VROM

CONVENTION ON NUCLEAR SAFETY

Dutch National Report 2005

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

Third Review Conference (April 2005)

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

The Hague, September 2004

CONTENTS

LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviation	Full term	Translation or explanation (in brackets)
ALARA	As low as reasonably achievable	
ANS	American Nuclear Society	
ANSI	American National Standards Institute	
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	
COSYMA	Code SYstem from MAria (MAria = Methods for Assessing the radiological impact of accidents)	Computer code for radiological consequence analysis
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

Abbreviation	Full term	Translation or explanation (in brackets)
EIA	Environmental Impact Assessment	
EOP	Emergency Operating Procedure	
EPZ	Elektriciteitsproducent Zeeland	(Operator of Borssele NPP)
EU	European Union	
€	EURO	€1 = US$0.9 (approximate exchange rate at end 2001)
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	
HEU	High Enriched Uranium	
HFR	High Flux Reactor	
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)

Abbreviation	Full term	Translation or explanation (in brackets)
IPSART	International PSA Review Team	Current name of IPERS (IAEA)
IRI	Interfacultair Reactor Instituut	Operator of the HOR
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	Nuclear Safety Service (The Netherlands)
KTA	Kerntechnischer Ausschuss	Nuclear Standards Technical Committee (Germany)
KWU	Kraftwerk Union	(Siemens nuclear power group, nowadays Framatome ANP)
LEU	Low Enriched Uranium	
LOCA	Loss of coolant accident	
MBq	MegaBecquerel	(Mega = 10^6)
mSv	milliSievert	(Milli = 10^{-3})
µSv	microSievert	(Micro = 10^{-6})
MMI	Man Machine Interface	
MW_e	Megawatt electrical	
MW_{th}	Megawatt thermal	
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)

Abbreviation	**Full term**	**Translation or explanation (in brackets)**
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)
P&Id	Process and Instrumentation diagram	
PIE	Postulated Initiating Event	
PORV	Power-operated relief valve	
PRA	Probabilistic Risk Assessment	
PSA	Probabilistic Safety Assessment	
PWR	Pressurised-water reactor	
QA	Quality assurance	
RHR	Residual heat removal	
RIVM	Rijksinstituut voor Volksgezondheid en Milieuhygiëne	National Institute for Public Health and the Environment (The Netherlands)
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)

Abbreviation	**Full term**	**Translation or explanation (in brackets)**
SG	Steam generator	
SGTR	Steam generator tube rupture	
SSCs	Structures, Systems and Components	
Sv	Sievert	
TBq	TeraBecquerel	(Tera = 10^{12})
TMI	Three Mile Island	
TÜV	Technischer Überwachungs Verein	(Safety inspectorate, Germany)
USNRC	United States Nuclear Regulatory Commission	
VGB	Verein Grosskraftwerk Betreiber	(Power plant owners group, Germany)
VI	VROM Inspectie	(Inspectorate of the Ministry of Housing, Spatial Planning and the Environment)
VROM	Ministry of Housing, Spatial Planning and the Environment	
WANO	World Association of Nuclear Operators	
WENRA	Western European Nuclear Regulators Association	

INTRODUCTION

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 third in its series and describes the manner in which the Netherlands is fulfilling its obligations under the Convention.

The Netherlands has a small nuclear programme: it currently has only one nuclear power plant plus a small number of research reactors in operation. The technical details of the NPP are provided in Annex 1. It was originally thought that nuclear power would play an important role in the country's electricity generation programme. A small prototype reactor (Dodewaard BWR, 60 MWe) was put into operation in 1968, and in 1973 this was followed by the first commercial reactor (Borssele PWR, 480 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.

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[1] and Safety Guides in IAEA Safety Series 50, as amended for application in the Netherlands. The licence is granted under the Nuclear Energy Act (KEW).

Since 2002 there have been major political developments in the Netherlands: there have been two general elections and the current Dutch government, in office since spring 2003, has decided to postpone the closure of the Borssele NPP for 10 years, until the end of 2013.

The last review report mentioned that a dispute between the government and the operator about the earlier shut-down date had led to a court case. In September 2002 the court decided in favour of the operator, meaning that the government no longer had an agreement with the operator to shut down the Borssele NPP at the end of 2003.

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.

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[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.

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 operated in Petten by the Joint Research Centre of the European Commission. The key issues are the first 10-yearly periodic safety review and associated back-fitting, an investigation of the safety culture and a new 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 of the HFR in relation to the various articles. During the second review meeting in April 2002, 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.

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.

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 second review meeting of the Contracting Parties to the Convention on Nuclear Safety in 2002. 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. In addition, the chapter outlines the main differences between the 2001/2002 situation and the current situation regarding nuclear safety.

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

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[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) 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;
- a list of installations where significant corrective action has been found to be needed;
- 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 2002.

6.1 Existing installations

The Netherlands has only one nuclear power plant now in operation: the Borssele PWR (Siemens/KWU design, 480 MW_e); it also has one shut-down plant which is already at an advanced stage of decommissioning (safe enclosure): the Dodewaard BWR (GE design, 60 MWe). On 3 October 1996, the owners of the Dodewaard plant (SEP: a former alliance of Dutch utilities) decided for economic reasons to shut down the reactor permanently. The shut-down became effective on 26 March 1997. Dodewaard had been in operation since 1968. It 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. Originally intended to remain in operation until 1 January 1995, its operating life was extended first to 1 January 1997 and later to 2004. The plant is now in the so-called post-operational phase. All the spent fuel has been removed from the site and the plant is being transformed into a ‘safe enclosure’. Annex 2 contains further information on the decommissioning of the Dodewaard NPP.

Borssele 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.

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

Although research reactors are not formally subject to the Convention, it has been decided to include information about the High Flux Reactor (HFR), a relatively large 45 MW_{th} research reactor, in this report. The reason for this is twofold: firstly, the first 10-yearly periodic safety review has just been completed and has resulted in proposals for back-fitting of the reactor; secondly, there have been serious problems with the safety culture of the reactor which have called for immediate corrective action.

The High Flux Reactor (HFR) is a 45 MW_{th} pool type reactor commissioned in 1961 and located in Petten in the province of North Holland. The owner is the Joint Research Centre (JRC) of the European Commission but, when the next new licence is granted, the licensee and operating organisation will be the Nuclear Research and Consulting 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. As mentioned in the introduction, further details of the High Flux Reactor in Petten and the latest developments surrounding it are given in Annex 4.

6.2 Necessary corrective action

Borssele NPP

At the time when the Convention took effect on 13 January 1997, it had already been decided to shut down the Dodewaard nuclear power plant. The Borssele plant was just undergoing a major back-fitting and modernisation programme designed to bring it into 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 close down the Borssele NPP by the end of 2003. Since that time, two general elections have been held in the Netherlands and the current government has decided to postpone the closure of the Borssele NPP until the end of 2013. Accordingly, the NPP now requires regulatory attention and, if necessary, corrective action.

In addition, the second 10-yearly periodic safety review of the Borssele NPP started at the beginning of 2001 and is due for completion at the end of 2004. The description under Article 14 and Annex 1 provide details of the special focuses of this review and of the preliminary improvement plan drawn up as a result of it.

HFR

In the late nineties it was decided that the HFR should conduct a safety evaluation in the same way as NPPs are required to conduct a periodic safety review every 10 years. The reasons for this decision were as follows:

1. The existing licence for the HFR was out of date. It had been issued before the Nuclear Energy Act was passed and revisions had been very fragmentary.
2. The HFR had so far received limited attention from the regulatory body because of the heavy workload it was under at the time with respect to the two NPPs then in operation and the assumption that it presented a lower potential risk.

3. The HFR had been designed in the fifties and never systematically re-evaluated and brought up to date. Modernisation had been on an ad hoc basis and had consisted of replacement of the reactor vessel in 1984 and an upgrade of the control room in the late nineties.
4. The conversion of the fuel from high enriched uranium (HEU) to low enriched uranium (LEU) based on non-proliferation aspects required a safety evaluation.

The first 10-yearly periodic safety review has recently been completed and a new safety concept for the reactor and associated modification programme has been proposed. A request for a licence renewal to include these changes was submitted to the competent authorities in December 2003.

The safety review has provided a positive stimulus leading to major improvements. Regrettably, less desirable events have also occurred, leading to other major changes, mainly in the organisation, personnel and administrative procedures. During the summer of 2001, the KFD was confronted with the fact that the HFR had been started up without properly notifying the regulatory body (a prerequisite for start-up). As a result, the KFD required the licensee to organise an independent review of safety culture. This review was held in the autumn of 2001. However, its quality proved to be very poor.

Towards the end of 2001, a whistle-blower made public allegations that the operating organisation (NRG) was violating the Technical Specifications without informing the KFD, and was in some cases covering up these violations. An in-depth investigation by the KFD showed that the facts were not as serious as suggested by the allegations but that there was a clear lack of safety culture. Several reasons could be identified.

A few months later, two more events attracted media attention.

- Use of an improved ultra-sonic measurement technique showed that a defect in one of the welds of the core box of the reactor vessel seemed to be larger than in previous years. Via the whistle-blower, who was no longer an employee, the story reached the press and was reported as a serious crack in the reactor vessel. Despite the fact that an earlier assessment had demonstrated that the observed growth in the defect would not lead to a crack – or, worse, to a leak – public anxiety was aroused.
- The managing director of ECN (NRG's major stockholder) openly declared that he no longer could guarantee the safety of the reactor.

These two events, together with the adverse political interest attracted a few months previously, were the main reason why the Minister of Housing, Spatial Planning and the Environment (VROM) asked[3] JRC to shut down the reactor until:

- An external independent committee of safety culture experts had analysed the situation and advised on improvements and, as a consequence, adequate measures had been taken to prevent future mishaps;
- New measurements of the weld defects and analyses of these had shown decisively that the suspected growth was merely a result of using the new ultra-sonic technique;
- It was clear how many years the integrity of the reactor vessel could be guaranteed.

In the meantime, the IAEA had been asked by the licensee to send in a peer review team to make a thorough new assessment of the safety culture (limited-scope INSARR mission). The findings of the IAEA confirmed the safety culture problems and the likely causes.

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[3] Due to the supra-national status of JRC, there was no legal way to require an immediate shut-down of the reactor. It could only be requested.

On the basis of these observed deficiencies, JRC and NRG embarked on a safety culture improvement programme. Safety culture training programmes were provided, and the European Commission decided that the NRG should become the licence holder, whilst JRC remained the owner and therefore retained responsibility for the decommissioning of the reactor.

A month later, the reactor could be started up again. See Annex 4 for further details of these safety culture problems and their causes.

6.3 Overview of safety assessments performed

Borssele NPP

As already mentioned in the Introduction, the Chernobyl accident prompted the Dutch government to order a major safety review of existing nuclear power plants. As a first step, OSART missions were sent to both plants. These missions were very useful and effective, and recommended a number of changes to plant management. These are discussed further in the section on Article 10 of the Convention.

The major safety review was led by the Steering Committee for the Re-evaluation of Nuclear Energy (SPH) and resulted in the publication of a number of reports. An important part of it was a safety review conducted by GRS (Germany), which led to a number of recommendations in relation to severe accidents and other safety-related issues.

The resulting reports made it clear that a thorough, structured reassessment of both plants was required. It was obvious that there had been many changes, both in regulations and in attitudes to safety, since the reactors first started operating on a commercial basis in 1968 (Dodewaard) and 1973 (Borssele). As a separate issue, there was also a need for protection against the effects of severe accidents.

The basic concern was that, having been built in the late sixties and early seventies, the plants would not meet modern safety standards as laid down in various sets of regulations in Western countries since that time. (These were foreign regulations, since the Netherlands had not yet developed its own rules and regulations.) In addition, many other regulations were of later date and had consequently not been taken into consideration in the design of the plants. Later, the Netherlands chose to adopt the IAEA NUSS Codes and Guides, which were a reflection of these more recent regulations. The actual comparison of the installation with the regulations was conducted on the basis of these IAEA regulations, as amended for the Netherlands. Where these were not sufficiently specific or detailed, regulations, guidelines and standards of US or German origin were also considered (see also the section on Article 7.2(i)).

A systematic back-fitting and modernisation programme was started at both plants to enhance and complement the ad hoc back-fitting that had taken place to date.

In the case of the Borssele NPP, this programme was completed in mid-1997 and comprised:

- a comparison with modern safety regulations and practices, and the initiation of plant modifications where these were deemed useful or necessary to enable the plant to comply with these insofar as was practical; this work covered design, operation and quality assurance.
- the installation of hardware to help control or mitigate the effects of major accidents; this included a filtered containment vent and catalytic hydrogen recombiners.

- a full-scope PSA, comprising levels 1, 2 and 3, to identify plant vulnerabilities and to compare the plant risk with pre-defined quantitative risk objectives. Further details of safety policies, safety objectives and the role of PSAs in assessing safety are given in the section on Article 7.2(i) and in Appendices 1 and 2.
- a full-scope replica simulator for the training of plant staff.

The total cost of the programme was about €200 million (at the current exchange rate). Annex 1 contains a description of the modifications and the resulting net safety gain.

In 2001, a second 10-yearly safety review was initiated. This was finalised in 2003 and the final modification proposals were approved by the KFD at the end of 2004. The licensee currently aims to spend up to around 10% of the 1997 expenditure: i.e. €20 million. Article 14 and Annex 1 contain more details of this second 10-yearly periodic safety review.

HFR

The safety review of the HFR comprised the following steps:

1. Establishment of a new state-of-the-art Reference Licensing Basis (RLB);
2. A safety evaluation of all the technical, operational, personnel and administrative requirements laid down in this new RLB;
3. New safety analyses of a set of enveloping Postulated Initiating Events (PIEs);
4. A Risk Scoping Study (a limited-scope PSA);
5. Fire and flooding analysis;
6. Assessment of ageing;
7. Development of a new safety concept and proposals for modifications.

The Reference Licensing Basis was based on the IAEA Safety Standards and Guides issued specially for research reactors (IAEA Safety Series 35) and, where applicable, because of the size of the HFR, also on the IAEA Safety Standards for the design of NPPs.

An important task during this first 10-yearly periodic safety review was the identification of deficiencies with respect to the Technical, Operational, Personnel and Administrative (TOPA) requirements laid down in the RLB.

A comparison of the results of the Risk Scoping Study for the current situation and the situation after the implementation of the modifications mentioned in Annex 1 shows that the core damage frequency will be reduced by a factor of 40 (from 5.10^{-5} per annum to 1.10^{-6} per annum). The risk was dominated by a large-break LOCA in the primary circuit (inlet) and by the risk of dropping a heavy load fuel transport container in the reactor pool and thereby damaging the floor of the pool and the lines of the primary circuit underneath it. Relative simple modifications reduced largely the probability of damaging the core due to those two postulated initiating events.

6.4 Programmes and measures regarding safety and the timing of shut-downs

As mentioned in section 6.2 of this chapter, the second 10-yearly periodic safety review of the Borssele NPP started in 2001. In the beginning of 2004 the licensee finished this review and presented a preliminary list of modifications. Decisions on the need for safety upgrading will be taken once discussions between the licensee and regulatory body have concluded. In Annex 1 an overview is given of the proposed upgrading.

Construction of the safe enclosure for the Dodewaard plant started in April 2003. At that time, all the spent fuel was removed from the site. After the construction period, due to end in summer 2005, there will be a 40-year waiting period before actual dismantling of the plant starts. An important issue concerns the selection of necessary requirements and the identification of tasks for the waiting period and the resulting organization to realize this. The final approval of the KFD should be there in the first half of 2005.

In the case of the HFR, the approved modifications can start only after the new licence has been granted to the new licensee, NRG. They should be completed within two years of the grant of the licence.

6.5 Position of the Netherlands and the further operation of the Borssele plant

Since the completion of the large-scale back-fitting and modernisation programme of the nineties, the Borssele nuclear power plant has met most present-day safety requirements. The only exceptions are those relating to certain external events, such as major air crashes. These are not reasonably applicable in their entirety.

The Borssele utility intended to recover the cost of the programme by extending the plant's operational life to 2007, as compared with the original closing date of 2003 (i.e. 30 years after the start of commercial operation). This issue was the subject of intense debate in the Dutch parliament, given that there is considerable public opposition to nuclear energy in the Netherlands. As a result, the government and SEP (the former alliance of Dutch utilities) agreed in 1994 that the Borssele NPP should not continue operating beyond the year 2003. In order to place this closing date on a firmer footing, a licence restriction was issued in 1997 to the effect that the power plant should stop producing electricity by 31 December 2003. Several interest groups lodged an appeal with the Council of State (the highest administrative court in the Netherlands) and at the beginning of 2000 the Council of State revoked the licence restriction on formal legal grounds.

The political decision to close down the Borssele NPP was made in a period when electricity production was a public affair and under national supervision. Due to the economic deregulation of European electricity markets, the operator of the Borssele NPP later questioned the validity of this agreement and announced the intention to continue operating the plant after 2003. The government of the day took the view that the economic deregulation did not affect the earlier agreement and that the operator remained bound by it. In 2000, the government decided to take the matter to court and seek a ruling on it. This came in September 2002 and was in favour of the operator, meaning that the government no longer had a valid agreement with SEP that the Borssele NPP should close at the end of 2003.

As mentioned earlier, the new Dutch government, in office since spring 2003, has decided not to close the Borssele NPP until the end of 2013. This is 40 years after the beginning of commercial operation. At the time when the reactor was designed, this was generally considered to be the life span of power generating reactors of this type.

