lowest dose levels are 5 mSv H_{eff} or 50 mSv H_{th} in the first 24 hours after commencement of the emission. At these levels, 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 revitalisation
The Minister of Housing, Spatial Planning and the Environment (VROM) and the Minister of the Interior and Kingdom Relations, finalised a project to revise and update the National Nuclear Emergency Plan (NPK). The main purpose of the project was to reduce the differences between nuclear emergency management and response for other ‘regular’ types of disasters and crises which needs national coordination. Another main objective was to improve the Nuclear Assessment organisation by making it more professional and flexible and the preparation of strategies and means to inform the public and the media in case of a nuclear or radiological emergency.

The new system was tested in the National Full Scale Nuclear Exercise of 2005. In general, this exercise showed that the system worked well, but improvements could be made. In the process of implementing Lessons Identified, attention has been paid not only to the nationwide set-up but also to the local emergency organisation. Nuclear accidents now form part of regular emergency preparedness and response, and are also part of the regular reporting and control system. New directives, handbooks, monitoring strategies and equipment are in place. The next step will be to make the results operational at all levels of government and emergency organisations and to maintain the organisation and the system of the NPK to adequate standards.

Integrated exercises (i.e. involving both the plant staff and the authorities) have proved to be a useful way of improving the effectiveness of the licensee’s emergency plan and organisation and the emergency organisation of the authorities. After a period in which exercises focused mainly on specific aspects of nuclear emergencies and parts of the relevant organisations, integrated exercises are now being held on a more regular basis (every four-five years).

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. As is consistent with its responsibility for dealing with a nuclear accident, national government is also responsible for informing the public. This will be done in close cooperation with the local authorities in the threatened or effected area.

In case of emergencies that need national coordination, within the structure of the National Crisis centre (NCC), in 2005 the Expert Centre for Crises and Risk-communication (ERC) was established. 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, 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 Belgium and Germany. 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 just 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.

CHAPTER 2(D) SAFETY OF INSTALLATIONS

ARTICLE 17. SITING

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.**

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 (September 2007), there has been no ‘official’ announcement of plans to construct a new nuclear power plants in the near future. For this reason, the process described below for selecting, evaluating and deciding on a potential site reflects the pre-1986 situation. For the same reason, the IAEA Codes and Safety Guides on siting were never amended and adopted as a Dutch Nuclear Safety Rule (NVR). A number of elements from the Codes and Safety Guides on siting 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’. This is required under the Spatial Planning Act, NVR 1.1 (Safety Code for Nuclear Power Plant Design) and the relevant underlying guides. 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.

The Spatial Planning Act regulates the selection of sites for nuclear power plants. If the government were to decide to expand nuclear generating capacity, a site selection procedure would have to be launched (planning decision procedure). The planning procedure required by the Spatial Planning Act involves:

- the publication of an initial proposal by the government describing the potential sites, based on an initial site selection;
- the holding of public hearings;
- the submission of recommendations by various government advisory committees and councils;
- discussions aimed at obtaining consensus between the various ministries involved;
- parliamentary debates on both the initial proposal and the final government decision.

The main site-relevant factors that must be taken into account in the initial site selection process 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.

For the reference site, use is made of the mean population density of The Netherlands (5-20 km) and a 45° sector with a factor of 2.5 higher population density than the rest of the area (to account for the fact that, in reality, the population is not distributed uniformly). In addition, use is made of the concept of a Low Population Area around a nuclear power plant (0-5 km), and a weighting factor based on meteorological dispersion, to account for the fact that people living close to the site are more at risk than people living further away.

Other factors play a role only after this initial selection has been made. The outcomes of public hearings and reports from advisory committees are then taken into account. Such factors include:
- A more detailed look at the population density around the proposed site. For example, the size of the non-permanent population (i.e. day trippers and tourists) is taken into account. In addition, the population densities within a radius of 100 km and within the most populated 45° sector of this area are used to compare the sites.
- The amount of fresh water in the area in relation to the amount of condenser cooling water required.
- Ecological factors, such as whether or not the site may be described as constituting a landscape of special interest or a nature conservation area, or whether it offers opportunities for leisure activities.
- Current spatial planning policies for the area around the site, e.g. plans for further urban or industrial development.
- Economic factors, such as the use made of the land around the site, whether or not economically important centres are located in the vicinity, and the current infrastructure around the site.
- The location of the site in relation to the national electricity grid.
- The site's location-specific sensitivity to external hazards, such as external flooding, seismic events, high winds, aircraft crashes, gas cloud explosions, large toxic releases, etc.

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. Account must be taken of 'site-relevant factors' as mentioned in the section on Article 17 (ii).

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 ('MER'). 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 (known as the NDKK or the Dutch-German committee for nuclear installations in the border regions 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 be granted. This Expert Group advises the European Commission on the acceptability of the proposed installation on the basis of safety evaluations. The Commission informs the Member States concerned of the outcome of these evaluations.

ARTICLE 18. DESIGN AND CONSTRUCTION

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.**

18.(i) Defence in depth

In order to achieve the general safety objectives laid down in the various NVRs, 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), i.e. characterised by five different echelons. 'Defence-in-depth' is the name given to a safety philosophy consisting of a set of diverse and overlapping strategies or measures, known as 'echelons of defence'. A specific application is a system of multiple physical barriers of protection together with measures to keep each barrier intact.

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 echelon of defence is adequately preserved.
In the Operational Limits and Conditions 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 echelon of defence.

The third echelon of defence consists 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. The criteria are specified in Appendix 1.

The fourth echelon of defence 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 when they happen despite levels 1-3.

The fifth echelon of defence is covered by the strategies for off-site emergency preparedness. See the section on Article 16 for more information on these strategies.

In 2008 the Borssele NPP will finalise the last modifications derived from its second 10-yearly periodic safety review that was undertaken in 2003. For each echelon of defence, modifications have been implemented by the licensee. These consist more or less equally of technical, organisational, personnel and administrative measures. With regard to the five echelons 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 radiological consequences. See Annex 1 and Appendix 2 for more details.

Structures, systems and components
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 and class 4 is an extension for:

- components whose malfunction or failure could place a demand upon a safety system in the 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 'significant' if it improves ultimately the safety level of the plant; examples are important parts of the plant emergency operating procedures and important items in the plant safety analysis.

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. Allowing the contractor to work with a familiar code reduces the occurrence of inadvertent errors.

The original design and construction Safety-relevant fluid-retaining components (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 Electrotechnical Commission (IEC), the European Committee for Electrotechnical 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 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.

Safety Analysis
The Safety Report of the Borssele NPP is a 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 Safety Analysis Report (SAR), a.k.a. Technical Information Package (TIP), provides extensive background information on all safety related aspects regarding the installation and its surroundings. The SAR also includes all details of the design base accident analyses.

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 (Appendix 1 specifies the acceptance criteria for the analysis) have been anticipated and can be accommodated by the design base of the plant. For the safety analysis of the Borssele NPP, the design basis accidents have been grouped in the following 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 combinations of randomly occurring individual events could credibly 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 this implies that in the analysis the single 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 feedwater pumps). In the two 10-yearly PSRs this diversity has been enhanced.

Severe accident vulnerability
During the first 10-yearly 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, that 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.

The safety-relevant fluid retaining components were constructed in accordance with German material specifications. For example, the steam generator tubing is made of Incaloy 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.(ii) Design in relation to human factors and man-machine interface

The licence of Borssele NPP requires to continuously have available all data of the plant and the detailed assessments on which the conclusions of the safety report are based. Also it is required to describe the conditions that systems, components and the organisation of the operational management have to fulfil (the technical specifications), as well as the measures that have to be taken to allow the plant to operate within the licence requirements. This extensive set of information, the Technical Information Package (TIP) is the starting point for all modifications and maintenance activities and is updated with each modification.

The 1997 modification programme undertaken at Borssele included consideration of a whole range of man-machine interface elements (which are 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, equal to that for internal events.

ARTICLE 19. OPERATION

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.**

19.(i) Appropriate 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 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 is 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 are found in 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 outside 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. The establishment and performance of an appropriate CP remain, however, 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, surveillance and inspections to assure a sufficiently safe functioning of the reactor before restart is allowed.

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), Scientech (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 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_{th} 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 principal 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 ventilation 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 THIRD CNS REVIEW MEETING

Developing KFD organizational efficiency and recruiting personnel

Developing efficiency of the KFD-organisation

In April 2004, reorganisation of the KFD resulted into having two divisions: one for power reactors and one for research reactors. There has been an internal and an external review of the effect of the reorganisation. The external review showed appreciation by the licensees and the governmental bodies sharing responsibility for overseeing the nuclear facilities in the Netherlands. The internal review (i.e. within the KFD) showed that improvements were possible and were needed. As an instrument for the improvement process, an ‘improvement agenda’ has been established. An important issue on the agenda is the Quality Management. Also part of the improvements is the clear definition of the strategy of regulatory oversight (by the KFD). Heart of this strategy is the principle of continuous improvement of nuclear safety, security and safeguards. The strategy has been adapted by the VROM-Inspectorate and is communicated to the licensees in the nuclear sectors and the governmental bodies with which the KFD shares some responsibilities.

KFD moves forward improving its performance and has deployed several additional initiatives:
- Improve co-operation with other governmental bodies, that share responsibility for instance on conventional (= non-nuclear environmental aspects, occupational safety and water discharges in overseeing nuclear facilities to reduce overlap and inconsistencies.
- Improve communication on the oversight of nuclear facilities to share information on oversight activities. The joint governmental bodies have agreed to create a Front Office Nuclear Oversight for the Petten site. This Front Office will develop a website. This website will present public information and in addition will have a section with limited access, only available to governmental bodies involved in licensing and inspection and partly available to the licensees.
- Discussion with licensees on the optimisation of reporting requirements. It is expected this eventually will lead to reduction of the oversight burden for the operators of nuclear facilities.

Recruiting new KFD personnel

Since the third review meeting of the Convention, KFD has recruited five new staff. Three of these replace experienced staff that have left the department through retirement. The two others will strengthen the KFD in the area of security issues during the coming two years. Three of the ‘newcomers’ were trained by their predecessors, one of which returned from retirement for this particular task.

The (non-nuclear) expertise of some of the new staff has proved to be an ‘enrichment’ to the practice of nuclear oversight. They came from very different backgrounds like aerospace, civil engineering and psychology. All new personnel have taken part in an extensive training programme and in addition have contributed during their training to KFD-tasks.

The current total KFD professional formation is about 23 man-year equivalents, including three managers. Before January 2008, one additional staff member will be recruited (replacement). But in the next five years, an additional six experienced employees will retire. For the recent replacements, the time to transfer knowledge proved to be less than anticipated. This is due to a new early retirement plan, which offers retirement to 57-plus staff. In addition the limited number of (suitable) candidates has delayed employment of new staff, also reducing the time available to receive training from their predecessors. Current policy is to start job replacement activities one year before retirement.

KFD to increase international cooperation and assistance programs

Since the CNS-2005 the following developments have taken place:

- Increased number of exchange meetings with GRS
- Increased participation in OECD/NEA/WGIP workshops
- Increased participation in OECD/NEA/CSNI coordinated research programmes
- In 2006 one management team member participated in the IRRS-mission in France as observer
- In 2008 one management team member will participate in the follow-up IRRS-mission in France
- In the security area in 2005 a IPPAS-mission was conducted; participation in the ENSRA has been started in 2006; starting with 2007 several bilateral meetings on security have been organised: USA, Germany, Belgium; this will be completed with Sweden and Canada
- In 2006 three countries were visited to exchange information about the reporting requirements
- In 2006 KFD organised an IAEA INES course in the Netherlands
- KFD staff participated in two IAEA consultancy meetings in 2006: one in the security area and one on PSR
- In 2006 KFD organised the OECD/NEA/WGRISK meeting
- In 2006 KFD organised a two week IAEA regional training course on physical protection
- Netherlands organised the NERS meeting in 2007
- In the framework of PSR exchanges have taken place with ASN

Independent assessment of sustainable organization of the regulatory body for the Netherlands

At the third review conference of April 2005, the Netherlands announced it would report on this issue at the fourth review conference.

In 2005 a pilot study was commissioned to make an inventory of the state of affairs concerning the organisation, the tasks and the developments of the regulatory body with regard to nuclear safety, nuclear security and safeguards and radiation protection.