The announcement of the impending closure of any organisation is likely (if not certain) to have an impact on operational continuity if nothing is done in the remaining period. The rising average age of staff is also a problem that requires attention. The regulatory body recognises the problem of retaining enough staff of the necessary quality in view of the planned closure. This aspect is being taken into account in the supervision of the nuclear safety of the Borssele plant by the regulatory body. The subject was discussed with plant management on various occasions over the period when the Borssele NPP was set to shut down at the end of 2003. The licensee has indicated that it is considering the matter and will take any necessary action and the regulatory body will also remain attentive.

NVR 2.2.1 (Staffing of nuclear power plants) stipulates that plant management must provide sufficient resources (human, financial, technical, etc.) to continue the safe operation of the plant. Since the obligation to fulfil this NVR is a licence condition, the stipulation is a regulatory requirement.

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 license;

(iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses.

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 of 1963 (Kernenergiewet, Kew);
- the Environmental Protection Act (Wet milieubeheer, 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 in the relevant Dutch regulations.

The **Environmental Protection Act**, in conjunction with the Environmental Impact Assessment Decree, stipulates (in compliance with EU Council Directive 97/11/EC; see also the section on Article 17 (iv)) that any licence application for a nuclear installation must be accompanied by an environmental impact assessment.

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 license 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) Licenses 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 intervening 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 shut-down 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 of 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 license 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 (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) 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 Nuclear Safety Series (NUSS) programme, now referred to collectively as 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 amendments to the IAEA Codes and Safety Guides, which then became the draft NVRs. The amendments were formulated for various reasons: to allow a more precise choice from a range 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, in some cases after seeking the advice of the (former) Reactor Safety Commission. The regulations were then formally adopted, at the Code (i.e. requirements) level by the Ministers and at the Safety Guides (i.e. guidelines) level by the Directors-General of the relevant ministries.

The license granted to the nuclear power plant includes specific conditions under which the NPP has to comply with the NVRs. It is this mechanism that allows the regulatory body to enforce the NVRs. At the Code 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 Codes 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.

It was on this basis that the regulatory body in the Netherlands took the initiative to adapt the IAEA standards. The adaptations (or ‘amendments’, as they were termed) 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 come 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;
- Either agreement or request for advice from former Reactor Safety Commission;
- Final NVR;
- Formal establishment of standard via approval by Minister or Director-General;
- 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 relating 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.

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. Now that it is to remain in operation until the end of 2013, updating of the NVRs to reflect the latest IAEA standards is a matter of greater relevance. A project has been started to achieve this.

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 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 special measures like evacuation, iodine prophylaxis and sheltering may be taken by the Emergency Preparedness Organisation, 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 need, therefore, 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.

In addition to the provisions of the Nuclear Energy Act, pressure-retaining components must meet the requirements of the Steam Act and Steam Decree. (In the near future, the Steam Act will be withdrawn when new European legislation comes into force; new regulations to cover the changed situation are at an advanced stage of preparation). The Act and the Decree contain a number of requirements that must be met at all times. If there is a discrepancy between the foreign design code or standard and the Dutch rules, the most conservative standards apply.

The design assessment, the examination and pressure testing of the structures and components and the in-service inspections are all carried out by the Pressure Vessels Inspectorate. This was a government organisation for over 130 years but was privatised in 1995. It now operates under contract to the Dutch government, which authorises it to issue licences on the government’s behalf.

Requirement 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 check that the plant complies with the latest NVRs. 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 license 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 license is required to import, export, possess or dispose of fissionable material.

Under Article 29 of the same Act, a license 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, 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 (BiZa) and the Minister of Health, Welfare and Sport (VWS). See the table below for an overview.

	LNV	V&W	BiZa	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.

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)[4] is formed on an ad hoc basis as required.

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[4] The Reactor Safety Committee (an advisory body of the Dutch government) was abolished in 1996 in the wake of a major reshuffle of all government advisory committees. Nowadays, expert opinion is sought on an ad hoc basis from individual specialists, other technical or scientific organisations, or other regulatory bodies. The initiative for seeking advice lies entirely with the regulatory body.

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

Article 15b of the Nuclear Energy Act enumerates the interests for the protection of which a license 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.1), 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 license. 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 license 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.

Apart from the Nuclear Energy Act and Environmental Protection Act, the Steam Act also includes some provisions relevant to nuclear safety: it prescribes a licence per individual pressure-retaining component.

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 Decree on Supervision identifies the bodies that have responsibilities in this connection. Since 1 March 2004 the national regulatory body for supervision of Dutch nuclear installations is the Nuclear Safety Service (KFD) of the Inspectorate of the Ministry of Housing, Spatial Planning and the Environment (VI: VROM Inspectorate).

A separate section of the KFD is responsible for supervision nuclear security and safeguards (NBS). At the same ministry, the Chemicals, Waste and Radiation Protection Directorate (SAS) is responsible for assessing whether the radiological safety objectives have been met. It should be noted that this directorate is responsible for policymaking and licensing, and does not perform inspections.

With regard to nuclear fuel cycle installations and nuclear power plants in particular, almost all inspection 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.

Responsible for assessment and inspection of the integrity of pressure retaining components 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. In 1999 a project has started to implement the use of risk insights both for assessment and inspection. See also appendix 5.

Regulatory assessment

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 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..

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 environment protection have been met and whether the assessments (methods and input data) have been prepared according to the state of the art etc. As already mentioned, SAS assesses the radiological consequences associated with postulated transients and accidents in the various plant categories. Acceptance criteria for this are specified in Appendix 1. Further details of the assessment process are given in the section on Article 14.

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 KFD 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. These source terms are conservatively postulated.

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 all calculations.

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 license, the safety analysis report, the Technical Specifications and any self-imposed requirements;
- to report (to the director of the KFD) any violation of the license 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.

To check that the licensee is acting in compliance with the Nuclear Energy Act, the licence and the associated safety analysis report, there is 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 in relation to all the relevant organisational, personnel and administrative matters.

The management of inspection 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. 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 actively participating in many working groups of NEA/CNRA and NEA/CSNI and in working groups of other international bodies as WENRA, IAEA and EU. WENRA has become more important than in the past. Although the last three years it was not realised, bilateral exchange of KFD inspectors with those of other European regulatory bodies for a few months at a time is strongly supported to improve the quality of future regulatory inspections

Many inspections performed by the KFD are characterised by an emphasis on technical judgement and expertise. They are compliance-based (in other words, 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 (that is, 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 (placing more emphasis on the areas most relevant to risk). A study aimed at the formal introduction of risk-informed regulations was initiated in 2002 and has not yet been completed.

Apart from these inspections, in-depth international team reviews are also carried out by bodies such as the IAEA (OSART, Fire Safety, IPERS, ASSET and INSARR). These reviews are the results of separate decisions. Some have been requested by the KFD, following a recommendation by the former Reactor Safety Commission. 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. These have been requested by the KFD and the HFR research reactor in Petten has now introduced a systematic self-assessment programme.

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 licenses. 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 and the Minister of Social Affairs and Employment 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.

Article 19.1 of the Nuclear Energy Act empowers the regulatory body to modify, add or revoke restrictions and conditions in the license in order to protect the interests on which the license is based. Article 20a of the Act stipulates that the regulatory body is empowered to withdraw the license, 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 license. This will be necessary if, for instance, comprehensive modifications are proposed or the license 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)
    - Nuclear Safety Service (KFD)
- Ministry of Social Affairs and Employment (SZW)
  - Directorate-General for Labour
    - Directorate Health and Safety at Work
- Ministry of Economic Affairs (EZ)
  - Directorate-General for Energy
    - 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 license 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 license 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 was to separate inspection and enforcement more sharply from legislation activities, policymaking and licensing. The newly formed Inspectorate is divided in five regions within the country. Besides 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.

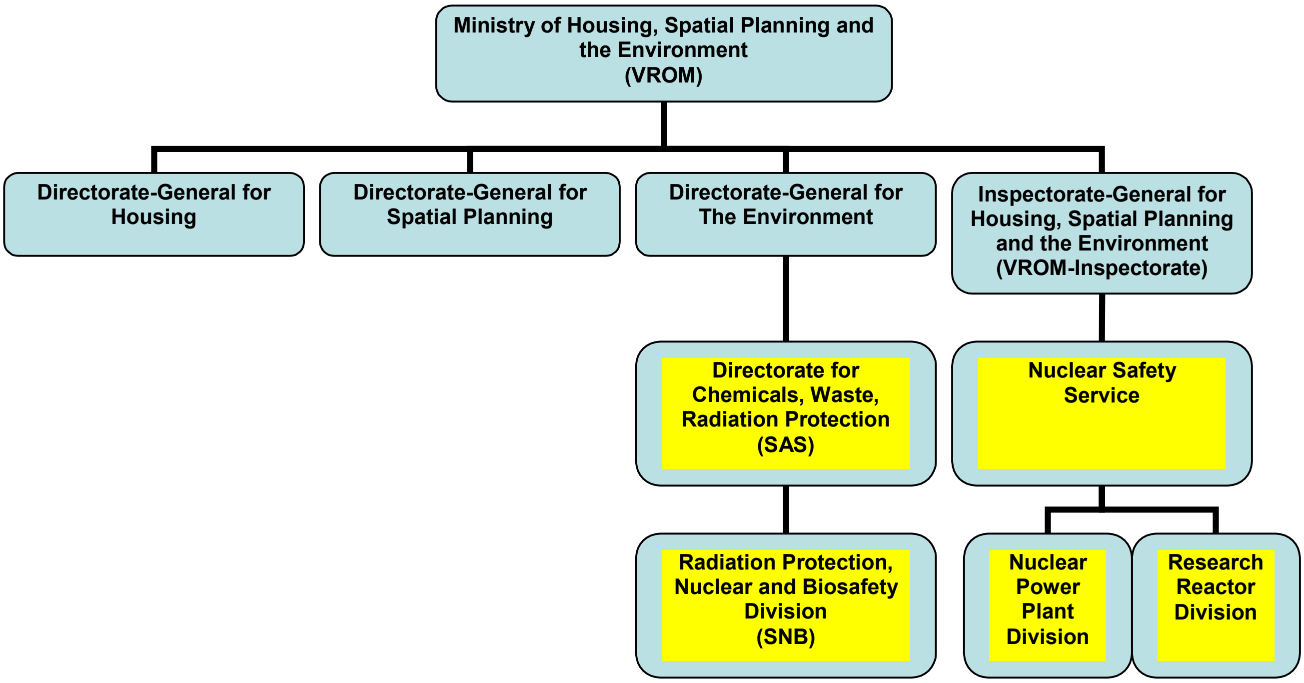

Figure 1: Nuclear safety and radiation protection within the Ministry of the Environment

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. These organisations will be described in more detail in this paragraph.

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.

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

Nuclear Safety Service (KFD)

The KFD encompasses all 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 at its disposal for contracting outside specialists. This is one of the basic policies of the KFD: that 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.

In the process of recruiting new personnel (see below), the KFD has searched for a non-technical specialist on human and organisational factors, following the trend in other regulatory bodies. So far this search has not been successful.

The security of nuclear power plants (in terms of nuclear security and safeguards) is a separate part of the spectrum of supervisory duties. Two man-years per annum are allotted to this work. The work transferred from VI-ZW to KFD (see § 8.1.a) concerns about 1 man-year. This work is partly subcontracted to other parties and supported by RIVM (National Institute for Public Health and the Environment).

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%) and conducting assessments in the context of licensing/rulemaking (10%). 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 two people, one at university level and one at tertiary vocational college level, for more inspection-like activities.

Current organisation

The organisation has been changed from a matrix to a line organisation with two divisions of about equal size and supported by an administration bureau. Disciplines have been divided between the two divisions. The new organisational structure creates a focus on a limited number of licensees 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, there a policy of regular rotation of staff between the divisions has been established, depending on the yearly work programme. The two department heads will rotate every three years. During the execution of the daily tasks divisions support each other when necessary.

The total professional formation of the KFD, for all nuclear facilities is now 24,75 (including the 3 managers) full time man-year equivalents. Since October 2003 two new staff members have been attracted and one staff member has retired. Due to governmental budget savings staff will be reduced to 23,5 man-years in 2007. 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 has a policy of allocating between 10 and 15 days each year to training.

The main activities of KFD are assessment, inspection, enforcement and technical advising and support of SAS in the framework of licensing and the establishment of regulations.

As regards budgets for external support, there is a budget of about € 500.000 for contracting external experts or technical safety organisations in the Netherlands and abroad for special issues. 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 regulatory issues (about € 500.000 for Borssele and about € 15000 for the other licensees). This money goes directly to the Public Treasury.

Manpower situation

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 (30 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 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 is now about 58 years. The positive effect of growing experience of each individual is threatened to be overshadowed by the danger of disappearing experience (corporate knowledge) in a short period of time.

- The diminishing of nuclear safety expertise within the Netherlands as a whole. Concerning the education in this field, large budget savings threatens the existence of the research reactor facility of the Technical University of Delft. This, combined with a diminishing nuclear expertise, creates a situation, which causes concern.
- The financial situation in the Netherlands making governmental budget cuts unavoidable. These budget cuts do not leave the KFD unaffected.

The management of the KFD is alert for these developments and copes with them in the following way:

- The KFD pursuits to attract new staff members. In October 2003 two extra staff members were attracted. 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 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. But also the membership of WENRA and other international bodies are important as a support for the supervising activities in the Netherlands.
- Government budget cuts did have consequences for the formation of the KFD. In the years 2003 and 2004 the formation of KFD was reduced with 2¼ man-years. Therefore, the extension of the formation with 3 man-years, needed because of the extra tasks (radiological effects and other environmental effects, transport, nuclear security and safeguards) is only made partially effective. The net result is a formation reduction, taking into account the increasing number of tasks. The KFD management is seeking to cover this in the following way:
    - efficiency gain by internal integration of ‘old’ and ‘new’ KFD-tasks.
    - 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 management of KFD foresees that the above mentioned measures will not be sufficient to compensate the loss of experience within KFD due to retiring staff members in the years to come. Therefore KFD is developing new and expanding existing open contracts with external organisations (like AVN and GRS) to fill in the existing and expected gaps in the capacity of KFD and fields of experience.

Furthermore other developments in the ‘nuclear world’ and in society influence the sphere of activities of the KFD:

- Traditionally the staff of the KFD consists of technical or science oriented persons. However, 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.

- The Dutch society has a tendency to handle violations of rules and regulations more and more in a formal lawsuit. Citizens and non-governmental organisations are demanding transparency from regulatory bodies and ask authorities to enforce legislation strictly. This stronger focus on enforcement is new for 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, thereby showing a tendency of a change in nuclear safety policy from ‘safety first’ to ‘balancing safety against economic interest’. A similar tendency is shown at the HFR, where the commercial usage of the reactor (isotope production) became vital for the continued existence of the reactor.

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

These aspects gave rise to the intention of the management of the VROM-Inspectorate and the Directorate-General for the Environment of the Ministry of Housing, Spatial Planning and the Environment to investigate what the minimum criteria (critical mass) are for a lasting regulatory body in the Netherlands, which can meet the challenges in the future. This investigation will include all the tasks of a regulatory body, to mention: licensing, drafting technical regulations, assessment of licensee’s transmittals, supervision and research.

Directorate for Chemicals, Waste, Radiation Protection (SAS)

The main task of this Directorate is policy development and implementation in the field of radiation protection and nuclear safety in relation to the public and the environment. The Directorate is also responsible for licensing nuclear installations and nuclear transports in general (all procedural aspects), 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, and legal and licensing matters. These disciplines are grouped together in the Radiation Protection, Nuclear and Biosafety Division (SNB). 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 devotes about four man-years per annum to nuclear licensing and safety issues relating to all nuclear facilities.

8.2 Separation of protection and promotion

On 21 June 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 exclusively 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 LICENSE HOLDER

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

The principle that the ultimate responsibility for safety lies with the licensee is established in legislation at different levels. First of all 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. Secondly, three articles of NVR 1.2 (Safety requirement for nuclear power plant operation) stipulates 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 license condition, these provisions constitute formal obligations.

The license also states that the licensee must review the safety of the plant at both two-yearly and 10-yearly intervals (this point is examined in more detail below, in sections on other articles of the Convention). In addition, the licensee must draw up a decommissioning plan, which must be modified 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 license condition, but also an institutionalised corporate objective. See the section on Article 10 of the Convention for further details.

Compliance with the license 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 license and achieve its corporate safety objectives.

When an IAEA INSARR mission was held at the High Flux Reactor in Petten, it confirmed the KFD’s suspicions that there were serious safety culture problems at the research reactor, including deficiencies in the definition of responsibilities for safety. These problems were closely related to the inadequacy both of the documentation defining the responsibilities of the licensee and the operating organisation and of licensee control of the operating organisation granted the right to exploit the reactor commercially. As a consequence, an action plan was drawn up to improve safety culture and this was then translated into a new safety strategy, including an action programme. Action being taken includes a new safety management system comprising the following elements:

- Statement of a safety policy (including standards, resources and targets);
- Management structures, responsibilities and lines of accountability;
- Action to ensure competence;
- Communication and team support;
- Performance monitoring;
- Corrective action and improvement.

To guarantee that the licensee shoulders its responsibilities, an international team of safety experts has been appointed and the internal Reactor Safety Committee has been given a more profound role in operational feedback and decision-making on safety issues.