After completion of this study a follow-up study started by the end of 2006. The main scope of this second study is to define which tasks have to be carried out by the regulatory body and what is the best organisational structure to do that. In this context the question of the required manpower and quality of the staff will be addressed . Also will be investigated which tasks can be delegated to other organisations or can be performed by (private) organisations under contract. Furthermore the study will focus on the needs for the next 10 years and will consider different scenarios with regard to the existence or planning of certain nuclear installations.

It was also decided that this study would benefit from input of international experiences. Therefore questionnaires were send to and interviews were held with several other European regulatory bodies. Besides experts of the IAEA of the Regulatory Activities Section who have experience with the International Regulatory Review Service (IRRS) were consulted. The IRRS provides advice and assistance to Member States to strengthen and enhance the effectiveness of the legal and governmental infrastructure for nuclear safety.

At the time of drafting this CNS rapport it is expected that the results of this study will be available by the end of 2007. It is then up to the responsible ministers to decide which actions will be taken. This could possibly also include a request to the IAEA for an IRRS-mission to the Netherlands in the coming years.

Reduction of backlog in the modernization of regulations to deal with the increased life of Borssele to of (design) life

As described in the section under ARTICLE 7 the Dutch system of technical regulations under the Nuclear Energy Act is based on the IAEA standards. The formalized Dutch technical regulations (NVRs) contain a number of modifications of the IAEA standards to apply them on the national level. The process of studying and adapting the standards for national application is complex and time consuming. A selection of standards that were considered most needed have been implemented in the past. They are the standards for the Design, the Operation and the Quality Assurance of NPPs. At this moment the regulations in force are still based on the older versions of IAEA standards. The newest standards that were published by IAEA since 2000 have not yet been formalized although they have been used as reference documents for the last 10-yearly Periodic Safety Review. The reasons are mainly related to the political environment in the past concerning the operating lifetime of the Borssele NPP (see sections on ARTICLE 6 and ARTICLE 7).

With the presently existing clear picture on the future of the Borssele NPP, the project on the modernization of the regulations is ongoing and is aimed to be completed by the end of 2008. The project not only deals with modernization but also with extension taking into account the increased coverage of standards by the IAEA. New subjects are in the areas of research reactors, siting, and managements systems.

A special part of the project is the implementation of the WENRA reference levels. As far as they are not incorporated in the IAEA standards, which have contributed very much to the Reference Levels, they will be included in the respective NVRs.

Continue to develop ability to assess safety culture at both plant and regulator

The plant in Borssele currently is putting increased effort in enhancing its safety culture with support of WANO (refer to Appendix 4 for additional information). Together with the KFD a system will be developed of assessing the safety culture by a combination of performance indicators and regular independent review. The introduction of a safety culture officer and the Working Group on Safety Culture and Human Performance is a strong indication that the plant is committed to this aspect.

Early 2006 KFD attracted a new staff member who has expertise on safety management, safety culture and human performance.

Improve safety of Borssele in open electricity market

Historically in the nuclear industry a lot of attention is focussed on technical issues. The major changes in the electricity market, like the introduction of competition and unbundling the generation and distribution activities, causes huge organisational changes for the licensees These organisational changes may influence the safety performance (by influencing the safety culture and safety management) of an organisation. These changes emphasize the importance of organisational issues. Therefore currently a monitoring and inspection system on organisational issues is being developed. Because this system is in development, at the moment a combination of evaluations, assessment and indicators is being used.

At the Borssele NPP, programs are being implemented to improve the leadership of the managers and promote safety culture:

- 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 tours in the field, 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 effort is also made to promote safe work practices with for example 'the issue of the month' published in the company magazine, in the team meetings ('toolbox meeting') and with posters around the plant.

Recently the option to have a separate periodic independent assessment of the safety culture is discussed but not yet decided. Safety assessment is already part of the OSART Missions and WANO Peer Reviews (f.or example the Cross Functional Factors) which are frequently performed by international groups of experts at the Borssele NPP.

Finally it should be noted that KFD is updating the regulations as described in the section on ARTICLE 7. The new regulation will be based on recently published IAEA requirements and guides (also on the topic 'safety management' [5]).

Continue development of risk information as one of a set of tools for regulation and operation

The progress towards a more formal Risk Informed Regulation proceeds very slowly, especially from the side of the regulatory body. Nevertheless, some important steps have been made. Two pilot projects have been finalized by the licensee:

1. Optimisation of Technical Specifications - Allowed Outage Times (AOTs)
2. Optimisation of Technical Specifications - Test Intervals

As a basis the licensee has formulated numerical criteria for the optimisation of AOTs. These criteria are a factor 10 more stringent than those formulated in Regulatory Guide 1.177 published by the US-NRC (ΔTCDF x AOT $\leq 5. 10^{-8}$; instantaneous TCDF (point in time risk) shall never exceed the value

[5] 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).

of 1. 10^{-4}/year). The KFD has agreed with both these criteria and methods for these optimisation programs.

The KFD is in the process to formulate a national guide for risk informed regulation. As a basis US-NRC's Regulatory Guide 1.174 is taken. The main differences are:

- Instead of Large Early Release Frequency, Individual Risk (IR) is taken as a yardstick.
- Allowable risk increases are a factor of 10 more stringent than those formulated in the US document,
- It is expected that these risk increases are only temporal, and that on the long run the risk of the plant will decrease further. Although no strict timescales are given, periodic safety reviews will play a role in the regulatory oversight on these matters.
- Because there is only one operating nuclear power plant in The Netherlands (Borssele NPP), the guide will be tailor-made for Borssele, bearing in mind the current risk profile and risk criteria as formulated in the Radiation Protection Decree of the Nuclear Energy Act.

In Appendix 3 an overview is given of the use of PSAs in The Netherlands.

Enact licence condition to continuously improve safety as reasonable achievable (policy on back fitting being institutionalised)

The licences of all nuclear facilities in the Netherlands require a Periodic Safety Review (PSR). The Nuclear Energy Act contains the more general principle of ALARA, but no specific mention is made of the continuous improvement principle. Although an amendment of the Act could give a better legal basis to require licensees to follow the continuous improvement principle, in practice the lack of it is (at present) surmountable.

Although the Nuclear Energy Act has recently been evaluated, it is not expected that in short time a major review will take place.

In this framework, the results of the PSRs lead in most cases to modifications to further improve the safety of the installations. In this view it can be seen as the continuous improvement the KFD aims for.

Installation of proposed modifications resulting from 2nd 10-yearly periodic safety review

The operating licence of the Borssele nuclear power plant stipulates EPZ to conduct and report a PSR every ten years. This PSR is extensive and provides an assessment of the developments in technology and regulations with respect to the current licensing basis of the plant. The PSR reviews both design and plant operation, with technological-, organizational-, personnel- and administrative aspects.

The review has been based on the following documents:

- IAEA 50 SG O12, Periodic safety review of operational nuclear power plants
- IAEA INSAG Series No.8, A common basis for judging the safety of nuclear power plants built to earlier standards;
- IAEA Safety Report Series No.12, Evaluation of the safety of operating nuclear power plants built to earlier standards;
- Policy document on back-fitting (see Appendix 2)
- Current safety standards, design codes and methods as agreed with KFD.

The most recent PSR covers the period 1993 – 2002 and consists of an evaluation-, a conceptual- and an implementation phase. An important result of the evaluation phase is the conclusion that Borssele is operated safely, in compliance with (inter)national regulations and current state of the art technology. In addition, areas for further improvement and optimisation have been identified. The improvements have been selected, amongst others, for their impact on the total core damage frequency contribution (TCFD, PSA Level 1) and on the individual risk contribution (PSA Level 3). It appears that the results of the PSR show that there is a potential for a reduction of the total CFD by a factor of four, despite the two earlier back-fitting projects of 1985 and 1997. An important factor in this respect has been the increase of the so-called mission time in the PSA from 24 to 72 hours. This identified areas for improvement beyond the original 24 hours after the occurrence of an event.

The evaluation phase started in 2001 by gathering information from various sources, such as:
- Assessing new and upcoming regulations, safety standards etc.
- Input from personnel (interviews in own organization)
- Information from ageing programmes (conceptual and physical)
- Probabilistic safety analysis (In house living PSA model and know-how of commercial companies in the field of PSA).

More than 1200 issues were gathered and clustered in 26 so called basic reports. In a process of clustering and screening 176 issues of potential improvement were selected based on know-how and PSA data. This process and the result were presented to the KFD and accepted with adjustments.

The potential improvements were further analysed during the conceptual phase (2003-2005) and measures were formulated in order to realize improvements. Cost estimates were made together with the expected benefits to optimise the gain in nuclear safety and based on:
- Probabilistic information. Impact on the total core damage frequency (CDF) and the individual risk were calculated with a plant specific living probabilistic safety assessment model.
- Deterministic information. Upcoming regulations and defence-in-depth approaches (failures, availability and reliability) were analysed.
- Gain in the field of radiation protection.

The issues for improvement were split into Technical (design) measures and OPA (Organizational, Personnel and Administrative measures). All measures have been assessed and accepted by the KFD.

The modifications to the plant resulting from the technical measures are conducted in a separate project. The implementation is partially done by own personnel; the remainder by a consortium of Belgatom and GTI. The implementation of the OPA measures is completely done by the own organization. This final part of the PSR will be finished by the end of 2007.

OSART mission to Borssele NPP at the end of 2005

At the request of the government of the Netherlands, an IAEA Operational Safety Review Team (OSART) of international experts visited Borssele Nuclear Power Plant from 21 November to 7 December,2005. Operational performance was reviewed and current practice was observed.

The team was composed of 12 experts and 4 observers and the collective nuclear power experience of the team was approximately 345 years.

The findings of the team included four recommendations and twenty-three suggestions for improvements, but the team also found fifteen good areas of performance.

The overall impression of the team was that the plant has many attributes associated with a strong safety culture. A stable work force with long experience in the plant has facilitated these developments.

In June 2007 an OSART Follow-Up mission took place. According to the team there was found sufficient resolution and/or progress on the issues.

Clarify independence of authority of KFD with respect to Article 8 of the convention, authority to shut-down the plant in case of a significant safety concern

Subject to the provisions of Art.37b of the Nuclear Energy Act, the Minister of VROM (together with the Minister of SZW) is empowered to take appropriate actions, including shutdown, in case of a significant safety concern. By decision of end May 2007 this power is mandated to the Inspector-General of the VROM-Inspection, and the Inspector-General has mandated this power to the Director of the KFD.

That means that if immediate action is required and there is no time or possibility to inform the Minister, the Director of KFD is empowered to act immediately.

If there is no immediate action required, the Director of KFD will inform the Minister about the situation and will give advice which actions should be taken. It is then up to the Minister to decide in this matter.

Appendix 1 SAFETY POLICY AND SAFETY OBJECTIVES IN THE NETHERLANDS

Safety objectives

Safety policy in the nuclear field is based on the following safety objectives.

The general nuclear safety objective (see IAEA NUSSAG report entitled ‘The Safety of Nuclear Installations – Safety Fundamentals’, Safety Series No 110):
To protect individuals, society and the environment from harm by establishing and maintaining in nuclear installations effective defences against radiological hazards.

This 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.

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.

The Dutch government 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.

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.

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 [Lower House of the States General, 1988-1989 session, 21137, Nos. 1-2, The Hague 1989], 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' [Lower House of the States General, 1988-1989 session, 21137, No. 5, The Hague 1989]. 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' [Lower House of the States General, 1989-1990 session, 21483, No. 1, The Hague 1990]. These two 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

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_{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_{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 24 hours after the start of the release should not exceed 5 mSv. The PSA can help in fixing these figures. For example, the limit of 5 mSv was used as an acceptance criterion in the design of the containment emergency venting filter for the Borssele NPP.

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 government felt it would be useful to enhance the reactor safety concept, which had to 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

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 undergoes modification 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.

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.

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.

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.

Since there is no formal guidance on backfitting in the Dutch regulatory system, a PSR/Backfitting rule will be considered in the near future.

Appendix 3 THE ROLE OF PSAS IN ASSESSING SAFETY

a. The role of PSAs in the Netherlands

The background to the introduction of PSAs in the Netherlands was political and at the time of their introduction PSAs were primarily meant for use in relation to site-related problems in the chemical industry and the transportation of dangerous substances. The subsequent decision to extend the use of PSAs to NPPs was also politically based. Nevertheless, 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 demonstrate rough 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 an absolute belief in the numbers.

Both the Dutch nuclear power plants 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 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 was formulated for the existing NPPs. Although back-fitting primarily addresses the design-basis area, the beyond-design-basis area and associated severe accident issues are also taken into account. 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 (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.

It became clear at a later stage 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. 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 and review of the PSAs

At the start of the Dutch PSA programmes in 1988/1989, there were no national PSA guidelines. To make matters worse, 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. At the first round of talks between one of the licensees (i.e. the Borssele NPP) and the regulatory body (in 1988), 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. 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. 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.

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 use of PSAs for configuration control, the optimisation of Technical Specifications, or event analysis are potential applications. The current ongoing LPSA applications, such as 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., will be continued or intensified. However, the number of applications may need to be increased in order to make maximum use of the LPSA.

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 good number of the applications are explained to some detail.

Evaluation of modification proposals (design review)

In 1993 the first 10-yearly periodic safety review took place. At that time the PSA was not yet finalised. This resulted in a major modification program. Therefore, the new safety concept was mainly derived from a deterministic safety concept of the German Convoy plants. However the PSA could play a large role in the optimisation and evaluation of the deterministic safety concept, 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 Modifications reduced the TCDF from 5.6 10^{-5}/year to 2.8 10^{-6}/year.

In 2003 the second periodic safety review took place. The PSA played an important role. 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. For each echelon of defence-in-depth concept measures were suggested:

- Installation of igniters and 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 ECCS pumps (TJ) lead to a reduction of TCDF by 20%
- Improvement of 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 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 5.10^{-8} for ΔTCDF x AOT
- TCDF shall always < $1.\ 10^{-4}$/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, but also to take 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.

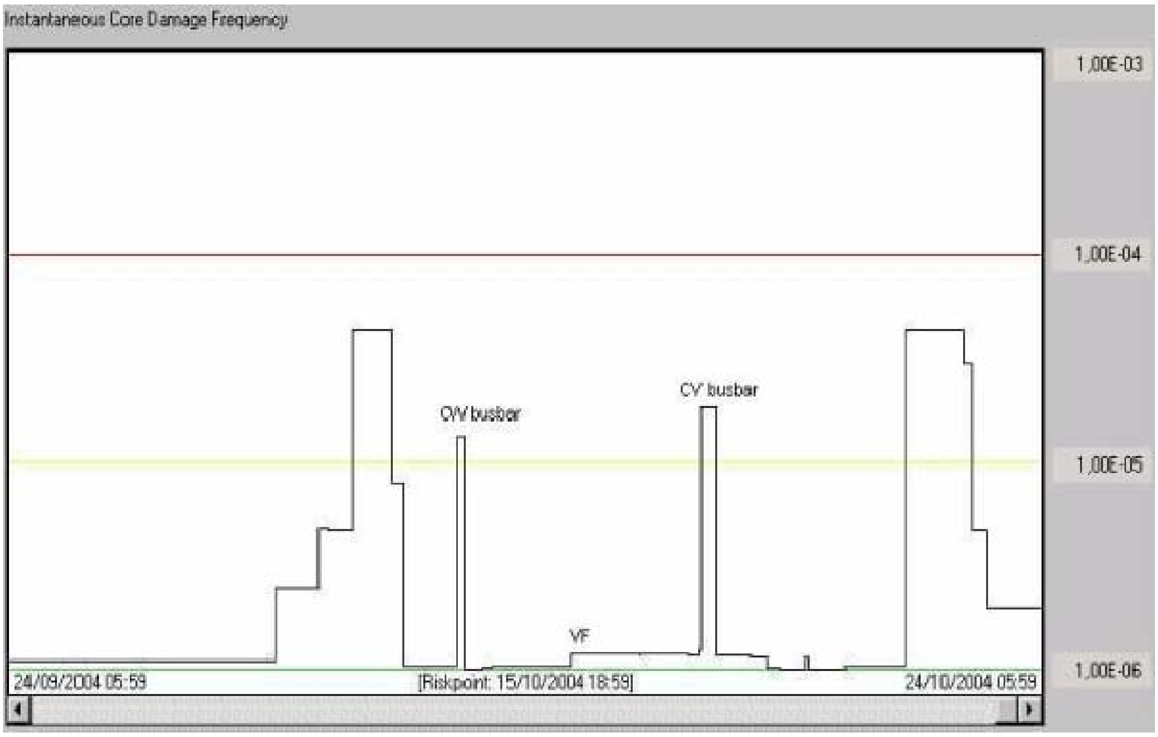

Figure 2 Result of outage planning in 2004

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. 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 case 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 codes being used for forecasting the consequences.

For the definition of the planning zones for evacuation, iodine prophylaxis and sheltering conservatively the PWR-5 source term from WASH-1400 (Rasmussen Study) is still taken as the reference source term. Because the dose criteria for evacuation, iodine prophylaxis and sheltering will probably be lowered in the near future, a re-evaluation of the reference source term will be done by SAS/SNB together with the KFD. Doing nothing would imply that the planning zones would become significant larger than currently is the case and also larger than is actually needed. Therefore, a more realistic and Borssele NPP specific source term will be developed for this purpose.

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. 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

Because 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, the IAEA was asked to advice the KFD in order to support this process. 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*?", were the focal points of this review.

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[6] . 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;

[6] The near term benefit was stressed due to the at that time expected closure of the plant at the end of 2003

- one-time exemptions from Technical Specifications and other licensing requirements; and
- 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. There are no new reactors planned.

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 $1.\ 10^{-4}$/year.
For optimisation of AOTs the licensee has adopted a value of 5.10^{-8} for DTCDF x AOT and TCDF always < $1.\ 10^{-4}$/year.

Appendix 4 THE SAFETY CULTURE AT BORSSELE NPP

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' (HPs), 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.

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.

Evaluation of safety culture programme

In the recent 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 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;
- Introduction in 2006 of a working group for Safety Culture and Human Performance;
- 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.

The Borssele NPP and the KFD will discuss on a yearly basis what the results are of this new approach. These 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 op 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

	Adaptation of IAEA Safety Series No. 50-SG-Q12
NVR 2.3.13	Quality Assurance in Operation Adaptation of IAEA Safety Series No. 50-SG-Q13
NVR 2.3.14	Quality Assurance in Decommissioning Adaptation of IAEA Safety Series No. 50-SG-Q14

ANNEX 1: TECHNICAL DETAILS OF BORSSELE NPP

1. Technical specifications

The Borssele nuclear power plant is a light water PWR with a thermal power of 1366 MW and an 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^3
Average linear heat rating	20.27 kW/m
Average heat flux	599 kW/m^2
Fuel	UO_2
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 ^oC
Core inlet temperature	292.5 ^oC

Main coolant pumps

Number of pumps	2
Rated flow rate	18000 m^3/h
Speed	25 s^{-1}
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^3
Volume secondary side per SG	123.6 m^3
Height	17200 mm
Surface SG exhaust (smallest)	0.362 m^2
Design temperature	350 ^oC
Material of U-tubes	Incoloy 800
Number of U-tubes per SG	4234
Total heat transfer area	3600 m^2

Pressuriser

Overall volume	40 m^3
Water volume (at full power)	24 m3
Steam volume (at full power)	16 m^3
Total power heaters	2000 kW

Primary pressure relief

Number and type	Three tandem PORV/Safety Valves (SEBIM);
Details:	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^3
Water volume (normal operation)	25 m^3
Gas volume (normal operation)	15 m^3
Temperature (normal operation)	50 ^oC

Safety systems

High-pressure core injection system

Number of high head pumps	4
Capacity	190 m^3/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^3/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^3 of borated water
Boron concentration (H_3BO_3)	2300 ppm B
Pressure	1 bar

Medium-pressure core inundation buffer tanks

Number of tanks	4
Capacity per tank	21.5 m^3 of borated water
Boron concentration (H_3BO_3)	2300 ppm B
Design pressure	31.5 bar
Operating pressure	25 bar

Containment spray pumps

Number of pumps	2
Capacity	50 m^3/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^3/h
Maximum discharge head	185 bar
Type	Piston pump
Number of borated water storage basins	2
Capacity	243 m^3/ 262 m^3 of borated water
Boron concentration (H_3BO_3)	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^3/ 469 m^3

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	500 elements in high density racks
Actual storage	104 elements (May 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.

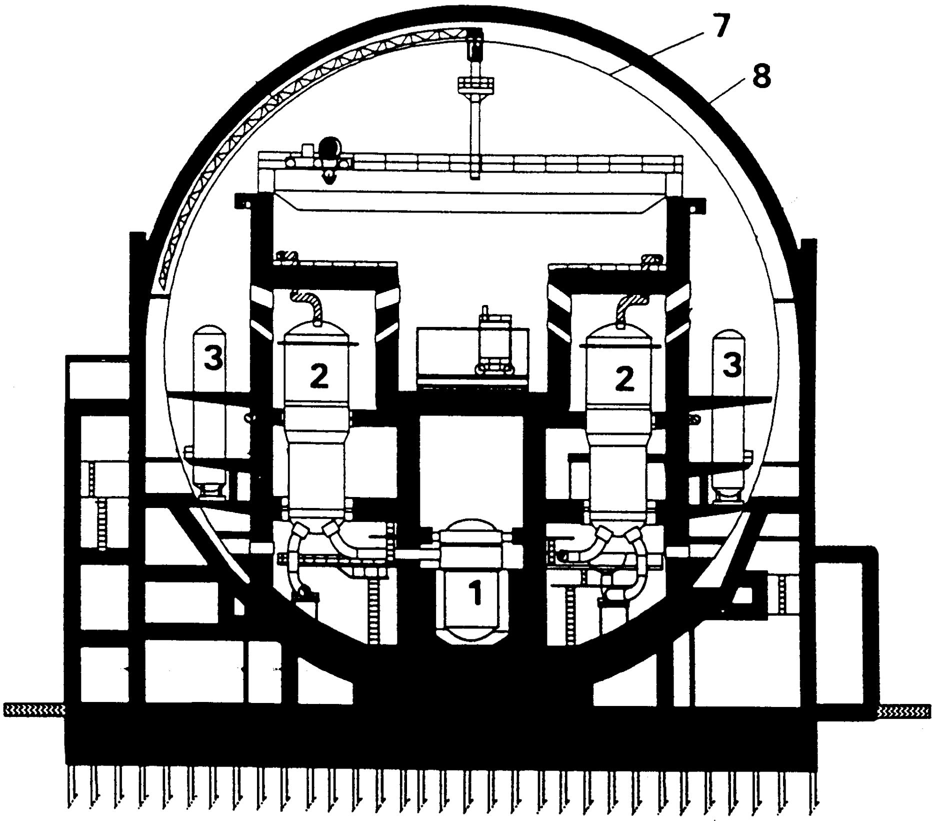

Figure 3 Cross-section of reactor building of Borssele NPP

1. Reactor pressure vessel
2. Steam generator
3. Medium-pressure core inundation buffer tank
7. Steel containment
8. Secondary concrete enclosure (shield building)