However, the most important improvement is the request to transfer the licence from the current licensee (the Joint Research Centre of the European Commission, JRC) to the operating organisation (the Nuclear Research and Consultancy Group, NRG). This will make safety priorities in relation to the commercial exploitation of the reactor more visible and traceable.

See Annex 4 for further details of the safety culture problems at the HFR.

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 attached 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 a nuclear facility, unless this cannot be reasonably required. Reference is made to the Safety code 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. 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 of the Borssele plant is a member of WANO and of the Siemens/KWU Reactors Owners Group, 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 (see the sections on Articles 11 and 14 of the Convention) and is therefore subject to regulatory review and inspection.

As a whole, the power plant operates in full accordance with the principles set out in the NVRs on Operation, which include a rigorous in-service inspection and testing programme, as well as maintenance and control of ageing.

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. As already mentioned, regular safety updates have to be performed, at two-yearly intervals for operational aspects and at 10-yearly intervals for aspects that may affect the principles underlying the plant design basis. These periodic safety reviews and the resulting improvement or modification projects are aimed solely at further improvement of plant safety. Safety improvements may relate both to the design and the operation of the plant.

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, more especially, 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 in progress.

Finally, the priority given to safety is demonstrated by a recent policy document focusing on the principle of continuous improvement of nuclear safety in relation to risk-informed regulation. The document specifies that the licensee's PSA should demonstrate that the modifications made by the licensee result over the years in a gradual systematic reduction of risk.

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.

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 since been conducted as a consequence of this recommendation.

- The first mission was a pilot ASCOT review conducted in 1994 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 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 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.
- Finally, planning is currently under way for a second OSART mission, to be conducted in November 2005. Given the recent developments in areas of organisational change, it is to be expected that interest will continue to focus on this issue.

More details of the safety culture at the Borssele NPP are given in Appendix 3.

HFR

Towards the end of 2001, the KFD was confronted with serious safety culture problems at the High Flux Reactor (HFR), a 45 MWth research reactor. Due to the actions of a whistle-blower who alerted the media, these problems attracted political attention. This resulted in a temporarily month-long closure of the reactor in early 2002. It only started up again after a special IAEA-INSARR mission had been conducted with an emphasis on safety culture and after an action plan to improve the safety culture had been drafted by the licensee and approved by the regulatory body.

Several causes of the problems could be detected. The most important were:

- Insufficient control exercised by the licensee (the Joint Research Centre of the European Commission, JRC) over the operating organisation (the Nuclear Research and Consultancy Group, NRG). Only three to four JRC staff members were involved in operational matters, even though NRG had been granted the right to exploit the reactor commercially without being given formal responsibility for safety (only under contract to the licensee).

- The managements of both JRC and NRG were mainly scientists, whilst the operators were technicians. This caused a severe lack of communication between the two groups.
- The plant's internal reactor safety committee was consulted only on a voluntary base. This meant that there was sometimes no consultation at all on matters that should have required it.

As a result of the action plan, a large number of actions have been taken over the last few years. Consequently, the safety culture has been greatly improved.

Annex 4 contains a more detailed description of the safety culture problems at the HFR.

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

The Netherlands is a prosperous country with a stable social structure, a reliable banking system (subject to strict government supervision) and only a small number of days lost to strikes every year. It is a setting in which a huge range of firms operate on a businesslike footing, i.e. they are used to meeting their obligations. Electricity companies are no exception to this. Consequently, a firm operating an NPP has a good idea of its future financial liabilities, in both the short and the long term. In this sort of environment, there are good opportunities for creating a profitable energy industry that can also meet the relevant requirements regarding financial stability. The liberalisation of the electricity market did not have any direct material effect on this situation. In the long term, however, some consequential events may have an adverse impact and therefore regulatory attention is continuously required.

In the light of the country's social structure, operating organisations are expected to be financially sound businesses with sufficient financial resources at their disposal to enable them to take all relevant measures, including those relating to safety. For this reason, no special action has been taken to guarantee the liquidity of the businesses in question, with the exception of the licensing restriction referred to above.

Due to the effects of the liberalisation of the European energy market, it may be advisable to consider the general introduction of legal requirements relating to company financing and organisation. Market liberalisation may lead to the departure of the old, very stable commercial and financial environment and behaviour, perhaps with a negative influence on long-term safety practices and culture.

History and legislative aspects of the liberalisation of electricity production in the Netherlands

Until a few years ago, the Dutch Electricity Generating Board (SEP), a consortium of the Dutch utilities, among others, took care of all international contracts in the electricity sector. The SEP also owned the Dodewaard NPP. In order to achieve a liberalised electricity market, the cooperation agreement between the utilities and the Electricity Act of 1998 had to be dissolved. However, until that time many of the costs were incurred in nonconformity with the market (e.g., capital investments which were not profitable in the short run, such as the construction of a demonstration coal-gasification plant or the district-heating projects). These costs, often incurred as a consequence of government encouragement, could be borne by the electricity sector as a whole (i.e., the SEP). After the European decision to liberalise the electricity generating market, it was necessary to find a way to resolve the financial consequences. First of all, the utilities tried to create a big new Dutch utility by merging the existing utilities. When this failed, a legal solution was necessary in order to achieve a proper liquidation of financial commitments and contracts, and a solution to the problem of the costs that had been incurred by the SEP in nonconformity with the market. On 21 December 2000, the Transition Act Electricity Production Sector was published. This Act regulates the liquidation of the SEP.

In principle, each of the separate utilities is to be responsible for a set proportion of the total costs associated with past commitments and contracts. The government is to cover the costs made in nonconformity with the market via a surcharge on charges for the transport of electricity.

The national grid is to remain independent of the other parties in the electricity market, such as electricity producers, suppliers or brokers. They are not allowed to possess more than 10% of the shares.

The Act’s explanatory memorandum reports the advice of a Special Advisory Committee on these matters. With regard to the nuclear power plants, this is as follows:

> *The Committee recommends that the ownership of the Dodewaard plant should be transferred from the SEP to COVRA (Central Organisation for Interim Storage of Radioactive Waste). This will also apply to the Borssele plant after its closure. Given the political nature of decision-making on the closure and decommissioning of NPPs, it is strongly advised that the government should be the sole shareholder in the COVRA organisation.*

The government intends to follow this advice. Negotiations are, therefore, currently in hand regarding the transfer of the Dodewaard plant to the COVRA organisation. An important issue in these negotiations is the funding of decommissioning. Since 2003, shares in COVRA have been transferred from the owners of the utilities and ECN to the government.

Legislative aspects

The Nuclear Energy Act contains a number of articles, which deal with criteria, interests and conditions under which a license can be awarded. The explanatory memorandum on Article 70, which states that a license 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 be associated with financial solvability.

The license does not automatically pass to the license holder’s successor in title. 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 license. This allows the authorities to assess whether a new license holder can offer the same standard of expertise, safety, security etc. as the previous one. Indeed, the authorities will refuse to issue a license to a proposed new license holder where a change in ownership alters certain circumstances that are of vital importance from a licensing point of view.

Rules and regulations on adequate financial resources

Although NVR 2.2.9 (Management of nuclear power plants for safe operation) contains no direct requirement to possess adequate financial resources to ensure the safe operation of an NPP, it does require this indirectly. 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 are 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.

Rules and regulations on financing decommissioning

Article 1801 of NVR 1.2 states:

> *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 license must be accompanied by an indication of the costs of decommissioning and how it proposes to meet them.

In the course of operating the NPPs, the licensees of the Borssele and Dodewaard plants have built up (or are in the process of building up) the necessary funding to meet the cost of eventual decommissioning (see annex 2 for a description of the decommissioning plan and associated costs for the Dodewaard plant). It has to be remembered that in the past (prior to deregulation) energy policies and associated finances were regulated by the Ministry of Economic Affairs and all utilities (private or otherwise) had public shareholders.

Although, JRC no longer will be the licensee for the HFR in the future, it will remain its owner. Consequently, it has officially stated in its contract with NRG (the new licensee) that the European Communities will bear the entire cost of decommissioning the plant.

Nevertheless, the conditions of the new licence state that the licensee is to provide financial guarantees with regard to decommissioning. A written guarantee from the owner (i.e. the European Commission) will be sufficient to fulfil this requirement.

11.2 Sufficiency of qualified staff

History

When NPPs were first designed and operated, ‘human resources’ were a subject of little interest to either the licensee or the regulatory body as compared with the interest in hardware. The situation began to change, however, around 1980. At first, more attention was paid to staff who were directly involved in plant operation. This led to the formulation of rules for the recruitment, training and assessment of control room staff in 1984. In addition, there was a gradual increase in interest in human behaviour, a trend accelerated by the results of analyses of events where the human factor had been found to play an important role.

Legislative aspects

The Nuclear Energy Act stipulates that an application for a license 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 latter has recently been revised and made operational. The licensee has to submit its education and training plan for the regulatory body’s information and approval.

Operation

The organisational structure of the plant is described in the Technical Specifications (see the section on Article 14), 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 license, and hence subject to inspection by the regulatory body. Any major organisational changes, e.g. at management level, must be reported to the authorities. After the first 10-yearly review and following extensive modifications at the Borssele plant, manpower was reduced by about 10% to return to an operational level that was more appropriate to standard, normal continuous operation. The extra manpower capacity needed for the modification project was not needed for the normal operation of the plant.

Under NVR 3.2.1, control room operating personnel need to be in possession of a special license. This is issued once the candidate has completed a specified period of training and passed an examination set under the supervision of 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 licenses:

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

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

The operators receive simulator training on a Borssele-specific simulator at a training centre in Essen (Germany). The training is given in Dutch. They are also trained in communication, both with other staff on the same shift and with outside contacts. Both the training programme and the simulator need to be approved by the regulatory body.

Since the Dodewaard power plant is in the process of being decommissioned, the regulatory authorities no longer require shift staff to undertake training courses on the Dodewaard simulator. The training programme does, however, place more emphasis on radiation protection.

Another category of plant staff whose work has a direct bearing on safety is health physicists. They are also required to be in possession of appropriate qualifications.

Other personnel include those responsible for functions such as maintenance, technical support, quality assurance, security, administration, training, management, etc. Training and education requirements are laid down for all these staff categories and include on-the-job training. A full description of the programme and the organisational structure is available for assessment and inspection by the regulatory body.

Over the last few years, there have been some vacancies on the operating staff of the HFR. As a result, the effect of holidays, sick leave etc. has sometimes been to reduce the actual number of control room operators to the minimum specified in the Technical Specification. In view of the negative political and media attention the HFR has attracted over the last few years with regard to its safety culture, the operating organisation NRG was urged to fill these vacancies as soon as possible. New operators have recently been trained and all vacancies have now been filled.

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 skill, 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 aircraft, 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

As mentioned in the preceding response to the NSC, 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, even though they do not include a specific document on the subject. The main reason for this is the lack of objective, quantitative requirements. Since the NVRs are part of the licence, licensees are required to give full consideration to human factors.

12.3 New developments

In the most recent past, increasing importance has been attached in the Netherlands to the subject of human factors in relation to nuclear safety. Safety management has come more clearly to the forefront, with attention shifting towards a more integrated approach to certain areas, such as organisational changes. It has also become clearer that there is a large overlap with the subject of quality management systems (discussed in the section on Article 13). Increased understanding and experience is essential, as major current and planned licensee reorganisations are explicitly subject to monitoring, evaluation and approval by the regulatory body in order to ensure maintenance of nuclear safety levels during and after the reorganisation process.

Action to produce this increased understanding and experience has included discussions and exchanges of experience during OECD/NEA/CSNI SEGHOF (Senior Expert Group on Human and Organisational Failures) meetings and workshops, as well as the publication of documents such as INSAG-15 and INSAG-18, CSNI TOP 4, NUREG reports (e.g. no. 1764) and IAEA contributions on the subject of human factors.

12.4 Human factors in incident analysis

The basic problem in HF incident analysis is the high level of engineering experience-based judgement that is needed to produce a result that is in principle qualitative. The Netherlands maintains close cooperation with international research activities, such as the work of the Halden laboratories, in order to obtain and understand failure data relating to human actions.

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.

For the Netherlands, the problem is that different parts of the world use different approaches to deal with the HF side of incidents and accidents. The method currently being used by the Dutch licensees and regulatory body is the original American method known as the HPES (Human Performance Enhancement System). Since this is a fairly old and time-consuming method, other alternatives are now being discussed with the support of SEGHOF group members. These alternative methods include the German GRS method for the in-depth evaluation of notifiable events, the German VGB, the Swiss HSK and the approach described in the recent HF NUREG report series (Qualitative Assessment of Human Action Safety Significance).

The aim is to arrive within the next few years at an acceptable solution for the Dutch situation (with its restricted nuclear programme and small regulatory body). This should be a reproducible method allowing the regulatory body to evaluate the role of human factors in reported incidents and possibly, as a result, to produce guidance for the future actions of the licensee and the regulatory body.

Licensees in the Netherlands (especially those for the Borssele NPP and the HFR European-owned research reactor) address the subject of human factors in their annual reports. In the period since the last CNS report, only minor incidents and near misses have been reported.

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. This is the case at the Borssele NPP, which is preparing for its 10-yearly licence review. It is engaged in a significant parallel reorganisation aimed at improving efficiency and reducing the number, or changing the level, of the personnel involved. The explicit reason for this reorganisation is (as usual nowadays) the liberalised energy market in which the need to compete in order to survive is creating a drive to reduce operational and maintenance costs throughout the whole of Europe. Since this process may have significant safety implications, it is up to the licensee to ensure – and to prove to the regulatory body – that current safety levels will be maintained, if not improved, throughout and following any such process of reorganisation.

The HFR organisation is transferring the license from the European Commission to the organisation that has already been contracted for some years to operate the (45 MWth) HFR. As in the case of Borssele, the organisational change parallels a 10-yearly licence renewal process.

When evaluating the HF side of these licensee plans and activities, the regulatory body checks for changes in areas such as support services, recruitment and training policies and the management system.

It has proved more difficult to assess the influence on safety levels of changes in the level of staff or in the level of management responsible for safety issues, and therefore to put the case for safety during management meetings. According to INSAG-18, processes like downsizing or changing competence levels have resulted in understaffing and lack of staff competence.

Outsourcing is another measure seen as a possibility to reduce costs. However, it may lead to over-reliance on external sources of expertise and hence to future uncertainty about its availability. There is also a danger that managements 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. Some Member States do have such rules. One example is Sweden, where the licensee is allowed to use contractors for certain activities but the contractors must be approved by the Swedish regulatory body. The introduction of government guidance in this area is to be considered in the Netherlands in the near future.

12.6 Safety management

The importance of good safety management at nuclear installations is well recognised in the Netherlands. It is closely related to safety culture. 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 organisation. Safety must be an item on the agenda of work meetings and time, tools and budgets must be provided to allow and encourage staff to give full attention to the maintenance of high safety levels.

An external consultant specialised in this area was contracted to study and survey the problem in the Netherlands. The end results revealed the size of the problem and how it should be tackled. Safety management is a cornerstone of safety, but the actual red line from top to bottom was not clear and unambiguous. There is also a large overlap between safety management and other types of safety programmes. Safety management is an integrated safety programme and should be treated as such.

For the time being, safety management supported by international exchanges of information and experience will continue to play an important role in ensuring safe nuclear operation.

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 world, 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 section 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 based on the requirements and safety guides in the IAEA Safety Series, where necessary amended for specific use in the Netherlands.

Working on the same principle, the completely renewed Quality series from the IAEA Safety Series has been used over the last few years to revise the Dutch Nuclear Safety Rules (NVRs) as regards quality assurance. The Netherlands has actively supported and contributed to the whole revision process at the IAEA. 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.

The new QA regulations acquired the force of law on 19 March 2004, when they were published in the Government Gazette.

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 was 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 Borssele case also requires more attention because of other factors: principally the series of planned organisational changes which are soon to be clearly specified and the results of the second 10-yearly safety review. In these respects, the interface with human factors (see Art. 12) is again important. One such area is the minimum staffing level for the various sections of a licensee's organisation. This appears to depend somewhat on the sort of power plant, the country's overall nuclear industry infrastructure, the scope of the country's total nuclear programme, etc.

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 have at present almost no specific criteria, while others have made extensive provision on this point in general or specific regulations and/or guidelines.

It is hoped that international cooperation and knowledge and experience transfer will lead to a better understanding of these problems in the near future, coupled with a set of criteria and regulations for the Netherlands.

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 etc. and the KFD is now planning a certificate audit for this in mid-2004.

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

Required safety assessments

A licence is only granted if the applicant complies with the NVRs on Design, Operation and Quality Assurance 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. An SAR gives a detailed description of the safety analyses, P&Ids and other supporting documents. To illustrate the difference, an SR will be a two-volume document, whereas an SAR will be a twenty-volume document.

The SAR is supported by a Probabilistic Safety Analysis (PSA), comprising levels 1, 2 and 3 (see Appendix 2). The PSA – in particular, the level-3 part of it – is needed to demonstrate that the facility meets the probabilistic safety criteria set by the Minister of Housing, Spatial Planning and the Environment.

As the NVRs are fairly general and lack the technical detail commonly found in national nuclear regulations in some other countries, 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 (either by the licensee at the request of the regulatory body). 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 (IPSART missions, formerly known as IPERS missions) and by giving training courses in PSA techniques and PSA review techniques. Appendix 2 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 license 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.