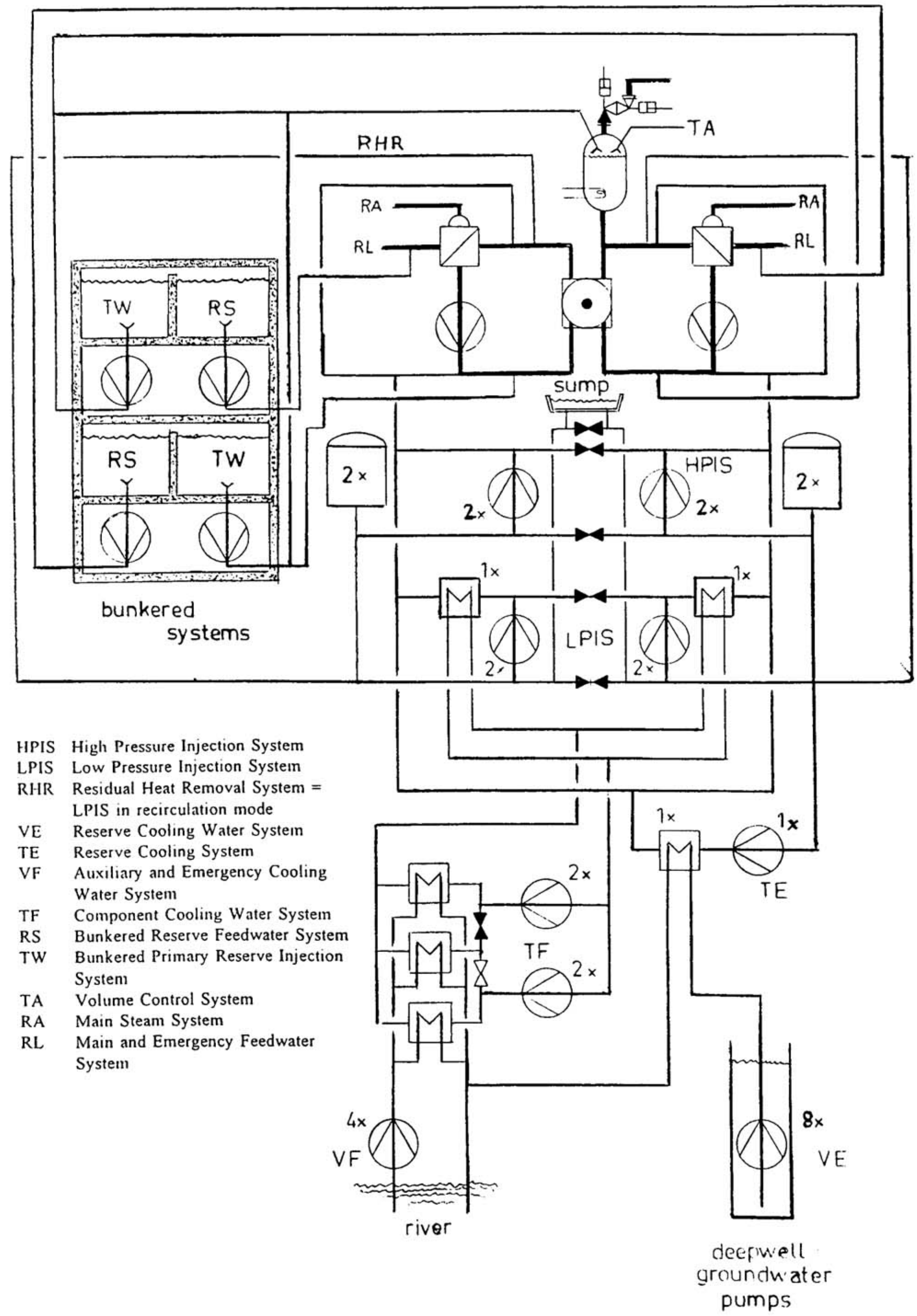

Figure 4 **Safety features of core injection & RHR systems at Borssele NPP**

2. Safety improvements from the first 10-yearly periodic safety review (the 1997 modifications)

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 bar.
- 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.

3. Proposed 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. To mention are:

Technical measures:

- Installation of detectors and igniters at site boundary counteract external gas clouds. This measure reduces the total core damage frequency (TCDF) by 6% and the individual mortality risk by a massive 54%;
- Increasing the supply of diesel oil in the bunker systems from 24 hours to 72 hours. This will reduce the TCDF by 20% and the individual risk by 7%;
- Installation of improved seals for the pumps in the low pressure injection system. This measure reduces the TCDF by 20%;
- 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. This will reduce the TCDF by 15%;
- 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;
- Improving the emergency operating procedures to prevent dilution of primary water after starting of the main coolant pumps;
- Introduction of SAMG for non-power conditions;
- Supplementary study of the radiation induced embrittlement of the reactor vessel internals;
- Improving the ageing management system;
- Optimising the 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 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).

4. 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.

5. 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:

Beta/gamma emitters (excl. 3H)	200 GBq
Tritium	30 TBq
Alpha emitters	200 MBq

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 $1 * 10^{-3}$ 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.