First10-yearly periodic Safety Review

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

In ANNEX 1 of the Second 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 periodic Safety Review

In the beginning of 2004 a second ten-yearly periodic 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, personal 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 periodic 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 most important technical, organisational, personal and administrative measures.

Safety Assessments related to changes of the license

Significant changes to the installations that imply changes to the design assumptions, as laid down in the safety report, require a license. To demonstrate that the safety impact of these changes remain within the prescribed limits and are as low as reasonably achievable 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 license in order to be able to use higher enriched fuel elements (from 3.3% up to 4%). External experts were consulted for the review. In this case special emphasis was given to issues associated with high burn-up fuel in relation with reactivity insertion accidents (RIA-accidents)[5]. This was repeated at the end of 2003. A modification of the license 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 (see Article 10).

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.

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[5] It was proven by analysis that the enthalpy rise in case of rod ejection accidents of both the transition cores and equilibrium core remained far from the areas where fuel and/or cladding failures were detected at the RIA-experiments in Cadarache (France). Because new cladding material was foreseen, which wasn't fully qualified in the high burn-up region, a qualification program was initiated involving the deployment of 4 lead test assemblies in the core of the Borssele NPP.

Internal safety review of technical and organisational modifications at Borssele NPP are organised as follows:

- Technical: All aspects of technical modifications relevant to safety are documented in a ‘Modification Plan’. This report is reviewed 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 with a request for authorisation. 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 Resource 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 license, NVR (amended IAEA codes and guides) and other relevant regulatory documents and produces a report on his findings. These two reports (the final proposal and 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 license 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 scope and frequency of the in-service inspection programme for pressure-retaining components are checked by Lloyd’s RN (the former Stoomwezen BV) or, since 2002, any qualified independent and certified organisation. At Borssele, Lloyd’s RN checks the primary pressure boundary integrity under the Pressure Vessels Act and under ASME XI. At the request of the KFD, the Lloyd’s RN also carries out inspections of the functional capability of pressure-retaining components (e.g. operability of valves). The KFD conducts regular inspections and audits to check the plant’s other inspection and test activities.

As already mentioned, e.g. in the section on Article 14 (i), the NPP must produce an evaluation report every two years demonstrating that the way in which it is being operated, with its existing (trained) staff, procedures and organisational structure, meets the requirements set out in the licence. The report and its findings are evaluated by the KFD.

Similarly, the NPP must produce an evaluation report every 10 years giving an assessment of whether the design still conforms to the latest rules and regulations and to current international safety practices. This report and its findings are also evaluated by the KFD.

The current license awarded to 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 license 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) is a topic of current debate. For this reason, 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

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 so 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.

The licensee has set a 5-years average of 10 mSv per annum as the objective for the individual effective dose limit for radiological workers at the Borssele NPP. The licensee’s ultimate goal is to achieve a 5-years average of 7 mSv per annum (meaning that a radiological worker who receives a dose of 10 mSv during a particular year should receive less during subsequent years, until his average dose is no higher than 7 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 last two years, it has decreased to about 0.3 manSv per annum.

The current license lists the radiological data that the licensee must document and file, and 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 license is the licensee’s obligation to measure the radiation levels and levels of contamination at those locations where workers may receive an effective dose of 5 µSv or more in less than one hour. The licensee is required to document and file these measurements.

Employees 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 filed.

The licensee is required to report to the regulatory body every three months the individual doses received by employees who work at locations where they are exposed to an effective dose of at least 5 µSv 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 license 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 draft a dose evaluation report and inform the regulatory body of the results.

If the anticipated collective dose relating to any job exceeds 20 man-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 20 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.

One of the conditions of the license 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.

15.2 Radiation protection for the public

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.

As prescribed in the license, 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 Thermoluminescence 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. Such a plan is, however, 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 license also specifically addresses the question of an emergency plan: license 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. The license for the Dodewaard NPP contained an identical article. However, the original emergency plan and organisation are no longer in force since the plant is now being decommissioned.

There are certain statutory regulations on off-site emergency planning and the action 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 government 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 (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 three 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).

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 includes a list of the authorities that are responsible, *inter alia*, for preparing the organisation of nuclear power plants for dealing with emergencies. 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 Advice 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 Ministry of the Interior's National Coordination Centre. 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.
- The National Information Centre also located within the Ministry of the Interior. 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. The NPK organisation is currently being revitalised in order to achieve closer harmonisation with the regular emergency planning and response organisations.

Intervention levels and measures

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

- 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 Board 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 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 as follows:

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 more especially 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 $\geq 0{,}1$ * 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 license. 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 and the Minister of the Interior are currently in the final stages of a project to update the National Nuclear Emergency Plan (NPK). The main purpose of the project is to reduce the differences between nuclear emergency preparedness and the planning and those of response for other ‘regular’ types of disasters and crises. Another main objective is to improve the organisation and the means to inform the public and the media in case of a nuclear emergency.

The bulk of the project has been completed. Attention has been paid not only to the nationwide setup but also to the local emergency organisation. Nuclear accidents now form part of regular emergency preparedness and response, and 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 all the results operational at all levels of government and emergency organisations.

Future developments

Integrated exercises (i.e. involving both the plant staff and the authorities) have proved 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 years).

In addition to the regular schedule of exercises, special attention is to be paid to operationalising the results of NPK revitalisation. A National Staff Exercise is planned for 2005. In preparation for this exercise, which will involve the Borssele NPP, many smaller exercises will be conducted all over the country to test the new arrangements and resources. The emphasis in the nationwide exercise will be placed on information and communication between the NPP and the government and between the different tiers of government.

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, central government is also responsible for informing the public. It does this in conjunction with the local authorities in question.

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).

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) takes place on a regular basis between the Netherlands and Germany. With Belgium, the same approach is in preparation. 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.

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) and 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. There are currently no plans to construct any 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 license 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 license for a nuclear installation includes an obligation to submit an environmental impact assessment (EIA). As part of this procedure, neighbouring countries that could be affected by the installation are notified on the basis of the Espoo Treaty and an EU Directive:

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

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

(i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence-in-depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

(ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

(iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

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 (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.

The current design of the control, protection and safety systems at the Borssele NPP, as described in the plant’s safety report, as well as their maintenance, inspection and testing fully satisfy the requirements for maintaining the second and third echelons of defence. The safety report indicates that the radiological consequences of design-basis events, as calculated in the various safety analyses, meet the radiological criteria that specify smaller acceptance doses if the assumed frequency of the Postulated Initiating Events (PIEs) increases. These criteria are specified in Appendix 1.

The installed engineered safety features, the existing symptom-based Emergency Operating Procedures (EOPs) and the recently implemented Severe Accident Management Guidelines (SAMGs) demonstrate that the fourth echelon of defence is also adequately maintained.

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.

Annex 1 describes the measures taken at Borssele as part of the modernisation project and explains how these have strengthened the existing levels of defence-in-depth. Appendix 2 presents the quantification of the risk reduction achieved as a consequence of this modernisation project in terms of total core damage frequency before and after the modifications.

The Borssele NPP has recently undertaken its second 10-yearly periodic safety review. For each echelon of defence, modifications have been suggested 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 individual and societal mortality. See Annex 1 for more details.

18(ii) Technologies incorporated in the 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, the Dutch Design Code for pressure-retaining equipment, and various Siemens/KWU component specifications. The periodic safety review (PSR) conducted in 1994 found the original design basis to be conservative, based on recent versions of the respective industry codes.

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

Starting with the refuelling outage of 2005 new fuel elements with the improved corrosion and hydrating resisting Zirconium-Niobium cladding material M5 will be 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

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 qualified suppliers 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.

To sum up, 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).

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

The only nuclear power plant now in operation in the Netherlands (Borssele) is a light water reactor of the PWR-type. Potential for a less negative moderator temperature feedback exists at Borssele only during start-up with a freshly loaded core. This is due to the high boron content of the coolant. This was why, unusually for PWRs, protection was also required against an ATWS event during start-up.

Alongside the stable power operation, there is a reactor protection system that initiates all safety measures in such a way that no operator action is required for a period of at least 30 minutes. In addition, there is a ‘limitation’ system that initiates activities on safety parameters before safety limits are exceeded and engineered safety features are automatically triggered. All relevant safety parameters are shown on a special panel, so that the operator is able to check all important safety parameters at the same time.

The modification programme undertaken at Borssele included explicit 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 and the addition of an emergency control room and local control points to the available controls in an emergency. Other important elements were the design 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 designing remote controls or 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 lay-out.

See Annex 1 for a more detailed description of man-machine interface aspects at the Borssele NPP.

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 license 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.

It should be noted that experience in this area is limited, as no new power plants have been built in the Netherlands since 1973. This section is therefore based on experience with the Borssele Modification Project in 1997 and the present periodic safety review process.

19(i) Appropriate safety analysis and commissioning programme

As discussed in the section on Article 14(i), an in-depth safety assessment of the NPP is made on the basis of the safety analysis report. The commissioning aspects are reviewed once this assessment has 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.

19(ii) Operational limits and conditions

The NPP license states that 'the conditions must be described 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, such as the split and criteria document for relocation of items outside the TS to a lower level. 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 Technical Specifications must be reported to the KFD. The KFD checks on compliance with the Technical Specifications during its regular inspections. More recently, a project has been started to improve the allowable outage times and surveillance requirements based on the risk-informed approach.

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 license, 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 reactor safety committee of the plant, the ISI programme have to be approved 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 process needed, how communication between various groups and departments is regulated 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).

The entire EPZ organisation in Borssele is currently being re-evaluated by the utility with a view to improving efficiency and safety and to meeting the strong cost imperative resulting from the deregulation of the electricity market. So far, no negative impacts on nuclear safety have been identified. However, the increased competition is leading to some savings being made in relation to maintenance (for example, through the use of contractors and possibly through risk-informed and optimised approaches to maintenance). Possible negative impacts on nuclear safety need to be carefully monitored by the regulator, KFD, which actually requires a continuous improvement in safety. Safety assessments by the KFD are supported by AVN.

19(iv) Anticipation of operational occurrences and accidents

The 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. Severe accident management (SAM) guidelines have recently been introduced. These are intended to provide guidance on accidents involving core damage and potential radioactive discharges into the environment.

The Borssele licensee follows the approach adopted by the Westinghouse Owners Group (WOG), both for EOPs and SAMG. The SAM 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. Recently, 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, Framatome ANP (formerly 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 licensee has built up considerable expertise in recent years and is able to manage most safety-related activities. 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, Framatome, NRG, Belgatom and AVN.

Since the regulatory body has only a very small staff, it makes frequent use of outside support for its assessments and inspections. Support is provided by the RIVM in the Netherlands, GRS in Germany and AVN in Belgium. Inspections and assessments have also been carried out with the aid of the IAEA. In addition, assistance is sometimes given by the private owned Nuclear Research and consultancy Group (NRG). However, this assistance is very limited since NRG provides technical assistance to the Borssele NPP and NRG will be 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 is great concern about the future of courses in nuclear engineering at Delft University of Technology and funding for the operation of the reactor (HOR) at the Reactor Institute (IRI).

19(vi) Reporting of incidents

An incident-reporting system is a condition of license 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 license 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).

The following are examples of category (b) events:

- (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), 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.

Apart from having the duty to inform the authorities, the licensee is also required to evaluate the event and take any appropriate action that may be required.

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 will 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, Framatome ANP, 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, including Principal Working Group No. 1 and its successor 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 also reports any incidents to the WANO and the VGB. Information is regularly exchanged on a bilateral basis with all neighbouring countries, plus a number of other countries. 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, there is still room 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 licenses 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 all wet waste to COVRA. The plant is presently being transformed into a safe enclosure. This ventilation building will contain the remaining materials for 40 years 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 bodies. 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 NPPs’ 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(i).

PLANNED ACTIVITIES AIMED AT IMPROVING SAFETY

As is already mentioned, in 1997 the Borssele NPP has completed a comprehensive programme for bringing the plant's safety level in line with modern safety insights. This activity has been initiated by the first ten yearly periodical safety review, as already has been discussed. Therefore, the government believes that there is only a very low probability of accidents accompanied by large-scale releases. The final stage of this programme has been the development and implementation of severe accident management guidelines (as was indicated in the section on Article 19(iv)). These efforts have been initiated, despite the low probability of such accidents. In parallel with this, studies are being conducted on the residual risk from local hydrogen explosions, after catalytic recombiners have been installed in 1997 (which rule out global explosions). These studies are still ongoing.

Currently, the Borssele NPP has finalised its second 10-yearly periodic safety review. As a consequence, the licensee has presented a preliminary improvement-plan to increase the safety of the plant even further (see the respective sections in Article 14 and Annex 1).

Integrated emergency preparedness exercises, i.e. involving both the plant staff and the authorities, have been planned. In 2005 a large-scale national staff exercise with all relevant authorities (local, regional and national) will be performed.

In the National Report for the 2nd review conference of the Convention on Nuclear Safety it was indicated that the KFD has started a feasibility study on Risk-informed Regulation. Now, three years later, it has to be admitted that only very little progress has been achieved. To mention are: a visit jointly paid by the KFD and staff members of the Borssele NPP to a US-NPP that is leading in pilot Risk-informed applications (South Texas Project). A proposal of Borssele NPP, similar to the well-known Regulatory Guide 1.173 of the US-NRC was discussed between KFD and the licensee. In this proposal temporary risk increases were allowed (up to 2% of the total core damage frequency, thus an increase TCDF< 1. 10^{-7}/year) given that on the long term the risk in terms of TCDF or public health risk decreases. Recently this proposal was sent to the Minister of the Environment for his approval. The reason for this very limited progress is the limited manpower in the KFD as well as the unexpected burden on the regulatory body due to the safety culture problems at the HFR.

One of the issues of the 2nd review meeting for the next period concerned the backlog in introducing the latest IAEA standards in the Dutch regulatory system. Due to the prospects of early closure in 2003 of the Borssele NPP there was no urgency felt to adapt the new IAEA standards for application in the Netherlands. When the court case in 2002 ended in favour of the licensee to continue the operation of the Borssele NPP after 2003, the capacity within the regulatory body was insufficient to start immediately a project to adapt the IAEA standards to NVRs.

Now a project has been started to introduce the new IAEA standards for NPP operation and design, at first aiming to implement the standards for operation and after that those for design. The project planning indicates a completion in 2007.

An IAEA-INSARR mission has had a positive influence on the safety culture at the HFR. For this reason, according to the new license, the licensee of the HFR is required to undergo an INSARR review (or similar) every 5 years with an emphasis on safety culture.

To guarantee continuous improvement in the safety of the plant in an era characterised by deregulation and liberalisation of the electricity market, the KFD has given this principle a more formal basis by inserting a special new licence condition during a recent modification of the Borssele licence. This licence condition states that the PSA should be regularly updated and should be used to investigate whether safety improvements can be made. If this is the case, and if the costs associated with the improvements are reasonable, the improvements must be made

RESPONSES TO REMARKS MADE DURING THE SECOND CNS REVIEW MEETING

a. Maintaining the safety of Borssele NPP when continued operation is uncertain

At the time of the 2nd review meeting, the Borssele NPP was under threat of early closure by 2003. Subsequently, there has been a civil court case between the government and the NPP, in which the government took the position that the NPP had to comply with the 1994 agreement that it should close by 2003. The NPP argued that the agreement had not been made with the present licensee and indeed that deregulation and privatisation had since changed the whole electricity production scene. The NPP won the case. In fact, however, the political environment had changed in the interim period and attitudes to nuclear energy had become more neutral. The present government has said that the NPP will be closed at the end of its technical design operating lifetime. This implies closure in 2013. Discussions are now taking place between the licensee and the government on how to prepare for closure in that year.

In conclusion, the situation can be said to have changed very significantly from that in 2002 . There is no longer any intention of early closure and the licensee can plan for a longer period (and is in fact doing so). Generally speaking, the new situation is conducive to maintaining a basic structure that fulfils conditions for financial health and nuclear safety.

b. Reducing the Dutch backlog in adopting latest revisions of IAEA requirements and guides

In 2002, the expected early closure of the Borssele NPP discouraged any investment of the regulatory body's scarce capacity in work to incorporate the latest IAEA requirements and safety guides in the Dutch system of regulations. This system is to a very large extent based on previous IAEA standards. The normal approach is that IAEA standards are examined to establish their applicability in the Netherlands. Where modifications are deemed necessary to accord with national conditions, amendments are proposed. The new standard is then discussed with the licensee to see if there are good reasons for abandoning these amendments. So the whole process is time-consuming and it takes at least two years to complete the adaptation of an IAEA standard (including the formal procedure for an order in council). (See also Art. 7.2. for the description of the national system of regulations.)

Clearly, then, with the Borssele NPP due to close by 2003, the effect of the latest standards would have been very limited. Nevertheless, despite the threat of early closure, the Borssele NPP embarked on the second 10-yearly integrated safety review in accordance with the normal schedule. At the start of that project the KFD was able to arrange with the licensee that the review would be informally based on the latest IAEA standards then available. This implied that the new IAEA requirements for design and operation would at least be used as reference documents.

Turning to the present situation, the following points can be made.

The Dutch system of NVRs (the adapted IAEA standards) includes the IAEA areas of design, operation and quality assurance. Where the quality assurance (QA) standards have been developed and maintained differently by the IAEA, the NVRs have been exempted from the current modernisation of IAEA standards because they were already updated and republished in 1996. At the time of the second review conference, the KFD was already preparing to apply this series of QA standards, partly because they have a wider field of application. The whole project came to completion in March 2004 when an order in council was published containing the new QA NVRs.

Further plans to introduce the latest IAEA standards have suffered as a result of the limited capacity of the KFD, especially over the last couple of years. Most available capacity has been absorbed by the two big 10-yearly integrated safety review projects (at the NPP and the 45 MW_{th} High Flux Research reactor). In addition, capacity has been affected by the KFD's transfer to the Ministry of the Environment. The transfer itself was a time-consuming project and the increased political influence has given the work of the KFD an extra dimension. For example, quite a lot of time has been taken up by dealing with the safety culture problems and reactor vessel flaws at the HFR.

With the 10-yearly safety reviews coming to an end, more capacity should be available to update the NVRs. A project has been started this year with the aim of completing the amendments to the requirements for design and operation this year and the priority operational safety guides in 2005. The design safety guides will then be amended in 2006.

Another point worth mentioning is the active participation of the Netherlands in efforts to harmonise reference levels for NPPs in all EU countries as part of the WENRA project.

c. Maintaining the capabilities and improving the efficiency of KFD

Organisational developments 2002-2005

After the transfer in 2000 from the Ministry of Social Affairs and Employment, when KFD as a unit was placed integrally in the VROM Inspectorate, the following developments took place:

- In compliance with general policy of the Dutch Government (functional separation of law- and policymaking on one hand and of inspection/enforcement on the other) the three different Inspection units of the Ministry of Housing, Spatial Planning and the Environment were integrated into one VROM-Inspectorate, in force since January 1st 2002. In this reorganisation KFD was kept fully intact.
- During 2002 and 2003 KFD was evaluated and integration options within the VROM Inspectorate were studied. Main elements of the study were:
    - the transfer to SAS of law- and policymaking tasks, technical assessment of license application and technical advising for rulemaking (NVR etc.);
    - the concentration to KFD of all inspection tasks related to the licenses of nuclear installations (integration of the tasks of the VROM-Inspection Region South-West, tasks from the department of Crisis Management concerning the Revised National Nuclear Emergency Plan (RNPK) and the tasks concerning nuclear security and safeguards from the Ministry of Economic Affairs);
    - the concentration to VROM-Inspection Region South West (VI-ZW) of all inspection tasks related to the other license holders for ionising radiation (sealed sources, etc.);
    - a new organisational structure (and capacity).
- In 2003 it was decided to concentrate all tasks on supervision relating to nuclear installations in KFD and in principle to separate and to transfer tasks, which relate to law- and policymaking, licensing and regulations to SAS. A transfer under de condition that it would result in an effective and efficient situation for both KFD and SAS. A final decision is expected in April 2005.
- the new organisational structure of KFD was implemented on the 1st of March 2004 in line with the organisation of the VROM-Inspectorate. This meant a change from a matrix organisation with a director, three project managers (inspection, assessment and licensing/rulemaking/research) and a pool of specialists into an organisation with two separate divisions, each focussing the tasks inspection, assessment and licensing to a group of licensees.

Capacity developments 2002-2005

The following developments have taken place:

- The expected closure of the Borssele NPP has been postponed to the end of 2013 according to the current government plan. Therefore, investments in new staff are needed. In 2003 two new staff members were employed. Due to government budget cuts the formation of the KFD will slightly be reduced.
- The ageing of the workforce, apart from the newly attracted, has grown another 3 years. The average age of the KFD staff is currently about 58 years. On one side these highly experienced staff is an advantage, but on the other side there is a threat that this experience (corporate knowledge) disappears in a short period of time due to retirements and early retirements. Also, elderly staff members are entitled to reduce the time of work by one or two days per week. Currently for the KFD this results in an effective capacity reduction with about 1.5 man-years.

The respective managements of the Directorate-General for the Environment, the VROM-Inspectorate and the KFD do recognise these problems and try to cope with them in the following way:

- The KFD pursuits to attract new staff members. In October 2003 two extra staff members were attracted.
- The KFD seeks continuously contacts with colleague regulatory bodies abroad. Intensive contacts are established 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. But also the membership of WENRA and other international bodies are important as a support for the supervising activities in the Netherlands.
- The KFD tries to cope with the “staff reduction” due to the budget cuts in the following way:
  - Seeking efficiency gain by internal integration of ‘old’ and ‘new’ KFD-tasks;
  - Seeking internal cooperation with environmental inspectors (non nuclear) from the regional offices of the VROM-Inspectorate.
  - Seeking co-operation with other inspectorates within the Netherlands, e.g. the Labour Inspectorate.
- The management of KFD expects that the above mentioned measures will not be sufficient to compensate the loss of experience within KFD due to retiring staff members in the years to come. Therefore KFD is developing new and expanding existing open contracts with external organisations (like AVN and GRS) that fill in the existing and expected gaps in the capacity of KFD and fields of experience.
- The respective managements of the VROM-Inspectorate and the Directorate-General for the Environment have the intention to investigate what the minimum criteria (critical mass) are for a lasting regulatory body in the Netherlands that can meet the challenges in the future. This investigation will include all the tasks of a regulatory body, to mention: licensing, drafting technical regulations, assessment of licensee’s transmittals, supervision and research.

See Article 8 of this report for a more detailed description of the manpower situation at the KFD.

Maintaining capabilities and access to independent experts

As was mentioned before KFD has open contracts with GRS and AVN. The following actions were taken:

- GRS has been consulted on several safety issues: a new fuel design, effects of airplane crash, ageing issues, earthquake analyses, etc.
- AVN has been consulted to review the documents of Periodic Safety Review, the quarterly reports on incidents, and the reactor physics and fuel design documents for the HFR in Petten.
- An experienced AVN expert supports the inspection during the refuelling of NPP Borssele.
- Twice a year a management meeting with AVN is held.
- KFD is further developing foreign exchange by starting bilateral exchange with the Swiss HSK and the Belgian FANC in 2004.
- KFD considers peer review as very important. Except from the Convention on Nuclear Safety in 2004 and 2005 important peer reviews should take place in the framework of the WENRA project on harmonisation of regulations.
- It has been decided that in 2004 and 2005 the two department heads will intensify relations with colleagues in the most important neighbouring countries (Germany, Belgium, France, Great-Britain).
- The KFD has a contract with the NRC for exchange of information.

It has always been the policy to maintain capabilities through memberships of international groups. At the moment KFD is represented in OECD/NEA CNRA and CSNI and in most WGs. Furthermore, KFD is represented in IAEA/NUSSC and IWG-NPPCI. KFD is represented by its Director in WENRA and at the IAEA-General Conference. Staff members of KFD are also represented in NERS and NRWG (EU).

Employees of KFD take place on an ad-hoc basis in conferences and workshops, technical meetings etc. For the new employees an introduction plan for two years has been determined. With this plan they are trained in the general tasks of a regulator and take part in several national and international courses. Further training on the job coached by a colleague is an important element. Examples of international training courses are: IAEA Regional Training Course on NPP Regulatory Control, IAEA Basic Training Course on Nuclear Safety, OECD THICKET.

d. Further development of safety culture oversight process

Due to the limited manpower at the regulatory body and the major input necessary at the High Flux Reactor (HFR), relatively little attention has been paid to the impact of the liberalisation of the electricity market on the safety culture of the Borssele NPP. The more theoretical study that was to be performed by a management consultant did not produce the expected results. This study should have investigated the main organisational loops to secure the quality and safety level in the licensee’s organisation and derive practical inspection tools to assess and inspect changes.

However, the lessons learned in relation to the safety culture problems at the HFR will be used to monitor the safety culture at the Borssele NPP. It is recognised that this approach is urgently needed to regulate the more or less continuous organisational changes being made at the Borssele plant in order to minimise costs.

e. Completion of current PSR for Borssele NPP, its review and approval by KFD

In 2002 the second PSR was started for the Borssele NPP, covering the period 1993-2002. The boundary conditions for this review were taken from the following documents:

- IAEA 50SG-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 (Dutch).

Clearly, the decision of the licensee to start the PSR despite the threat of early closure was correct, since it meant that the process was already under way when it became clear that the early closure was not to be implemented.

As a result, the PSR is now only a few months behind schedule. The evaluation of the safety case compared with current standards was submitted by the end of 2003 and the regulatory review of that evaluation including discussions with the licensee is now almost complete. This means that an approved survey of the issues to be the subject of the next phase plus proposals for improvement measures will be ready soon.

APPENDIX 1: SAFETY POLICY AND SAFETY OBJECTIVES IN THE NETHERLANDS

a. 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.*

b. The technical safety objective

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

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.

c. The radiological safety objective

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

d. Dutch environmental risk policy

The concept of risk management and risk assessment was first introduced into Dutch environmental policy in the 1986-1990 Long-Term Programme for Environmental Management. The concept was reassessed following debates in parliament. As part of the Dutch National Environmental Policy Plan [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.

d.1 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.

d.2 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)	
	Adult	Child (1 year old)
$F \geq 10^{-1}$	0.1 mSv	0.04 mSv
$10^{-1} > F \geq 10^{-2}$	1 mSv	0.4 mSv
$10^{-2} > F \geq 10^{-4}$	10 mSv	4 mSv
$F < 10^{-4}$	100 mSv	40 mSv

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.

d.3 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.

d.4 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 BACK-FITTING

a. 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.

b. 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 license 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 license. 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 license, 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 license, but this should in no way hamper the adaptations.

c. 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.

d. Implementation of back-fitting

d.1 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.

d.2 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.

d.3 Nature of a 10-yearly review

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:

    1. the specific operational procedures, with staff qualifications and training,
    2. the programme of tests performed on a regular basis,
    3. 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.

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.

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 of 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;
- Technical Specification optimisation;
- Optimisation of the maintenance programme;
- Optimisation of periodic testing;
- Shut-down period configuration optimisation;
- Day-to-day configuration evaluation.

This last application 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 and 4.6% for total maintenance.

So far, risk assessment data have not been used 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. IAEA Peer Advice on Living PSA applications in The Netherlands

The regulatory body is increasingly being confronted with requests for approval of design or operational changes which stem directly from, or are supported by, arguments stemming from LPSA applications at Borssele. For this reason, the IAEA was asked to advise the KFD in relation to questions like: ‘Are the LPSA applications at the Borssele plant state-of-the-art and sufficient, or should Borssele do more?’, and ‘How should the KFD respond to these applications, given a small regulatory staff and the possible short remaining lifetime of the Borssele plant?’.

The main conclusions and recommendations were as follows:

- Give high priority to completing the implementation of the risk monitor, so that it can be used for maintenance scheduling, operating decisions and risk follow-up.
- Select those applications that can benefit the plant in the near future. The 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, and risk-informed increment of on-line maintenance activities.
- 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, review existing risk-informed frameworks, bearing in mind that acceptance criteria need to be tailored to the specific situation in the Netherlands.
- The resources required to accomplish risk-informed regulation depend on how much use will be made of this approach, but the IAEA team suggested that the KFD should continue to allocate at least one person (someone with in-depth knowledge of the Borssele PSA) to PSA-related activities, and that all decision-makers should have some training in PSA.
- The IAEA team felt that, if the KFD requested applications at the Borssele NPP, these should be discussed with the plant to maximise mutual benefit. In addition, discussions gave rise to the idea that the KFD and the Borssele NPP could perhaps develop a consensus document on the conduct and assessment of PSA applications.
- Finally, the team suggested that the KFD could use PSA to focus the regulatory inspection programme on the most significant systems, components, and plant practices.

Following this advice, the KFD cautiously defined a follow-up programme/feasibility study on the action it might take to move towards more risk-informed regulation. It decided to take a step-by-step approach, first familiarising itself with risk-informed regulatory approaches in other Western European countries and then focusing on a particular application, such as Technical Specification optimisation.

e. Follow-up programme

The objective of this programme is to achieve 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 should be commensurate with risk contributions (i.e., regulations should be more stringent in the case of important contributors to risk, and less stringent for less important contributors to risk). Provided appropriate risk-informed regulatory criteria are developed, therefore, a systematic and efficient expenditure of resources is to be expected, while, simultaneously, a balance in overall plant safety can be achieved.

Examples of typical regulatory activities where risk-informed methods and requirements are thought to be helpful and are therefore being investigated in the project include:

- evaluation of design and procedural adequacy;
- performance of periodic safety reviews;
- assessment of changes to the licensing basis, e.g. Technical Specification optimisation: surveillance test intervals, allowed outage times, and limiting conditions of operation;
- assessment of operational practices or strategies on safety, e.g. plant systems configuration management, preventive and corrective maintenance prioritisation;
- prioritisation of regulatory inspection activities;
- evaluation of inspection findings;
- investigation of ageing effects;
- assessment of risk-based safety indicators;
- the need for regulatory action in response to an event at a plant;
- one-off 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 constrained by the present limited nuclear power programme: a single NPP (Borssele) in operation but scheduled for closure by the end of 2013, with no plans for new reactors.

The focus of future activities/events for the Borssele NPP is governed by licence requirements or external circumstances. It concerns initiation/continuation of:

- new 10-year periodic safety review, formally started in 2001;
- two-year operational safety review;
- monitoring of the plant safety culture during the expected plant staff reductions;
- deregulation of the electricity market.

In these circumstances, the emphasis in developing risk-informed regulation will be on the operational and not the design area. QA is also assumed to focus on operational items in this respect. The design area cannot be ignored, however, since the plant configuration is a major determinant of plant safety.

Given the limited scope both of application and of available KFD manpower, the development of risk-informed regulation will have to be based on existing approaches elsewhere; there is no likelihood of any separate ‘Dutch’ RiR development. The main vehicle could be the USNRC approach, supplemented by useful aspects of the approaches in Spain, Switzerland, Sweden, Finland, Belgium and the UK. Where sources are so diverse, special care will have to be taken to achieve a coherent and consistent product.

‘Deregulation’ is intended to help utilities to be and remain competitive players in the electricity market. In practice, it means that active support will be given to activities aimed at cutting costs, so long as they do not compromise safety.

The main objectives of the RiR project are therefore:

- to support the aforementioned (bulleted) activities;
- to focus KFD and plant resources on items relevant to risk; and
- to eliminate any unnecessary ‘regulatory burden’.

It is *not* the intention of the proposed RiR project to generate formal revisions of the NVR series on 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 at stake, where no written guidance can yet be formulated. In such cases, it will be necessary to decide how to proceed on a more ad hoc basis.

A special aspect of this project is to consider the feasibility of turning the current oversight process into a more risk-informed one including the eventual use of safety-significant performance indicators.

In order to gain high-level official and political approval for this transition to a more risk-informed approach to regulation, a letter was sent to the Minister of Housing, Spatial Planning and the Environment explaining the objectives and expected benefits of the new approach. The letter stressed that RiR is a means of achieving continuous improvement in the safety of the plant and that it will provide transparency concerning temporary risk increases associated with changes in the installation to benefit economic performance (e.g. power increase). It will guarantee that these are permitted only if they are justified and that, in such cases, risk increases will be as small as reasonably achievable.

However, to guarantee continuous improvement in the safety of the plant in an era characterised by deregulation and liberalisation of the electricity market, the KFD has given this principle a more formal basis by inserting a special new licence condition during a recent modification of the Borssele licence. This licence condition states that the PSA should be regularly updated and should be used to investigate whether safety improvements can be made. If this is the case, and if the costs associated with the improvements are reasonable, the improvements must be made.

APPENDIX 4: THE SAFETY CULTURE AT BORSSELE NPP

Reference is made to the Borssele NPP policy statement:

> *EPZ supports the intention in respect to safety culture as defined in the IAEA reports 75-INSAG-3 and 75-INSAG-4. 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 all necessary measures to establish and maintain a good safety culture.*

Apart from the aforementioned policy statement, the Operating Instructions of the Borssele NPP, which form a generally accessible set of information, include a policy document entitled ‘Nuclear Safety and Radiation Protection’ (92-0101, rev. 3), in which nuclear safety is declared to be the highest priority.

The policy document describes nuclear safety as being based on two principles: defence-in-depth and safety culture. The policy document is followed by a memorandum entitled ‘Concrete Measures’ (R6573), which lists the priorities. It 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.

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,
- 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.

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. STAR stands for: (in case of deviations) Stop, Think, Act and Review.

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 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.