6. Discharges, doses and other relevant diagrams for Borssele NPP

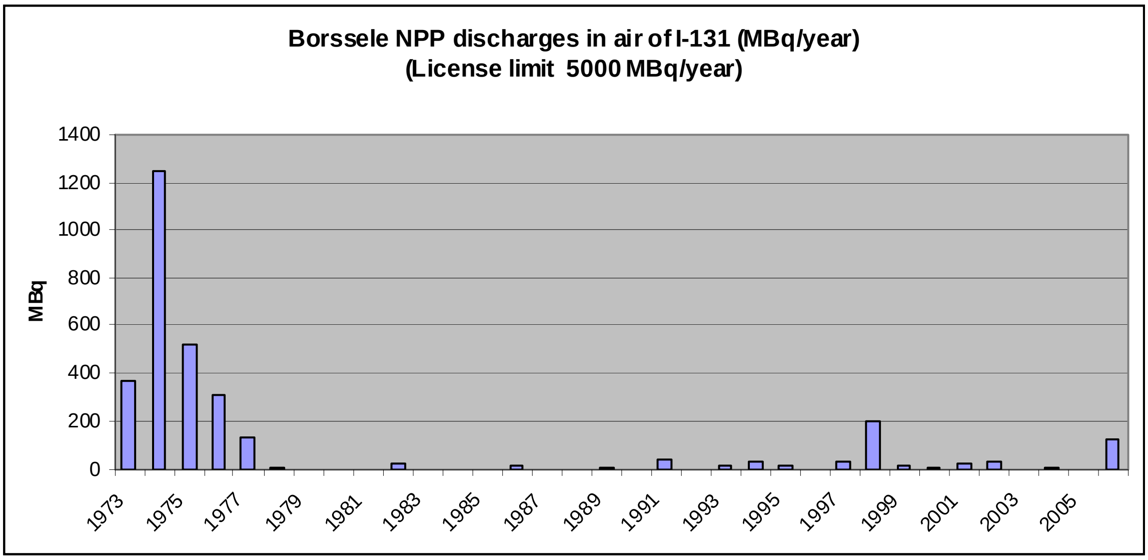

Figure 5 **Borssele NPP discharges in air of I-131**

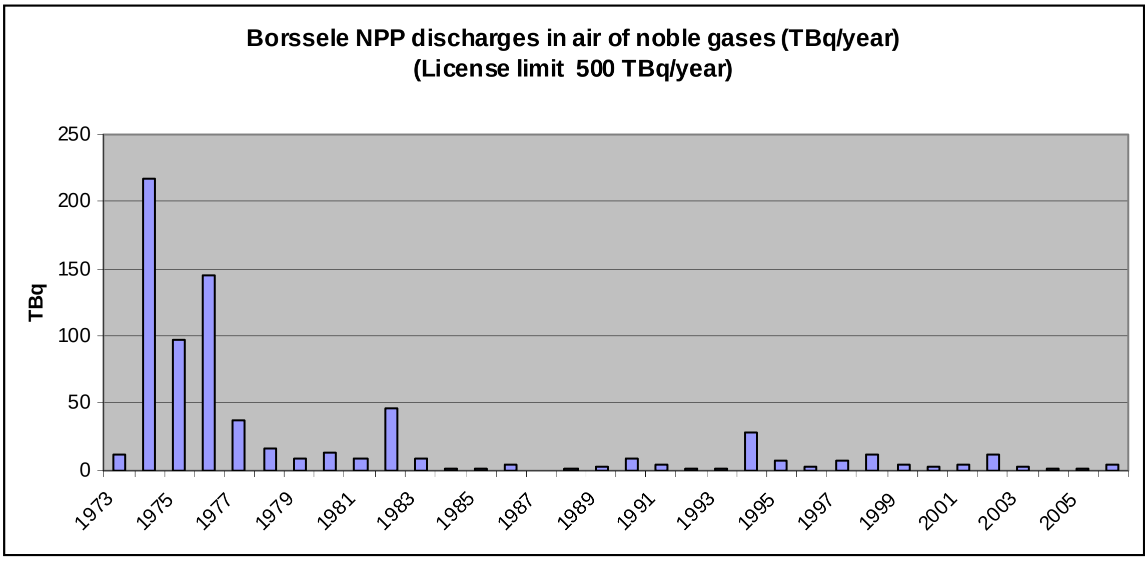

Figure 6 **Borssele NNP discharges in air of noble gases**

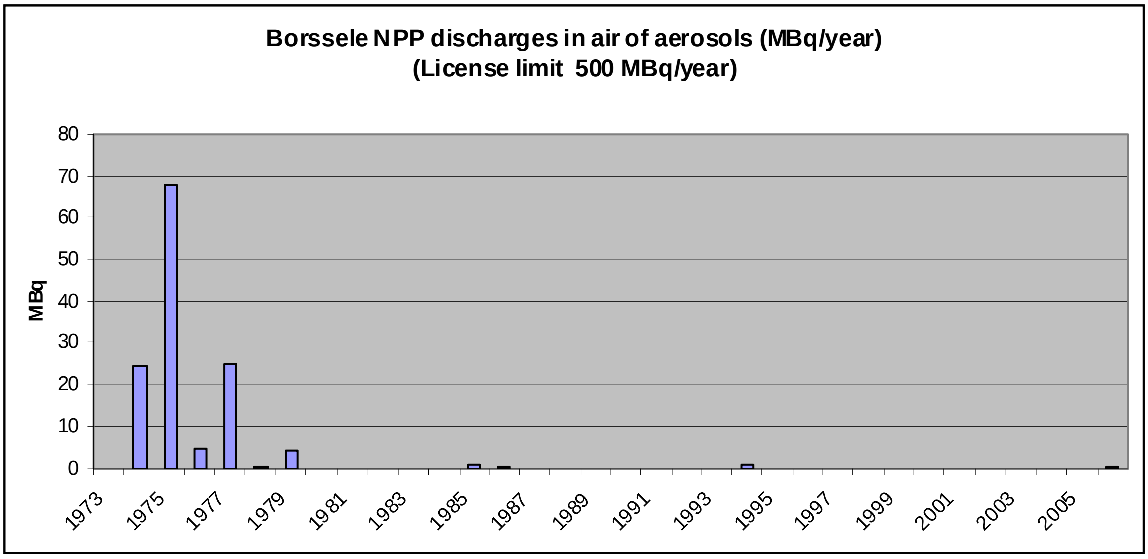

Figure 7 **Borssele NPP discharges in air of aerosols**

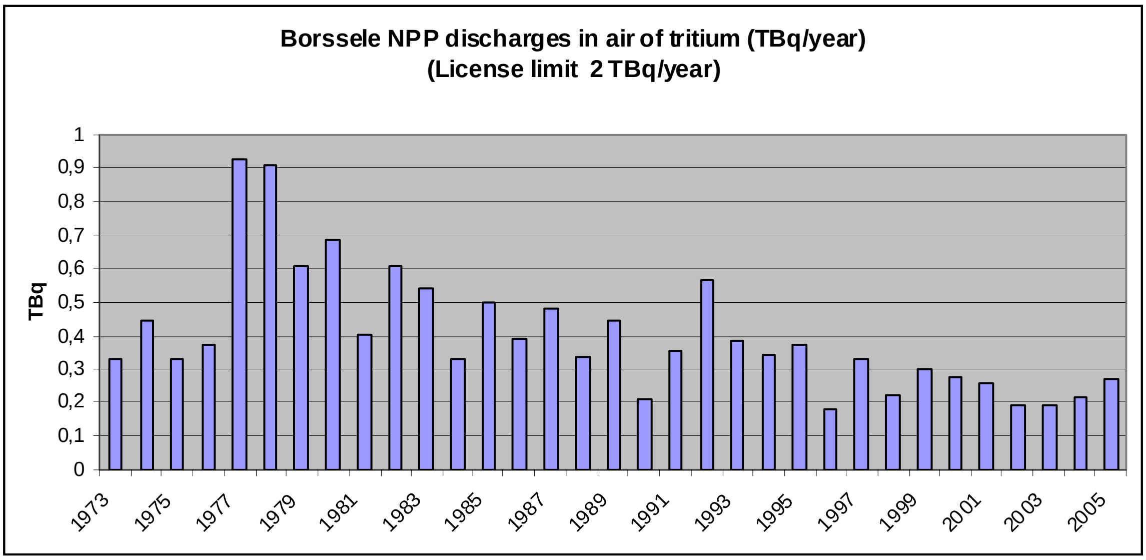

Figure 8 **Borssele NPP discharges in air of tritium**

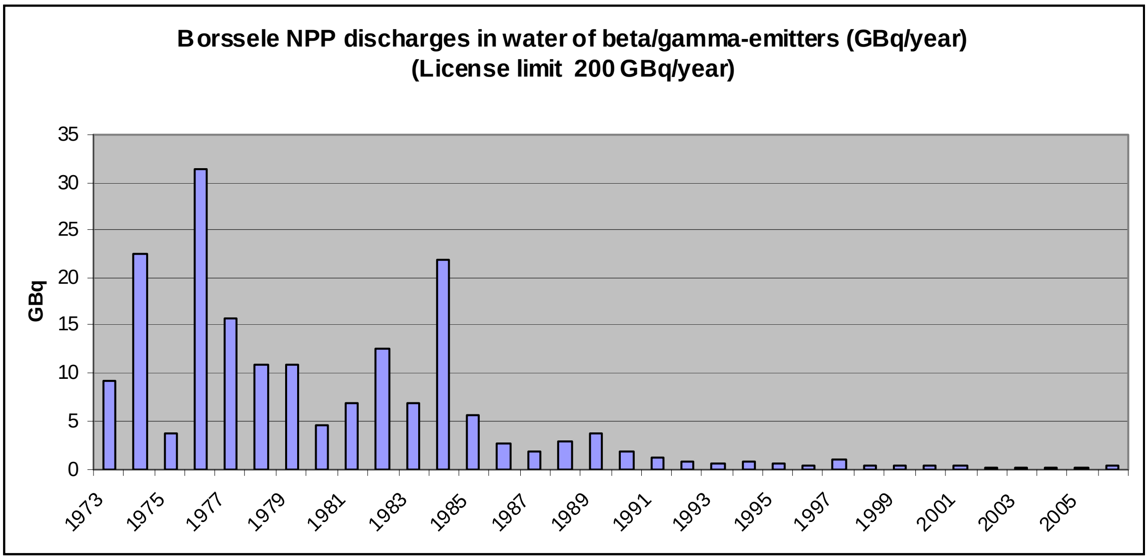

Figure 9 **Borssele NPP discharges in water of beta/gamma emitters**

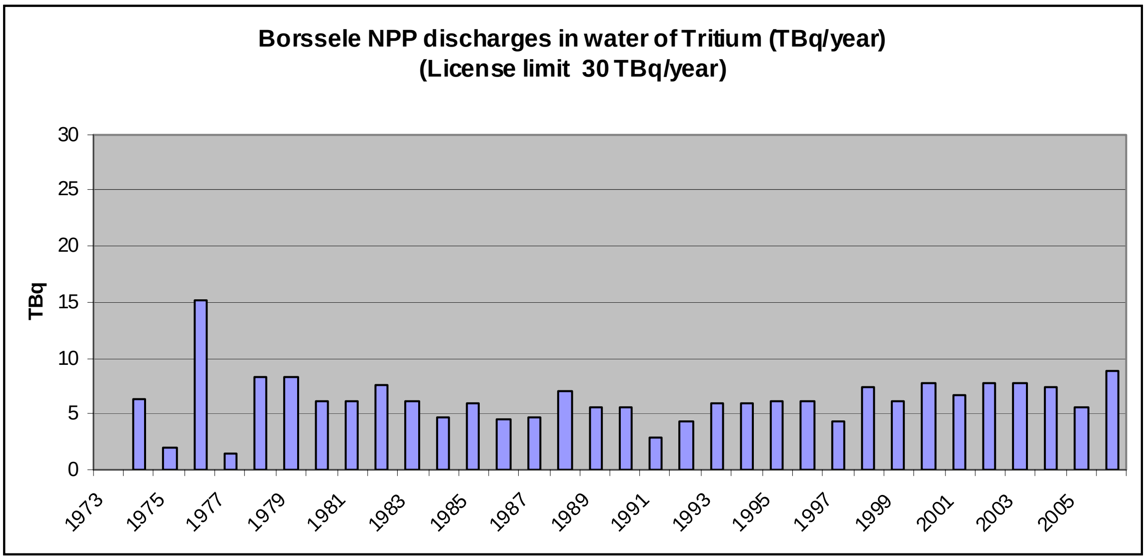

Figure 10 **Borssele NPP discharges in water of tritium**

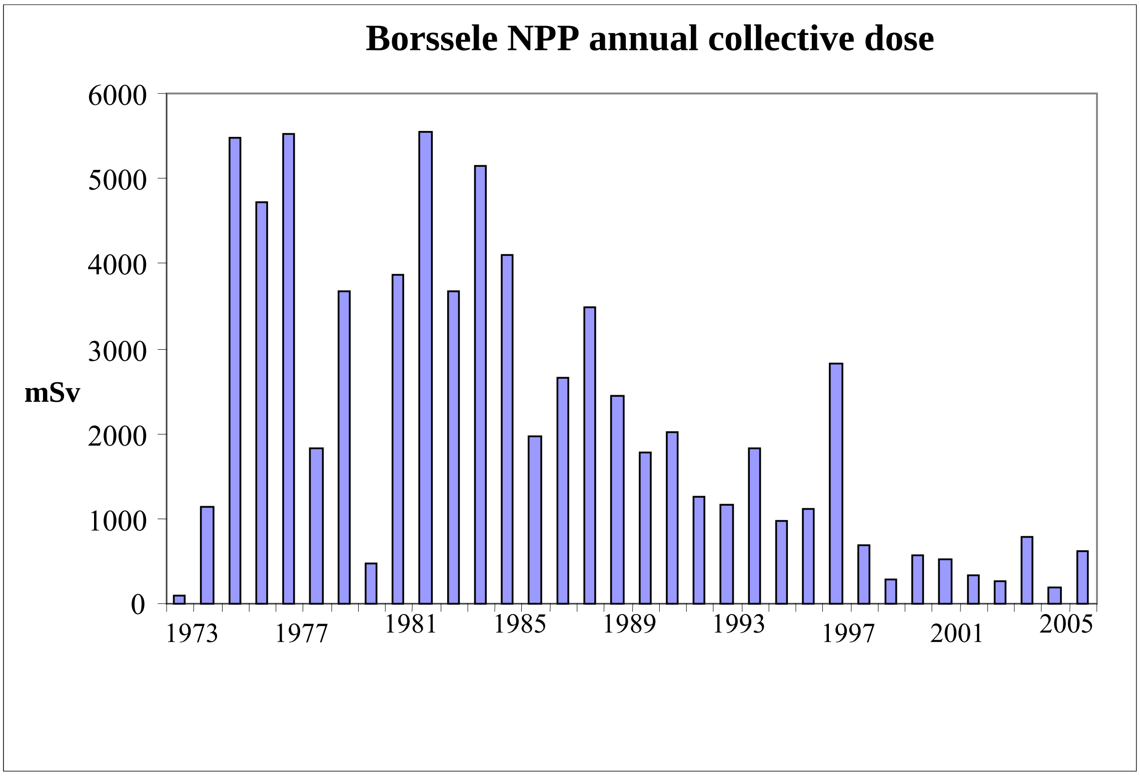

Figure 11 **Borssele NPP annual collective occupational dose**

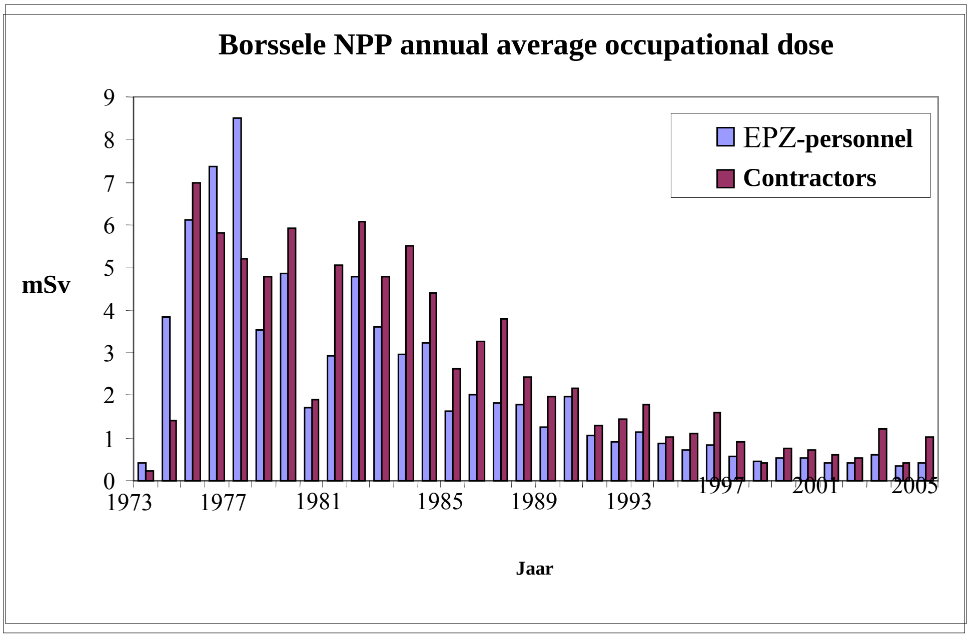

Figure 12 **Borssele NPP annual average occupational dose**

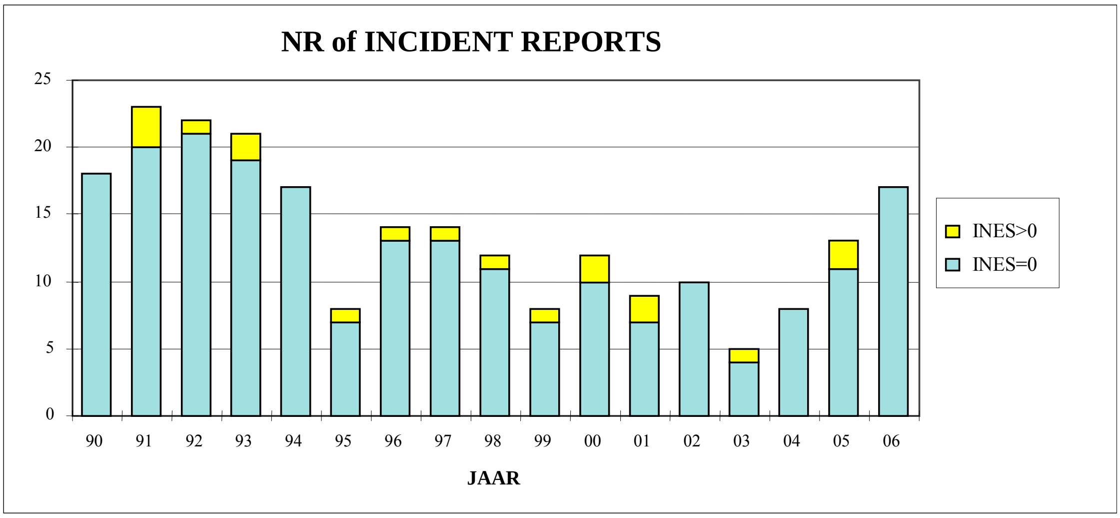

Figure 13 **Number of incident reports**

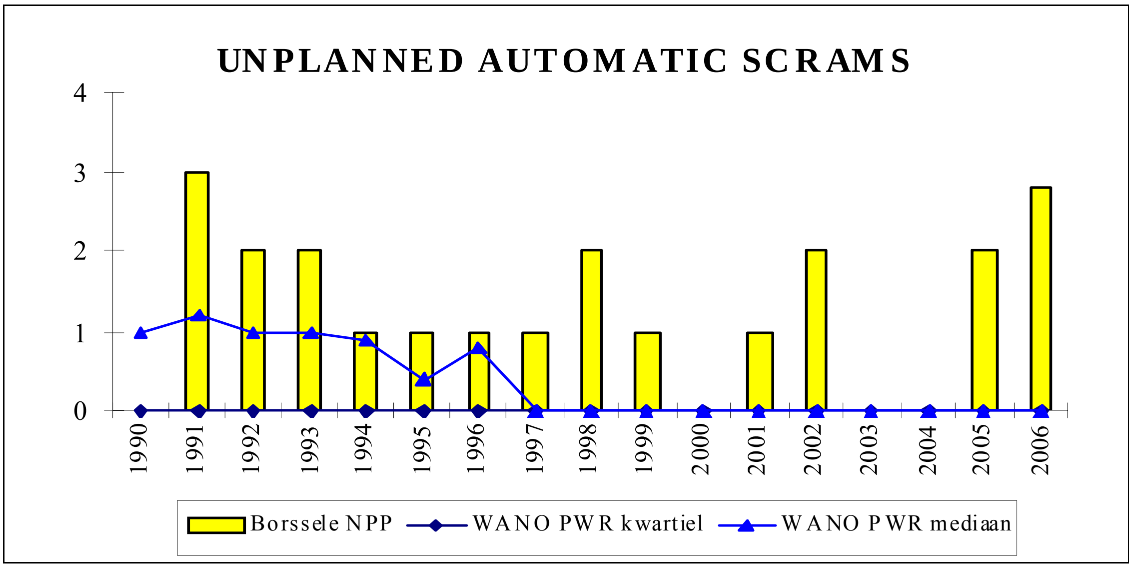

Figure 14 **Unplanned automatic scrams**

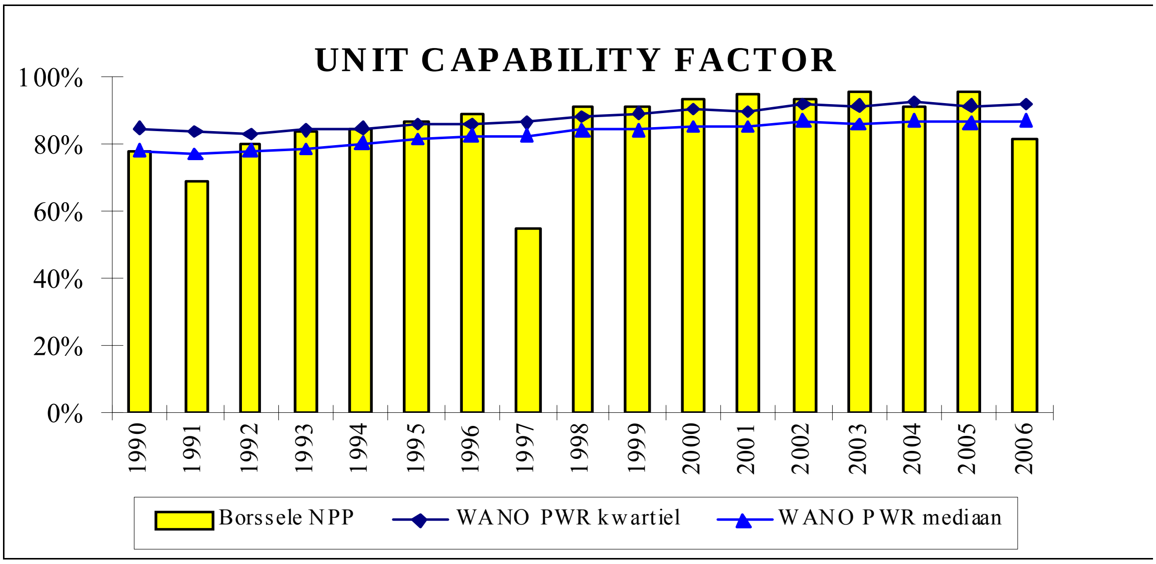

Figure 15 **Unit capability factor**

ANNEX 2: BORSSELE 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, an unilateral decision of the regulatory body to shut down the plant on a short notice (in 2013), even if technically possible, would most probably 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 31st 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) extra incentive for more sustainable energy management in relation to the closing date of the Borssele plant; 2) funding of decommissioning costs; 3) so-called ‘safety-benchmark’.

The (unofficial) English translation of the covenant is presented in the remainder of this Annex.

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[7] 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[8] shutting down Borssele nuclear power plant (by legislation) but has decided against this, owing to:
   a. the results of the surveys referred to below,

[7] 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.
[8] 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 [9];
8. the main conclusions to emerge from these surveys [10] 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_2 and NOx, and that the savings in CO_2 emissions are estimated to be 1.4 million tonnes CO_2 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 CO2 emission reductions of 0.47 million tonnes per year and Central Government shall achieve CO2 emission reductions of 0.93 million tonnes per year;
15. further analysis [11] 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

[9] Parliamentary documents II 2004/05, 30 000, no. 5
[10] Parliamentary documents II 2004/05 30 000, no. 5, appendix
[11] 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 [12];
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_2 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_2 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

[12] 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_2 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_2 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 [13]) 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_2 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_2 capture and storage;
- CO_2 neutral fuels;
- storage techniques for imbalance reduction by increasing non-baseload reprocessing;
- energy-saving options, such as heat pumps, micro-CHP (Combined Heat and

[13] Agreement of 3 August 2000 on reducing CO2 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 Tonnages 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_2 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

P.L.B.A. van Geel
(place: Goes date: 16 June 2006)

The Minister of Economic Affairs

L.J. Brinkhorst
(place: Goes date: 7 June 2006)

N.V. Elektriciteits Produktiemaatschappij Zuid-Nederland EPZ,

J.W.M. Bongers
(place: Goes date: 16 June 2006)

Essent Energie B.V.,

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: RELEVANT ARTICLES OF THE NUCLEAR ENERGY ACT

Article 13

1 A register will be kept in which a record will be made of the data relating to the fissionable materials, ores and other materials from which fissionable materials can be obtained that contain at least 0.1% uranium or 3% thorium by weight, of which notice has been given in accordance with the provisions of Article 14.

2 The organisation of the register will be prescribed, and the situations designated in which information from the register may be divulged to third parties, by or pursuant to order in council.

3 Our Minister of Economic Affairs is responsible for managing the register and for divulging information from it.

Article 14

1 All persons who transport, store or dispose of fissionable materials, ores or other materials from which fissionable materials can be obtained that contain at least 0.1% uranium or 3% thorium by weight, import them into or export them out of Dutch territory, subject to the provisions of this Act, are obliged to keep full accounts in this connection and to give notice in order to allow a record to be made as referred to in Article 13, in those situations such as are defined by order in council and in accordance with the regulations laid down by order in council.

2 All persons who identify the presence of ores or other materials from which fissionable materials can be obtained that contain at least 0.1% uranium or 3% thorium by weight, in the soil are obliged to give notice thereof in order to allow a record to be made as referred to in Article 13, in those situations such as are defined by order in council and in accordance with the regulations laid down by order in council.

Article 15

It is forbidden:

a to transport, store or dispose of fissionable materials or ores, or import them into or export them out of Dutch territory without being in possession of a licence;

b to build, commission, operate, modify or decommission a plant in which nuclear energy may be released, in which fissionable materials may be made or processed or in which fissionable materials are stored, without being in possession of a licence;

c to fit and to maintain in such a plant a device that is suitable for propelling a vessel or any other means of transport, or to commission, operate or modify such a device that has been fitted in such a plant, without being in possession of a licence.

Article 15a

Our Minister of Housing, Spatial Planning and the Environment; Our Minister of Economic Affairs and Our Minister of Social Affairs and Employment are empowered jointly to decide, in consultation with Our Minister of Transport, Public Works and Water Management if it concerns the transport of fissionable materials or ores, or discharges in water, with Our Minister of Agriculture, Nature Management and Fisheries if it concerns discharges in air or water and with Our Minister of Health, Welfare and Sport if it concerns medical applications of radiation, whether or not to grant an application for a licence as referred to in Article 15.