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 1.4	Safety Requirements on predisposal radioactive waste management, including decommissioning. Adaptation of IAEA draft Safety Requirement NS-152; RADWASS programme. (to be published in Government Gazette)

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
NVR 3.2.1	Requirements for the training of operating personnel of NPPs. (only in Dutch)

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

Safety Guide on Decommissioning

NVR 2.4.1	Safety Guide on decommissioning of nuclear power plants and large research reactors. Adaptation of IAEA draft Safety Guide NS-257; RADWASS-programme (to be published in Government Gazette)

ANNEX 1: TECHNICAL DETAILS OF THE BORSSELE NPP

1. Technical specifications

The Borssele nuclear power plant is a light water PWR with a thermal power of 1370 MW and an electrical output of approximately 450 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	450 MW
Gross electrical output	477 MW
Rated thermal power	1370 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 NiMoCr 37
Core outlet temperature	317.5 ^{o}C
Core inlet temperature	292.5 ^{o}C

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 SGs	2
Design pressure, primary side	176 bar
Design pressure, secondary side	88 bar
Design temperature	350 ^{o}C
Material of U-tubes	Incoloy 800

Number of U-tubes	4234
Total heat transfer area	3600 m^2

Pressuriser

Overall volume	40 m^3
Water volume (at full power)	24 m^3
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); two of the three are actuated by both a motor-operated pilot and bleed valve and by a self-actuated pilot valve; one is only actuated by a motor-operated pilot and bleed valve
Relief pressure (safety valve)	172 bar/ 176 bar/ 180 bar

Pressuriser relief tank

Total capacity	40 m^3
Water volume (normal operation)	15 m^3
Gas volume (normal operation)	25 m^3
Temperature (normal operation)	50 °C

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	Multi-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
Pressure	31.5 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 suppletion 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 suppletion system (reserve feedwater system)

Number of pumps	2
Capacity	14 kg/s
Maximum discharge head	900 m
Type	Centrifugal pump
Number of demin water storage basins	2
Capacity	496 m^3/ 469 m^3

Reserve core cooling/ RHR system

Number of pumps	1
Capacity	61.1 kg/s
Maximum discharge head	90 m
Number of Heat Exchangers	1 plate Heat Exchanger (titanium)

Emergency power

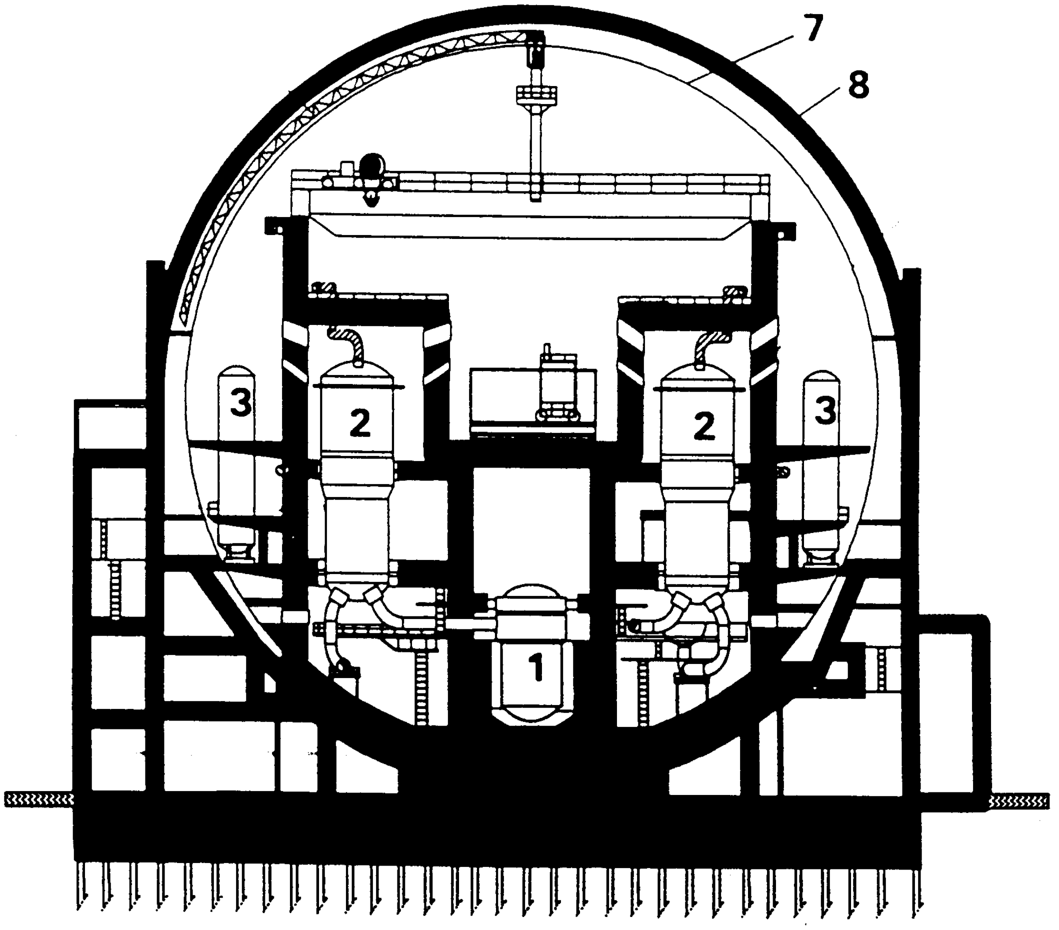
Number of diesel generators	5
Power (continuous)	3 x 4,343 MW and 2 x 0.88 MW

Spent fuel storage

Maximum capacity in inside-containment Storage Pool	500 elements in high density racks
Actual storage	104 elements (May 2004)

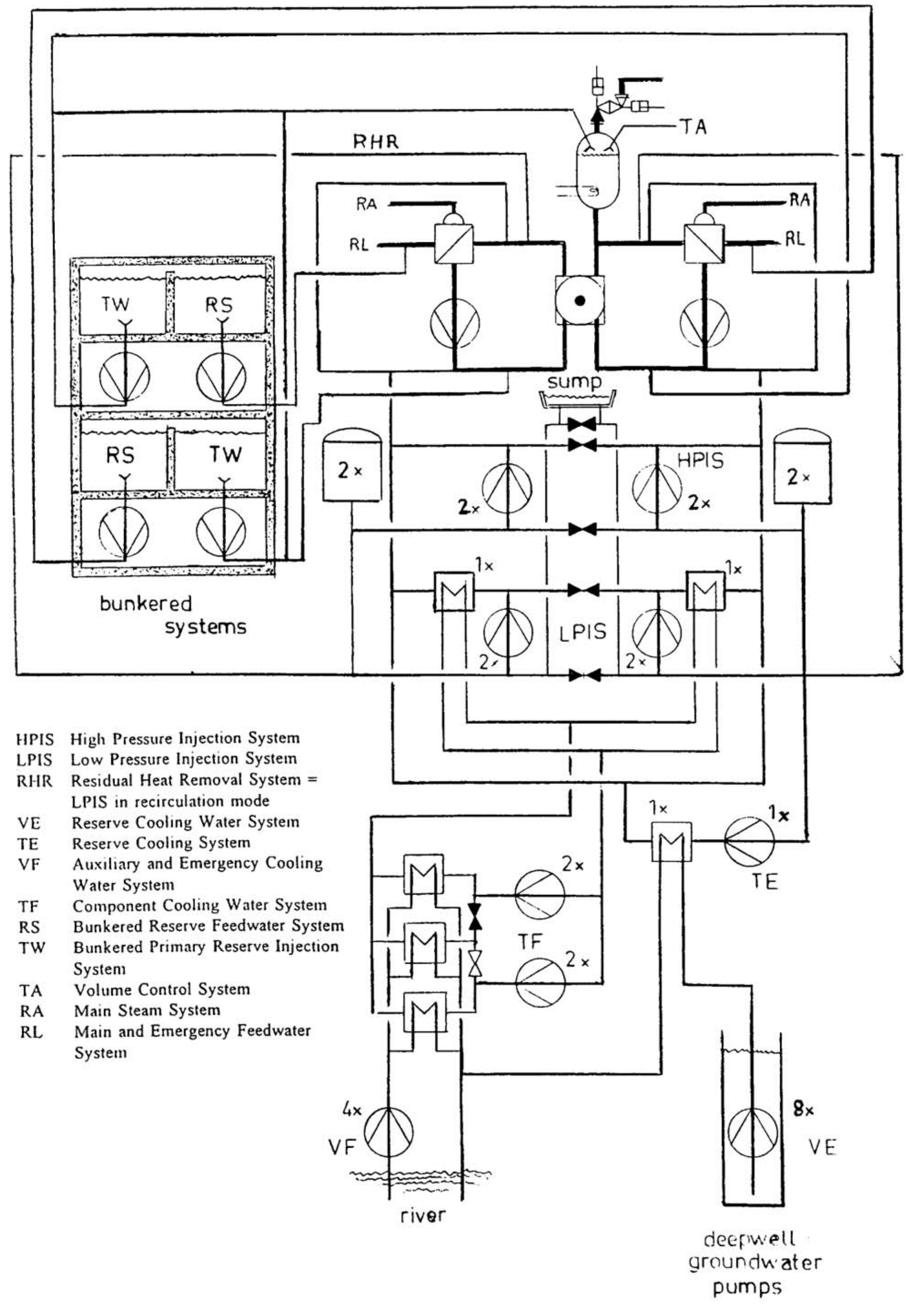
The end of this Annex shows graphs of the overall plant availability over the years, the number of incident reports from 1990 onwards and the number of unwanted automatic scrams over the years.

Figure 1. 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 2. Safety features of core injection & RHR systems at Borssele NPP



HPIS	High Pressure Injection System
LPIS	Low Pressure Injection System
RHR	Residual Heat Removal System = LPIS in recirculation mode
VE	Reserve Cooling Water System
TE	Reserve Cooling System
VF	Auxiliary and Emergency Cooling Water System
TF	Component Cooling Water System
RS	Bunkered Reserve Feedwater System
TW	Bunkered Primary Reserve Injection System
TA	Volume Control System
RA	Main Steam System
RL	Main and Emergency Feedwater System

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 feedwater 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 feedwater 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 setpoints 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 the turbine-driven pump of the emergency feedwater system by a motor-driven pump, to increase the cooling capacity of the primary system by means of the SG.
- Installation of check valves on inundation tank lines (low-pressure ECCS).

3. Proposed modifications due to the second 10-yearly periodic safety review

The Borssele NPP finalised recently its second 10-yearly periodic safety review. The evaluation process was started by collecting basic information concerning issues from the Check plan. An inventory was made of the evaluation-items on which different points of view existed between the operator and the KFD with regard to the safety level commonly applicable for an NPP. Then these evaluation items were examined upon their relevance for the Borssele plant.

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 radiation protection a point of view. The safety interests were characterized according to a method whereby deterministic as well as 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). 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:

- Installation of detectors and igniters at site boundary counteract external gas clouds. This measure will reduce 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 will reduce 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%;
- 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).

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.

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 can also be read in the office.
- Classified plant information is presented by panel instrumentation. Manual actuation of components must be executed from the panels.
- Working places are designated to a nuclear systems operator, to a conventional systems operator and to the supervisor/2nd shift leader.

- Operation of main control room and secondary control room is mutually interlocked. To abandon the main control room, the reactor has to be shut down and the main control room made unavailable by a key code.
- Actuation of components induced by the reactor protection system is dominant and will inhibit manual actuation from the control room panels. To by-pass this, 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 function monitoring system (CFMS) indicates the status of basic critical safety functions by colour codes with the possibility to instantaneously zoom in on status trees which lead to the use of the applicable AM procedures.

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.

Unless the high availability of the CMFS is a part of the PPS, this system is not safety certified. Therefore the information from the panels has priority over the status trees.

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. There are three levels of diagnosis in this procedure: an early diagnosis via E-0, a continuous diagnosis based on symptoms through the ORGs, 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 downward trend continued through to the end of 2003, when the figures were 0.5 mSv per annum for plant personnel and 0.7 mSv per annum for externally hired personnel.

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. In the period through to the end of 2003 there was a further decline in the total collective dose to a figure of 0.5 manSv per annum.

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 license for the Borssele NPP are as follows:

- **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

- **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: approx. 0.8 μSv per annum;
- maximal individual dose from releases in water: approx. 0.04 μSv 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 2.2 * 10-3 manSv per annum.

The (actual) collective dose to the public from the releases in water is estimated at 2.8 * 10-3 manSv per annum.

6. Discharge, dose and incidents diagrams for Borssele NPP

Diagram 1.

Borssele NPP discharges in air of I-131 (MBq/year); licence limit 5000 MBq/year

Diagram 2.

Borssele NPP discharges in air of noble gasses (TBq/year); licence limit 500 TBq/year

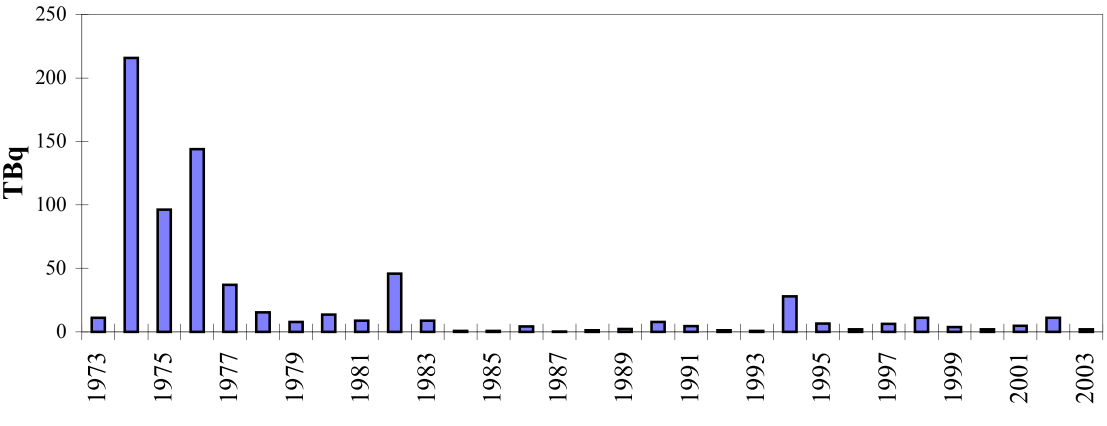


Diagram 3.

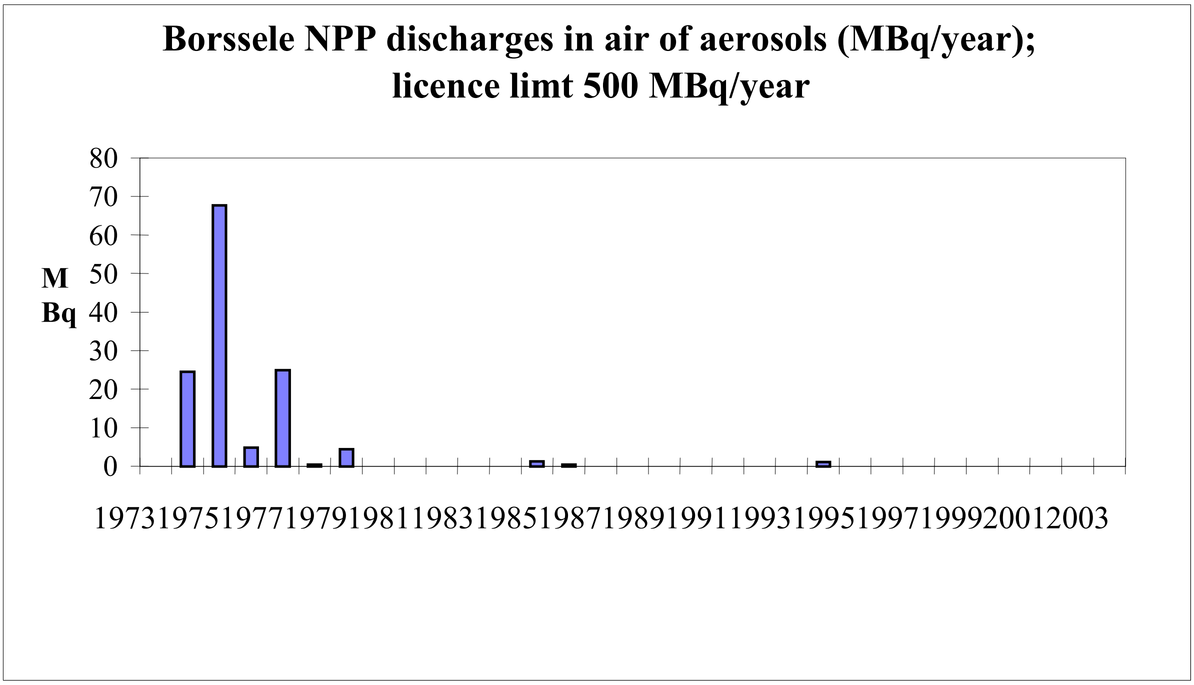


Diagram 4.

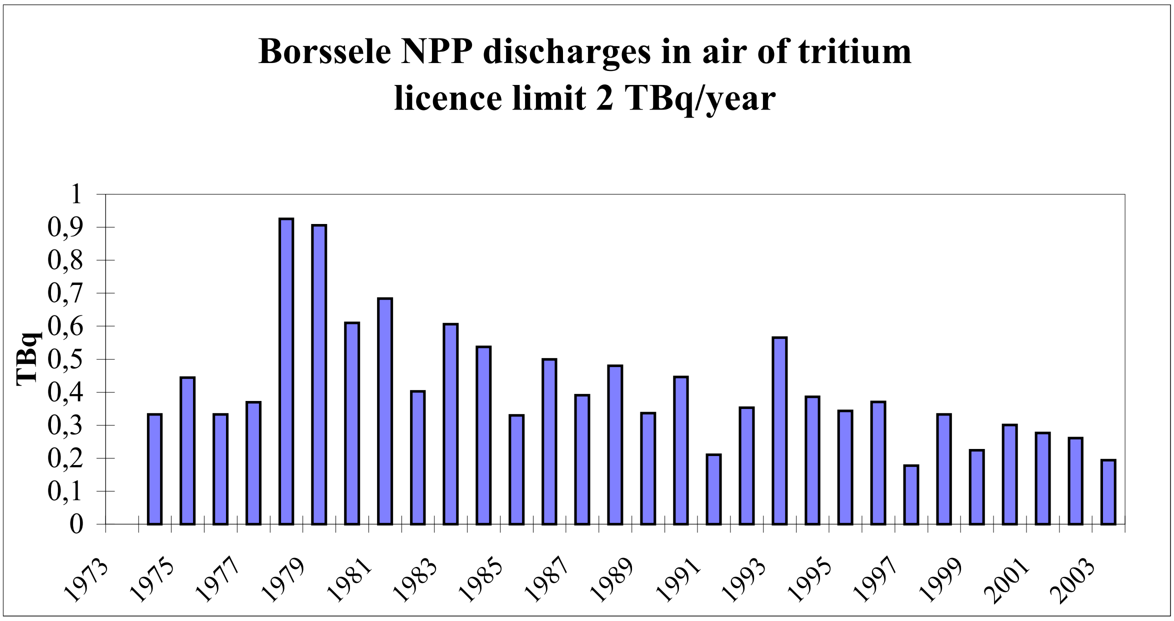


Diagram 5.

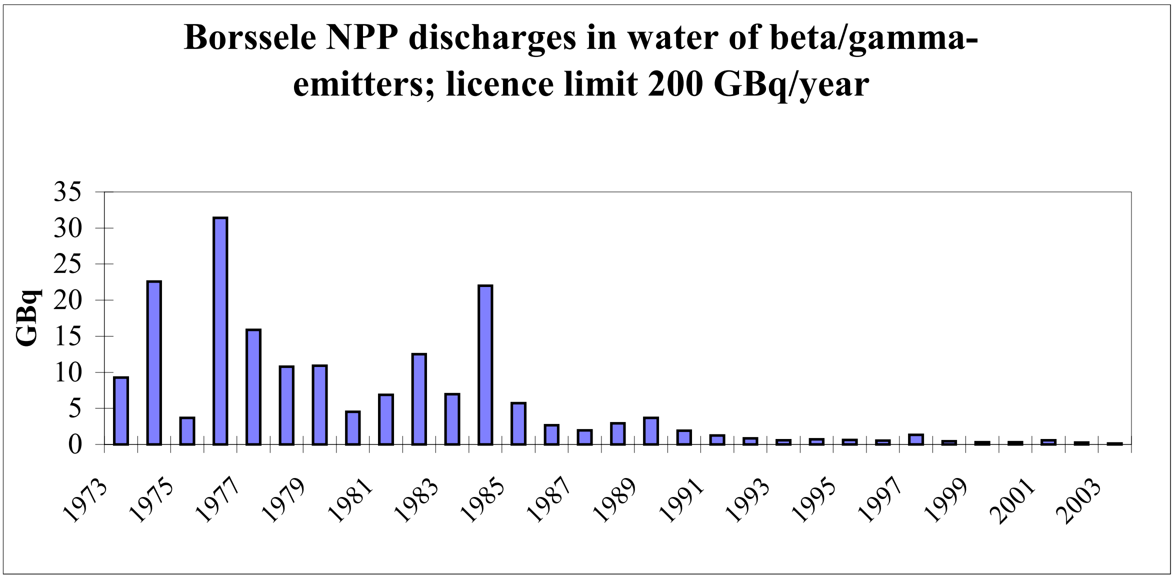


Diagram 6.

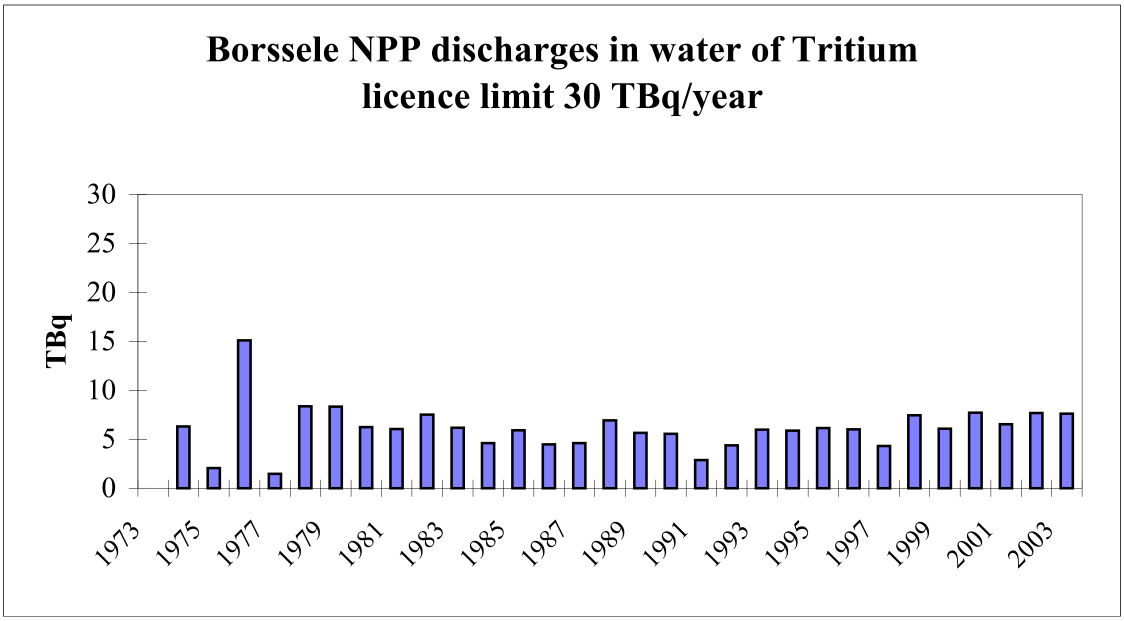


Diagram 7.

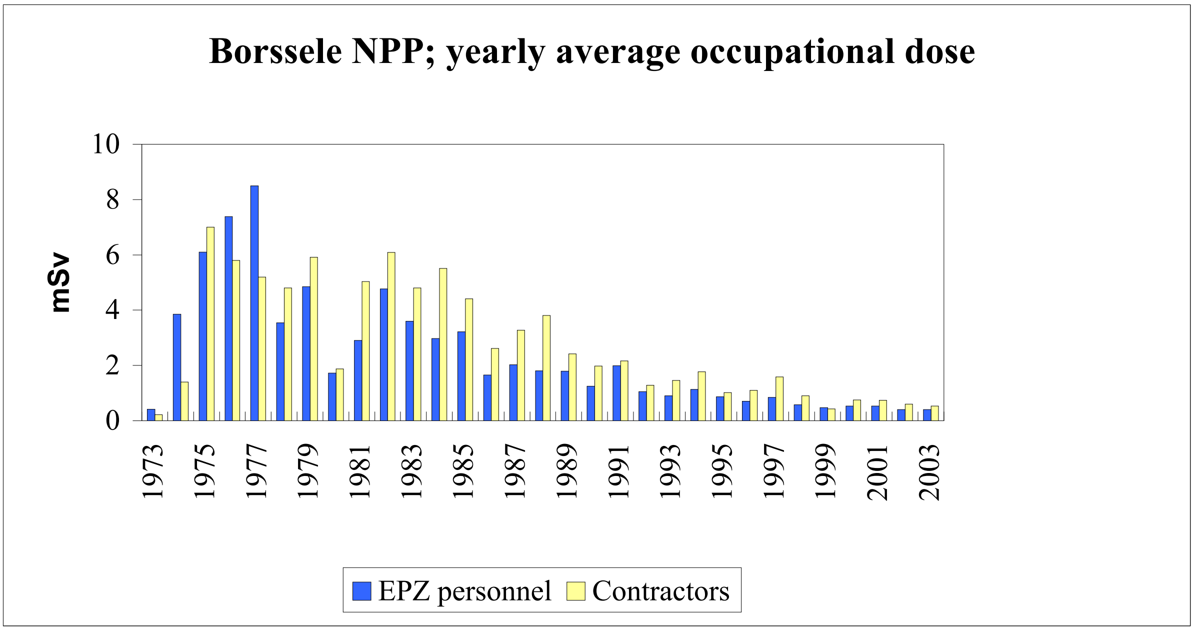


Diagram 8.

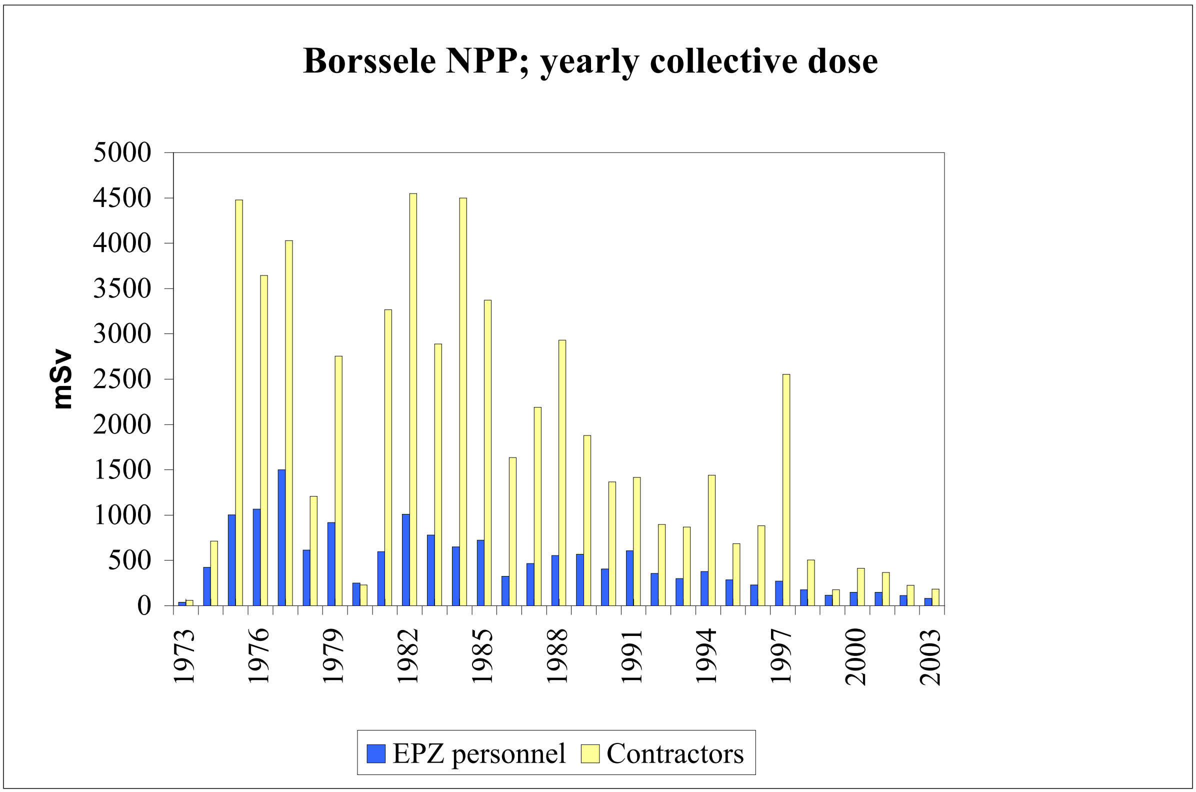


Diagram 9.

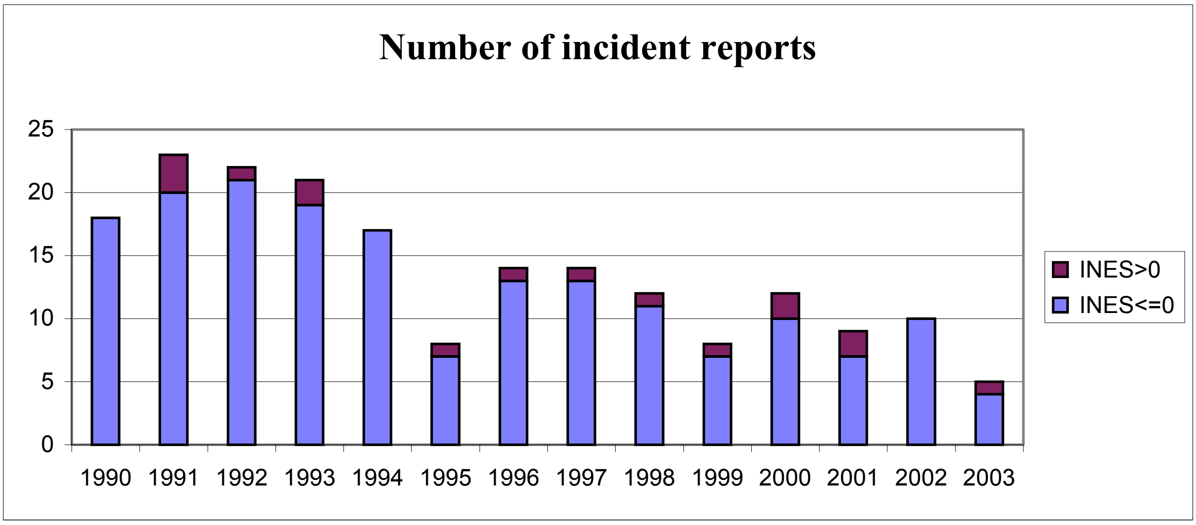


Diagram 10.

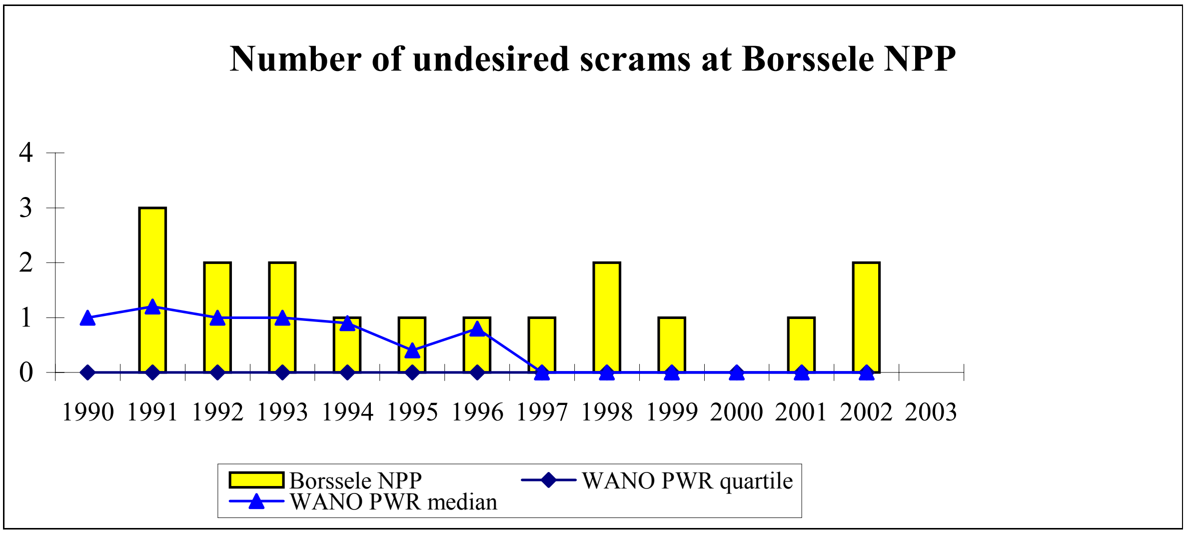
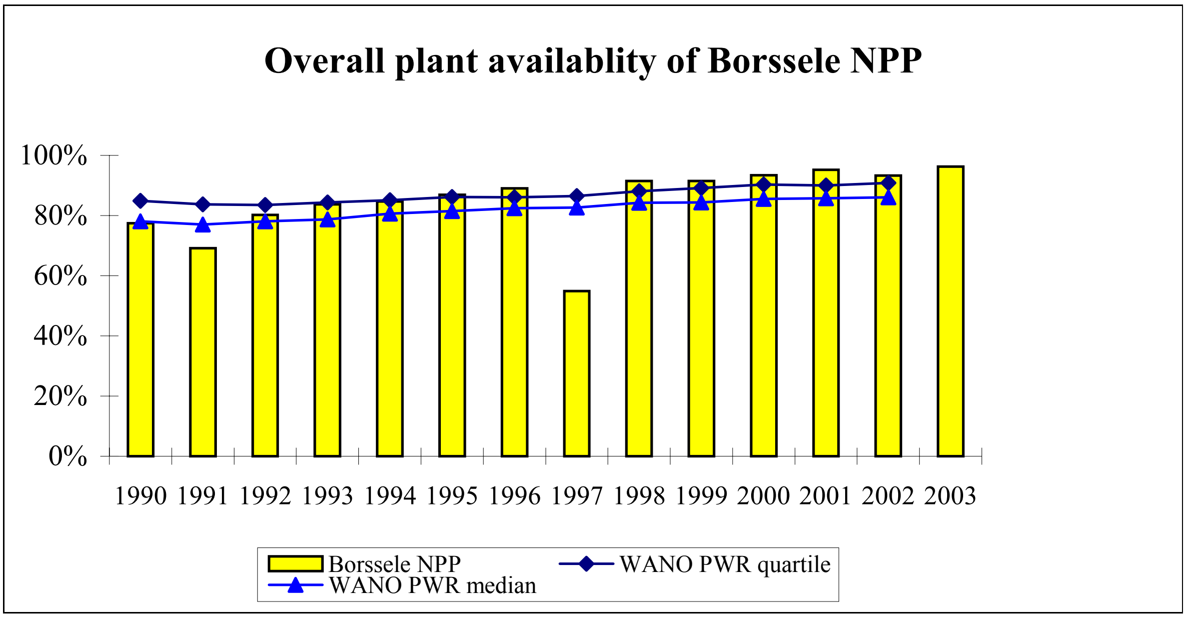


Diagram 11.