Article 15b

1 An application for a licence may be rejected only in the interests of:

a the protection of people, animals, plants and property;
b the security of the State;
c the storage and guarding of fissionable materials and ores;
d the supply of energy;
e the payment of compensation for any damage or injury caused to third parties;
f the observance of international obligations.

2 Other interests, in addition to those referred to in the first paragraph, may be designated by order in council.

3 If We have not sent to the Lower House of the States General, within three months of the date on which an order in council as referred to in the second paragraph has taken effect, a bill to amend this Act in accordance with the order, or if such a bill is either withdrawn or defeated, We shall withdraw the order with immediate effect.

Article 15c

1 A licence will clearly state its subject matter. The licence application is part of the licence, where this is so indicated in the licence.

2 A licence may be granted subject to certain restrictions, in order to protect the interests designated by or pursuant to Article 15b.

3 A licence is governed, subject to the relevant rules laid down by order in council, by those regulations that are needed to protect the interests designated by or pursuant to Article 15b. If it is not possible to prevent the activity in question from having an adverse impact on people, animals, plants and property by attaching certain regulations to the licence, the licence will be governed by those regulations which offer the maximum protection against this impact, unless it is not reasonable to set such a requirement.

4 If the fissionable materials, ores, plants or devices in question are governed by rules issued pursuant to Article 21, there may be discrepancies between the regulations and these rules only insofar as this is permitted by the rules.

Article 15d

1 The regulations attached to a licence will describe the objectives which the licence-holder is obliged to achieve in order to protect the interests designated by or pursuant to Article 15b, and which it will achieve in a manner to be determined by the licence-holder.

2 If the competent authorities deem this necessary, the regulations may state that certain specified means should be used to protect the interests designated by or pursuant to Article 15b.

Article 15e

1 Regulations other than those referred to in Article 15d may be attached to a licence in order to protect the interests designated by or pursuant to Article 15b.

2 A regulation may impose an obligation on the licence holder to meet, in connection with certain items specified in the regulation, certain requirements laid down by an administrative authority specified in the regulation. The regulations may indicate how the administrative authority in question

should publish these requirements. The announcement of such a requirement will specify the date as from which the obligation to meet the requirement takes effect.

Article 21

1 Rules may be laid down by order in council to protect the interests designated by or pursuant to Article 15b, relating to certain categories of fissionable materials, ores, plants, devices or components of plants or devices specified in the order. The order may state that the rules laid down in the order apply only to the particular types of situation specified in the order.

2 Instructions may be given by order in council to the effect that the prohibitions set out in Article 15 do not apply, in certain specified types of situation, to fissionable materials, ores, plants or devices which fall in a particular category specified by the order.

3 Articles 8.12. to 8.16 of the Environmental Protection Act apply mutatis mutandis to the regulations laid down under the rules, on the proviso that, in the application of the second paragraph, the only form of financial security which may be prescribed is the provision of insurance cover against liability for any losses resulting from an adverse impact caused by the plant on the interests designated by or pursuant to Article 15b.

4 Should an order in council issued pursuant to the first paragraph declare the provisions of the second paragraph to be applicable, the licence holder may be obliged to report any activities that are not subject to the prohibitions set out in Article 15.

5 Articles 8.40, second paragraph, 8.41, second, third and fourth paragraphs, and 8.42 of the Environmental Protection Act apply mutatis mutandis, on the understanding that the words ‘Our Minister’ are taken to refer to Our Minister of Housing, Spatial Planning and the Environment; Our Minister of Economic Affairs and Our Minister of Social Affairs and Employment jointly.

ANNEX 4: HIGH FLUX REACTOR (HFR)

1. General description

The HFR is a relatively large research reactor with a current thermal output of 45 MW_{th}. It is a tank in pool type reactor of a design similar to the old Oak Ridge Reactor in the USA (Figure 16, Figure 17, Figure 18 and Figure 19). Two other similar reactors of this type have been built: the R2 reactor in Studsvik, Sweden, and the Safari reactor in South Africa.

The aluminium reactor vessel with 4.5 cm thick walls (core box) is located at the bottom of a 9 m deep pool (Figure 17 and Figure 19). 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 circuit is connected to the reactor vessel. This primary circuit consists of 16” and 24” aluminium piping, a 43 m3 decay tank, three electrically driven main primary cooling pumps and three heat exchangers (see Figure 18 and Figure 20). 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.

The HFR was originally designed to operate with > 89% high enriched U.Alx 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.

2. History and use of HFR

The construction began in the mid-fifties at the Petten site, a location in the dunes close to the sea. The reactor became critical 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, the reactor was given 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.

3. 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 on the state of the art, also by visiting 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.

4. Licence renewal

In 2005 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 to be upgraded significantly. A new updated Reference Licensing Basis and a new Safety Analysis Report 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 became 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 needed a prior approval of the director of the KFD;
- The reference licensing basis as developed for the 10-yearly periodic safety review became a mandatory regulation for the HFR;
- An ageing management system had to be developed;
- A system for operational feedback had to institutionalised.

5. IAEA-INSARR missions

In 2002 an IAEA-INSARR mission was held 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 problems at that time).

As a result of the earlier safety culture problems 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 held. This requirement resulted that the follow-up mission of the 2002 INSARR was transformed in a full scope new mission. In 2005 this second INSARR-mission with the at that time largest scope and number of experts (10 experts) in the team was held. 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 2002.

An example of the good practises being identified by the INSARR-team is given by the following:

- NRG has established an integrated Management System in which all important aspects of the complete operation with respect to quality, safety and environment are combined:
  - All relevant aspects of the system are integrated in dedicated work processes;
  - Every work process gives a clear overview of the responsibilities and competences for the tasks to be carried out;
  - Common procedures allow applying uniform working methods.
- NRG provided training to all levels of management with special focus on leadership, open attitude and mutual respect. This facilitated the development towards a human/ learning organization and provides for a strong commitment of all level of managers and staff towards safety and resources.
- The stakeholders of the HFR established policies that give safety matters the highest priority, promoting a strong safety culture. These policies are implemented within a management structure having clearly defined divisions of responsibility and lines of communication.
- The reviewers of the INSARR team consider that the effort made by both the owner (JRC) and the licensee (NRG) in the pursuance of improving the present level of safety of the HFR is commendable.
- The significant improvements of the Risk Scoping Study/PSA carried out for the present version of the study motivated by suggestions of earlier IAEA-IPSART missions (2), represent a good practice.

Despite the good practises, the 2002-review team observed also several issues for further improvement. To mention some:

- A decommissioning plan was lacking
- Site-specific data and documentation such as environmental data for dispersion analysis, soil permeability data for dispersion in the groundwater, soil capacity data for the foundation analysis were lacking or not direct available.
- The safety classification of structures, systems and components was found to be incomplete. As a result the connection between safety analysis, structural design and equipment qualification could be inadequate.
- The team noted that the maintenance procedures for electrical equipment were not complete, as a regular schedule was not available and acceptance criteria are not clearly indicated. Moreover no individual files are kept for electrical equipment and instrumentation, making any ageing evaluation almost impossible. It was therefore recommended to bring the maintenance procedures of the electrical workshop compliant with the company QA.

NRG started an enhancement programme which is harmonized with the safety modification plan.
It should be noted that there is a decommissioning plan for the HFR and that the JRC as its owner will pay the decommissioning costs.

Table 1. Technical Details of the High Flux Reactor

Maximum thermal power	50 MW_{th}
Reactor coolant pressure (absolute)	0.34 Mpa
Maximum flow rate (3 pumps)	> 4150 m^3/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^3
Core inlet temperature	40-56 ^oC
ΔT over core	9-10 ^oC
	LEU
Fuel enrichment	19.25-19.95 %
Number of fuel plates per element	20
^{235}U-mass per fuel element	550
Uranium density	4.8 g/cm^3
Material fuel matrix	U_3Si_2-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^3
Volume of fuel storage pools	190 m^3

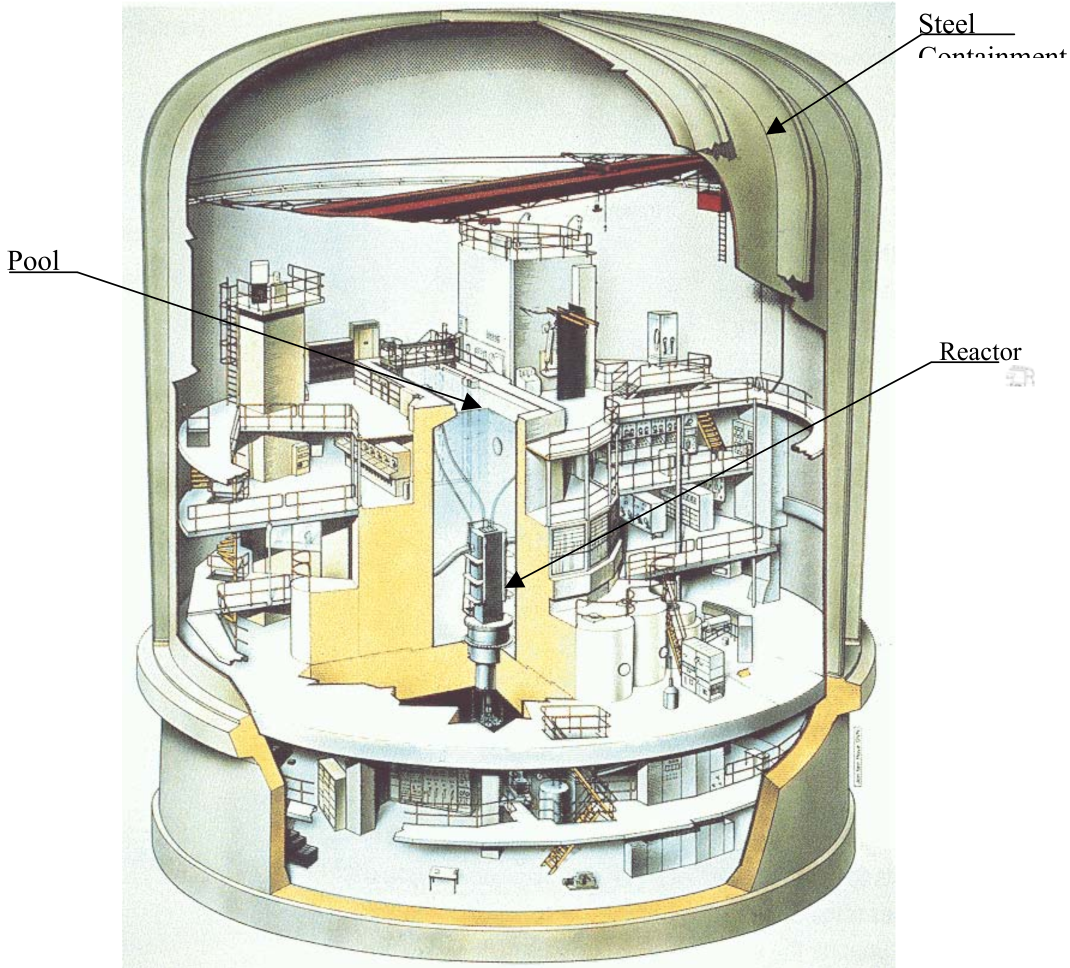

Figure 16 3D Cross section of reactor building of the HFR

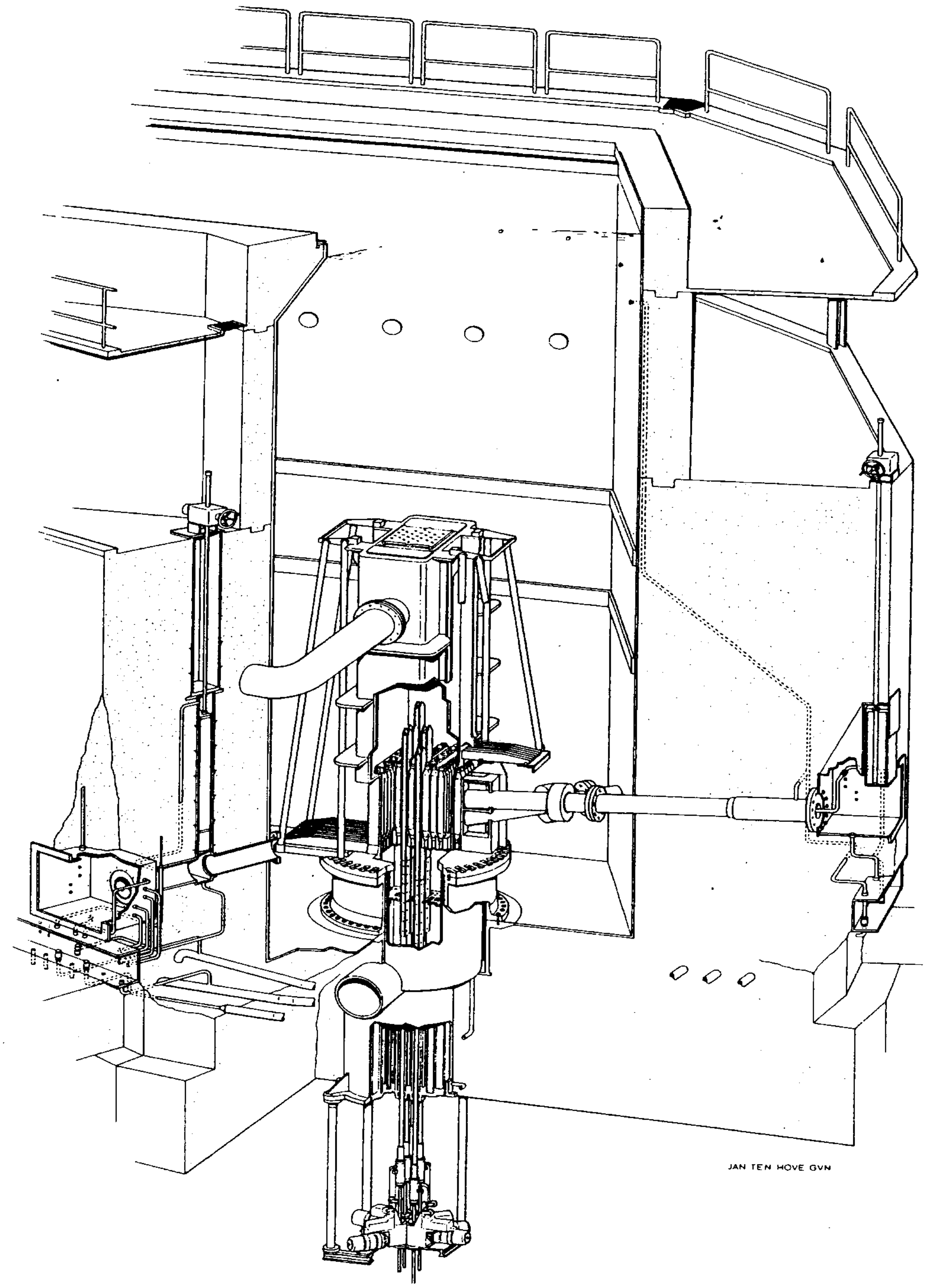

Figure 17 Reactor vessel in reactor pool of the HFR

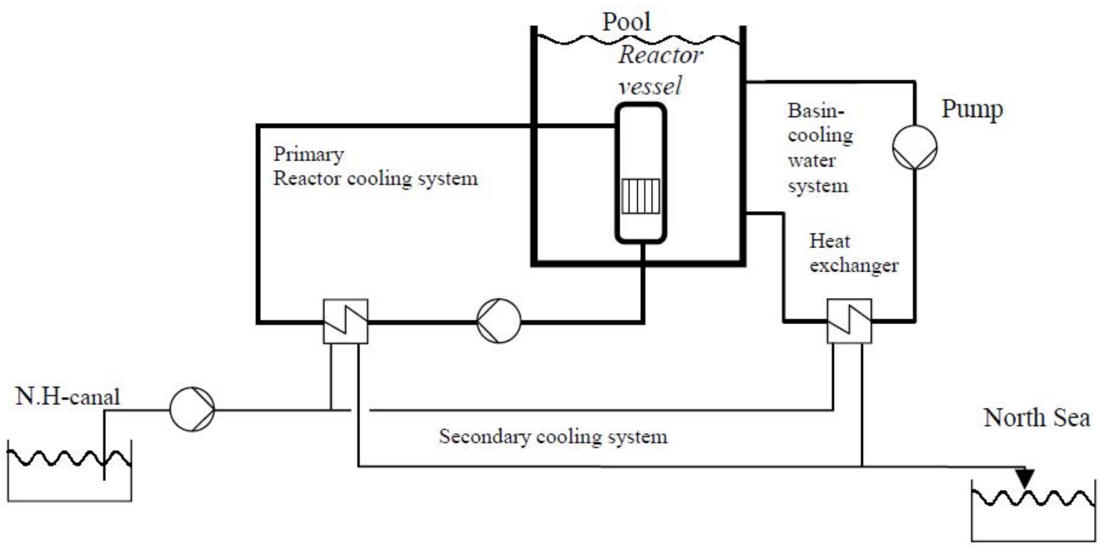

Figure 18 Schematic presentation of the primary, secondary en basin cooling system of the HFR

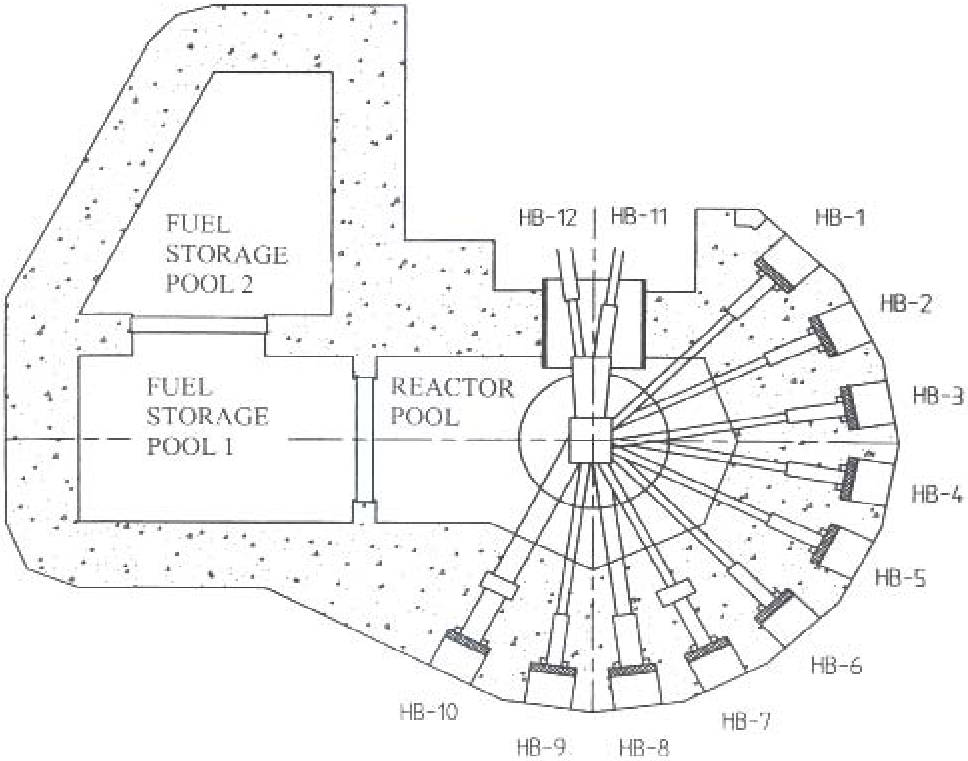

Figure 19 **Cross-section of reactor pool and spent fuel storage pools of the HFR**

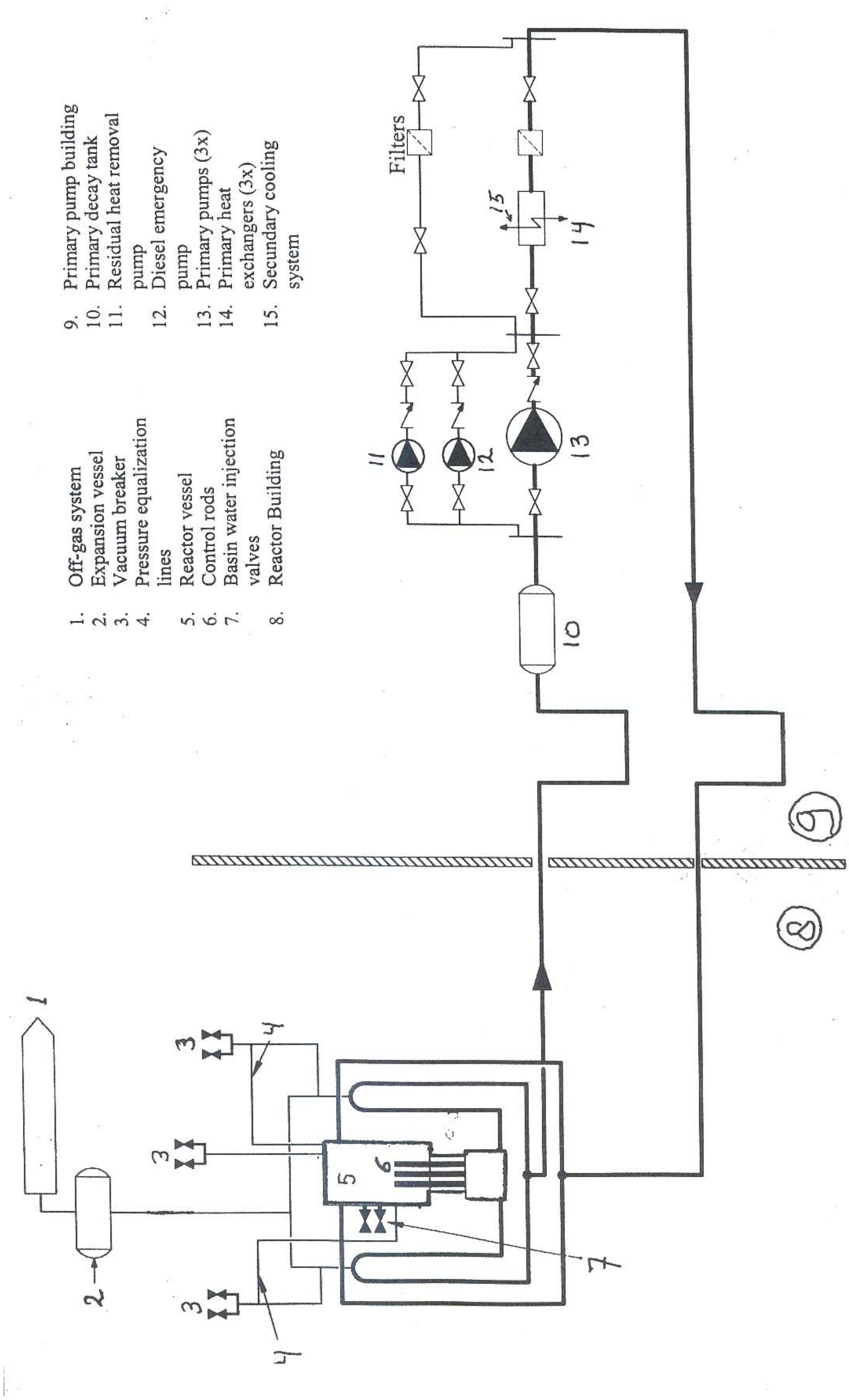

Figure 20 **Process flow scheme of primary circuit of the HFR (after modifications).**

ANNEX 5 EDUCATION AND STAFFING AT THE KFD

Introduction

This Annex provides detailed information on available disciplines at the KFD, 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.

Core disciplines at the KFD

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 an example of 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 safety organisations.

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 from SAS. 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, two within the formation and two on a temporary basis (for a period of two years).

The supervisory duties of the KFD include the security of nuclear power plants. In addition some tasks on security are subcontracted to other departments of the Inspectorate. 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.

Education of KFD staff

The KFD has a policy of allocating between 10 and 15 days each year to (refresher) training for each staff member. Examples of training for new staff are:

- basic training in radiation protection (15 days)
- basic training in nuclear safety (12 days):
    - reactor physics
    - reactor kinetics
    - nuclear fission
    - global lay-out of reactor and fuel
    - fuel cycle
    - waste management
    - reactor types
    - 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 GRS

Apart from the abovementioned courses, there is training dedicated to the technical discipline, including international workshops, conferences and visits to other regulatory bodies. 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 KFD that the core experts need to have sufficient knowledge to specify and to assess work done by external experts.

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. Unavoidably this issue has been discussed within the organization almost as long as the KFD exists. In 2008 it will exist 40 years.

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 extend the regulatory body. The present situation is essentially still the same.

The total professional formation of the KFD, for all nuclear facilities is now 22.5 (including the 3 managers) full time man-year equivalents. Currently about 50% of KFD experts are supervising Borssele NPP. A relatively large number of staff (3) have retired at the end of 2005, but have been replaced with new staff. In the next five years retirement of 6 more staff will take place. Since 2007 there is an increase of two staff members in the security area for two years on a temporary basis. Apart from the new staff members, each member of staff has at least ten years of experience in his or her respective discipline.

The KFD pursuits to attract new staff members. So far all retiring persons were replaced. The staffing policy of the KFD can be characterised as a persistently seeking of talented young people, who will fit in the KFD-organisation, can bring in new knowledge and can be trained on the job for their tasks as a member of the regulatory body. Furthermore the KFD is building a plan for replacement of the retiring and experienced staff members. The KFD is allowed to start recruiting one year before retirement of a staff member.

In the process of recruiting new personnel, the KFD has searched for a non-technical specialist on human and organisational factors, following the trend in other regulatory bodies. In 2006 that search was successful.

Challenges
The KFD remains a fairly small organization of highly specialized professionals, which is vulnerable to external developments. Focal points for attention for the KFD management are:

- The ageing of the workforce. The average age reported in 2005 was about 58 years. By employing some younger people this has been reduced. There is still a large group to leave within 5 years. This presents the danger of experience disappearing in a short period of time.
- The possible diminishing of nuclear safety expertise within the Netherlands as a whole. Recently large budget savings threatened the existence of the research reactor of the Technical University of Delft. Currently financing for the coming years is guaranteed. On the other hand the number of staff at the Nuclear Research & consultancy Group NRG is growing due to the current revival of the nuclear businesses worldwide.
- Governmental budget cuts have been announced. There is also a plan to reduce Government staffing in general by 20% in 2011. These budget cuts may not leave the KFD unaffected. It has already been decided to reduce the KFD-formation by one to 21.5 full time man-year equivalents.
- The threat of overloading by new projects in the next ten years:
    - In 2006 the Government signed an agreement (‘covenant’), which allows for operation until the end of 2033. Due to this new perspective the NPP has major plans to make the reactor fit for this purpose and to increase thermal power.
    - Replacement of the research reactor in Petten is planned.
    - Possible major modifications of the research reactor in Delft.

The management of the KFD is alert for these developments and copes with them in the following ways:
- Government budget cuts may have consequences for the formation of the KFD. Its management is seeking to cover this in the following way:
    - Efficiency gain by internal integration of ‘old’ and ‘new’ KFD-tasks (mainly security).
    - Internal cooperation with environmental inspectors (non nuclear) from the regional offices of the VROM-Inspectorate of the regions where the respective nuclear installations are located, thus taking the advantage of the knowledge and facilities of the regional offices.
    - Cooperation with other inspectorates within the Netherlands, e.g. the Labour Inspectorate and the Inspectorate for Transport, Public Works and Water Management, taking the advantage of the knowledge and facilities of those bodies.
- The KFD seeks continuously contacts with colleague regulatory bodies abroad. Intensive contacts are established with GRS in Germany and with the Belgian regulatory authorities AVN and FANC, taking advantage of not having a language barrier. Contacts are also build up with the Swiss regulatory body HSK and will be sought with regulatory bodies facing situations similar to those in the Netherlands. Therefore KFD has organised a meeting in June 2007 in the framework of NERS (www.ners.info). But also the membership of 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.
- KFD is developing new and expanding existing contracts with external organisations (like AVN in Belgium and GRS in Germany) to fill in the existing and expected gaps in the capacity and fields of experience of KFD.

Furthermore other developments in the ‘nuclear world’ and in society influence the range of activities of the KFD:
- Traditionally the staff of the KFD consists of technical or science oriented persons. However, some of the main safety issues are no longer technical in nature. Organizational aspects and aspects of human and safety culture require more and more attention from the industry as well as from the regulatory body.
- Generally speaking, there is a tendency to handle violations of rules and regulations more and more in formal lawsuits. Citizens and non-governmental organisations are demanding transparency from regulatory bodies and ask authorities to enforce legislation strictly. This stronger focus on enforcement requires additional attention in the daily practice of the KFD.
- As a consequence of the liberalization of the electricity market, a stronger commercialisation of the nuclear power generation industry is noticeable. A similar tendency is shown at the HFR, where the commercial usage of the reactor (isotope production) has become vital for the continued existence of the reactor. The regulatory body has to assess whether ‘safety first’ is not replaced by ‘balancing safety against economic interest’.
- In the coming years legal requirement to separate production and distribution of electricity producers might stimulate the takeover of small Dutch companies by larger foreign companies.

These developments require the Dutch regulatory body to reflect continuously on its role, tasks and position between the nuclear industry and society.