Overall plant availablity of Borssele NPP
100%
80%
60%
40%
20%
0%
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
Borssele NPP
WANO PWR quartile
WANO PWR median

ANNEX 2: TECHNICAL DETAILS OF THE DODEWAARD NPP AND DECOMMISSIONING DEVELOPMENTS OF THE DODEWAARD NPP

1. Introduction

The Dodewaard nuclear power plant is a light water BWR, designed by General Electric in the late 1950s (the design is known as the Humboldt Bay design). Construction work started in 1963 and the plant was in operation between 1968 and 1997. Dodewaard had a thermal power of 183 MW and an electrical output of 58 MW. The installation was characterised by the natural circulation of the coolant through the reactor core, which meant that no forced recirculation pumps were needed. The containment design can be described as a pre-Mark I design and comprises a reactor chamber (drywell), two pressure suppression vessels and two connecting ducts (see Figure 3). The reactor permanently ceased generating power in March 1997.

2. Decommissioning developments

History

The decision to close down the Dodewaard plant was announced to the public in September 1996 and took the authorities by surprise. Until that date, the plant had been expected to close in 2003. The reason for the decision to close earlier was that the licensee no longer believed in a nuclear programme in the Netherlands. As Dodewaard had always performed a research function for the utilities, being used to maintain the nuclear expertise necessary for further expansion of nuclear power generation capability, it made no sense to keep the plant open. Furthermore, the economic profitability of the plant was in doubt.

The Dodewaard plant went out of operation in March 1997. Since then, the reactor has been in a permanent shut-down state and a process has been initiated to decommission the plant.

The operator of the Dodewaard NPP (GKN) has opted for final dismantling of the plant after a waiting period of 40 years. Accordingly, a safe enclosure is to be constructed over the next few years.

In 1998 a modification of the operating license made it possible to implement a number of measures as a consequence of the termination of normal operation and in preparation for the installation of this safe enclosure. In addition, the spent fuel was moved from the core in the reactor vessel to the spent fuel pool. By the end of 2000, the first spent fuel was being shipped to Sellafield for reprocessing. All fuel is expected to have been shipped to Sellafield by the end of 2002. From that moment on, it will be possible to start the final activities for the installation of the safe enclosure.

An application for a license for these upcoming decommissioning activities (installation of safe enclosure and maintenance of this installation over the next 40 years) was submitted in May 1999. Since the decommissioning of a nuclear installation is an activity that falls under the scope of the EU’s new Environmental Impact Assessment Directive (Directive 97/11/EC), an environmental impact assessment (EIA) was also performed as part of the application.

This EIA compared three methods of decommissioning: (1) dismantling after 40 years, (2) direct dismantling and (3) in-situ decommissioning (no dismantling for a very long period and 'burial' of the site). In terms of environmental impact, there proved to be little difference between these options. GKN therefore opted for dismantling after 40 years as being the cheapest method.

After lengthy discussions within the government, the license was granted in 2001. In parallel, as part of the application, a new safety analysis report was prepared by the licensee. This was based solely on the licensee's preferred option of dismantling the installation after a waiting period of 40 years.

Apart from these legal activities, the regulatory body has amended the draft IAEA Safety Requirements publication 'Predisposal Radioactive Waste Management, including Decommissioning'; NS-152, and the draft IAEA Safety Guide 'Decommissioning of Nuclear Power Plants and Large Research Reactors'; NS-257. In the near future, these amended IAEA Safety Requirement and Guide will be incorporated into the Dutch Nuclear Safety Rules as NVR 1.4 and NVR 2.4. For the time being, they will be attached as conditions to the aforementioned licence.

Technical aspects

For the waiting period, a so-called safe enclosure is to be 'constructed'. This safe enclosure will consist of the reactor building, turbine building and radwaste building. All the other buildings (including the workshop, offices, ventilation stack, etc.) will be dismantled during preparations for the conservation period. The activities for the 'construction' of the safe enclosure comprise:

- modification of the entrances to the controlled area;
- locking of other entries;
- modification of sewage systems;
- installation of a new ventilation system;
- installation of new electrical systems;
- installation of new systems for security (e.g., surveillance, monitoring, guarding);
- installation of a new fire-detection system;
- decontamination of the radioactive contaminated systems and components.

Decommissioning costs

The cost of immediate decommissioning of the Dodewaard plant is estimated at around €150 million. About €95 million is for the so-called post-operational phase of the power plant (phasing out and decontamination of equipment, removal of spent fuel from the site, etc.). The cost of decommissioning after 40 years will be slightly higher, €175 million (at current price levels), due to the extra costs for conservation of the installation. However, if the necessary financial resources are set aside now, and assuming a (legal and even recommended) 4% interest rate and associated capital growth, an amount of €75 million will be sufficient.

These figures were calculated in 1994/1995 by the German company NIS, which specialises in NPP decommissioning activities. They were reviewed by a Dutch working group including representatives of both licensees and of the electricity sector in general, as well as observers from the regulatory body. In 1995 the government agreed that the conclusions of the NIS study should be used as a basis for funding. In 1997, however, when decommissioning of the Dodewaard plant ceased to be a hypothetical question and became an immediate practical and even political issue, and when it became clear that cost was the only determining factor governing the decision on the decommissioning strategy, the government decided to obtain a joint second opinion from the Netherlands Economic Institute and the Interfaculty Reactor Institute of Delft University of Technology. They reached the same conclusions as NIS: by delaying decommissioning, approximately €50 million to 60 million could be saved.

Latest developments

Given the fact that the Dodewaard NPP has to be maintained in a state of safe enclosure for a period of 40 years before final dismantling, it is essential that good organisational safeguards be put in place for this. Since the future of the present owner is very uncertain (GKN has no other activities), it has been decided to transfer the NPP (or what remains of it), including all financial assets, to an organisation that is better equipped to perform the necessary tasks over a very long period. The appropriate organisation for this is COVRA, the state-owned central organisation for radioactive waste management in the Netherlands. Its installations at Borsele can be used to store all kinds of radioactive waste (including waste from reprocessing) for a very long period (at least 100 years) until a final solution for storage has been found. The possible financial and other conditions for this transfer are being investigated.

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 license;

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 license;

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 license.

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 license as referred to in Article 15.

Article 15b:

1 An application for a license 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 license will clearly state its subject matter. The license application is part of the license, where this is so indicated in the license.

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

3 A license 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 license, the license 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 license will describe the objectives which the license-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 license-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 license in order to protect the interests designated by or pursuant to Article 15b.

2 A regulation may impose an obligation on the license 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 license 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 output of $45MW_{th}$. It is a tank in pool type reactor of a design similar to the old Oak Ridge Reactor in the USA (figures 1, 2, 3 and 4). 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 (figures 2 and 4). 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” aluminium piping, a 43 m^3 decay tank, three electrically driven main primary cooling pumps and three heat exchangers (see figure 3 and 5). The decay tank, primary pumps and heat exchangers are located in a separate pump building, together with an electrically driven decay heat removal pump and a diesel-driven emergency cooling pump.

The HFR currently uses > 90% high enriched $U.Al_x$ as fuel. This high enriched fuel (HEU) is located inside thin aluminium plates which are about 1.5 mm thick, about 70 mm wide and about 700 mm long. 23 of these plates are located in parallel inside almost rectangular fuel elements. The core consists of about 33 fuel elements, 6 control elements (lower part is a fuel element and the upper part a control rod), 4 corner elements, 9 external and 12 internal beryllium reflector elements and 16 in-core irradiation positions.

Recently, the licensee of the HFR has applied for a license to operate the reactor in future using low enriched uranium (LEU) with an enrichment of less than. 20%. For further details, see section below on HEU-LEU conversion.

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. License renewal and safety review

The existing license for the HFR is obsolete. It was issued before the Nuclear Energy Act entered into force and revisions have been very fragmentary. In the past, the HFR received relatively little attention from the regulatory body because of the heavy workload it was then under with respect to the two nuclear power plants then in operation and the assumption that it presented a lower potential risk. The KFD wished to update and modernise the license but made little progress. The Ministry of Economic Affairs, which was at that time running the secretariat of the competent authorities for the licensing of nuclear installations, was heavily involved (both programmatically and financially) in the research programme of ECN and of the HFR in particular. In the late nineties, two events caused a change:

1. Due to persistently negative (public and political) attitudes towards the construction of new nuclear power plants in the Netherlands, the Ministry of Economic Affairs shifted its attention from nuclear research to other energy research programmes.
2. The secretariat of the licensing authorities was transferred from the Ministry of Economic Affairs to the Ministry of Housing, Spatial Planning and the Environment.

These changes, together with the practice of complete 10-yearly safety reviews at the NPPs, enabled the regulatory authorities to embark on a modernisation plan for the HFR and its licence.

Scope

The scope of work for this safety review was agreed in discussions between the regulatory body and both the licensee (JRC-Petten) and the operating organisation (NRG). Firstly, a new Reference Licensing Basis (RLB) needed to be established in order to produce a state-of-the-art yardstick for nuclear safety. Secondly, a Risk Scoping Study was to be conducted for the identification of technical weaknesses which might be overlooked by the deterministic comparison with the RLB. A new set of safety analyses was to be made on the basis of a more complete set of Postulated Initiating Events (PIEs), including the assessment of fire, flooding and seismic events as well as ageing. Following recommendations from the analyses, a new safety concept was to be established, as well as a modification programme to achieve this safety concept.

Reference Licensing Basis

To produce a yardstick by which to measure a research reactor built to a very early design against the state of the art in nuclear safety, a new RLB was agreed between the regulatory body and both the JRC-Petten and NRG. The IAEA Safety Standards and Guides issued specially for research reactors (IAEA Safety Series 35) were taken as a basis for this. Because the HFR is a large research reactor, applicable parts of the IAEA Safety Standard for the design of NPPs were also used as a basis.

Risk Scoping Study

Since a full-scale Probabilistic Safety Assessment (PSA) as conducted for an NPP was thought to be too costly for a research organisation, it was decided to undertake only a limited PSA (a so-called Risk Scoping Study). Also, a full scope PSA for the HFR was considered very complicated due to the lack of reliable data for component failure as well as for operator handling.

The objective was to ensure that no potential occurrences presenting a substantial risk to the public would be overlooked in the deterministic safety analyses performed in relation to the HFR. Both the current plant configuration using HEU fuel and the future plant configuration using LEU fuel and with planned modifications had to be assessed. Because the initial objective was mainly to identify weaknesses and not to provide figures, the scope of the PSA was confined to hazards associated with the core. Internal initiators, including flooding and fire within the plant, had to be selected to:

1. identify those initiating events and sequences which might contribute to core damage or unusual releases of radioactivity and to estimate the core damage frequency (level 1);
2. identify and assess the containment failure sequences and associated source terms (level 2);
3. assess the off-site consequences in terms of public health risks of these source terms (level 3).

The first level of the Risk Scoping Study was reviewed by an IAEA IPSART mission. The mission's comments and remarks led to an upgrade of the study. A second review followed in 2002 with the emphasis on level 2 and level 3.

An important part of the Risk Scoping Study was the assessment of internal flooding and fire. Both the design review concerning fire protection and the fire hazard analysis proved to be very useful. They identified not only the presence of many unnecessary combustibles (such as filing cabinets), in particular in the control room area, but also a lack of spatial separation between redundancies and a lack of fire detectors.

Safety Evaluation

An important task during this first 10-yearly periodic safety review was the identification of deficiencies with respect to the Technical, Operational, Personnel and Administrative (TOPA) requirements laid down in the RLB. This TOPA review revealed several deficiencies relating both to the particular institutional situation (the separation between licensee and operating organisation) and to habits that had developed over time. In particular, there was inadequate definition of the management tasks, responsibilities and competences of JRC and NRG with respect to the operation of the HFR, and of the interfaces between the two organisations. That is to say, the scope of licensee control over the operating organisation was insufficient, and there were also problems regarding the safety culture.

Another important issue was the need to improve operational feedback. There was a need to improve the systematic, periodic review of operating experience (including experiments and maintenance, health physics performance and training/retraining courses) and to ensure that the Reactor Safety Committee was involved in reviewing incidents.

Safety Analyses

On the basis of IAEA Safety Series 35, a set of comprehensive Postulated Initiating Events (PIEs) was established, incorporating all possible failure scenarios at the HFR, including LOCAs, loss of off-site power, start-up accidents and fuel channel blockage.

The large-break LOCA (guillotine break) was analysed as a beyond-design-basis accident (no conservatism as e.g. required by 10 CFR 50 appendix K). Different sets of PIEs were defined as a basis for thermo-hydraulic safety analyses or radiological analyses. In addition, both internal flooding and fire events and external events were analysed.

Assessment of Ageing

IAEA-TECDOC-792 "Management of research reactor ageing" was selected as a basis for the ageing evaluation, together with the relevant guidelines for NPPs. Three different studies were performed:

1. electrical components (cabling, wires and connectors);
2. civil structures and buildings, especially decay of concrete;
3. mechanical systems, structures and components.

Safety Concept and Modification Programme

The safety concept of the HFR is that the HFR must fulfil 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 waiting period has been introduced during which no credit for operator intervention must be taken. The safety analyses and Risk Scoping Study conducted with this safety concept in mind have produced a number of recommendations for improvements, most of which will be implemented as part of a modification programme following the award of the new licence. 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 permitted separately and was implemented in late 2003. This will be discussed below. The major features of the modification programme are:

- installation of additional vacuum breakers on the primary system;
- installation of Accident Pressure Equalisation lines;
- controlled use of pool water by installation of basin water injection valves and locking the convection flow valves;
- replacement of diesel driven decay heat removal pump by diverse electrical pump;
- modification of Emergency Power System logic;
- limitation of the portal crane movement inhibiting hoisting above reactor vessel during reactor operation;
- installation of a manual operated alternative shutdown system for ATWS events.

HEU-LEU Conversion

Shortly after this modernisation project was commenced, the licensee decided to convert to the use of Low Enriched Uranium (HEU) as fuel instead of High Enriched Uranium (HEU). This is in line with the worldwide move to abandon use of HEU for non-proliferation reasons. It was decided that the necessary work to obtain a licence for this conversion should coincide with the modernisation project. Consequently, all the relevant neutron-physics core calculations and all the safety analyses had to be done again on the basis of the new fuel.

Transfer of the licence from JRC to NRG

Influenced by an IAEA Safety Culture Review (INSARR mission), the licensee (JRC) announced during the discussions on the progress of the licence renewal process that it would like to see the licence transferred to the operating organisation (NRG). JRC would remain the owner but NRG would be given full responsibility. In addition, JRC would guarantee the continuation of the current research programme for the next three to four years, thereby guaranteeing a good financial basis. JRC would also remain the owner of the reactor, so providing a guarantee for its future decommissioning.

4. Safety culture problems

During the summer of 2001 the KFD was confronted with the fact that the HFR had been started up without notifying the regulatory body of the results of a non-destructive test carried out in accordance with ASME requirements on a known weld defect in the reactor vessel. Such notification was a prerequisite for start-up. As a result the KFD required the licensee to organise an independent review of safety culture. This review was held in the autumn of 2001. However, its quality proved to be very poor.

Towards the end of 2001, a whistle-blower made allegations that the operating organisation (NRG) was violating the Technical Specifications without informing the KFD, and was in some cases even covering up these violations. The whistle-blower informed not only the director of the KFD, but also the press and members of parliament. On the basis of this information, questions were asked in parliament. An in-depth investigation by the KFD showed that the facts were not as serious as suggested by the allegations but that there was a clear lack of safety culture. Several reasons could be identified. In particular:

- The amount of control exercised by the licensee (JRC) over the operating organisation (NRG) was insufficient. Only three to four staff members were involved in operational matters, even though NRG had been granted the right to exploit the reactor commercially without being given formal responsibility for safety (only under contract to the licensee).
- The managements of both JRC and NRG were mainly scientists, whilst the operators were technicians. This caused a severe lack of communication between the two groups.
- The plant's internal reactor safety committee was consulted only on a voluntary base. This meant that there was sometimes no consultation at all on matters that should have required it.

A few months later, two more events attracted media attention.

- Use of an improved ultra-sonic measurement technique showed that a defect in one of the welds of the core box of the reactor vessel seemed to be larger than in previous years. Via the whistle-blower, who was no longer an employee, the story reached the press and was reported as a serious crack in the reactor vessel. Despite the fact that an earlier assessment had demonstrated that the observed growth in the defect would not lead to a crack – or, worse, to a leak – public anxiety was aroused.
- The managing director of ECN (NRG's major stockholder) openly declared that he no longer could guarantee the safety of the reactor.

These two events, together with the adverse political interest attracted a few months previously, were the main reason why the Minister of Housing, Spatial Planning and the Environment (VROM) asked[6] JRC to shut down the reactor until:

- An external independent committee of safety culture experts had analysed the situation and advised on improvements and, as a consequence, adequate measures had been taken to prevent future mishaps.
- New measurements of the weld defects and analyses of these had shown decisively that the suspected growth was merely the result of using the new ultra-sonic technique.
- It was clear how long the integrity of the reactor vessel could be guaranteed.

Protests from the medical sector about a threatened shortage of medical radio-isotopes led to the conversion of this conditional closure into a temporary closure lasting one month. In the meantime, the IAEA was asked by the licensee to send in a peer review team to conduct a new and thorough assessment of safety culture (limited INSARR mission). Serco Assurance was asked to assess the weld defect.

The general findings of the IAEA-INSARR mission were positive, to mention:

- Nuclear safety is recognised as important to the organisation.
- Technical competence is strong, giving the organisation the capability to manage complex issues.
- People are dedicated and hardworking. Safety culture is recognised as fundamental to good safety performance.

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[6] Due to the supra-national status of JRC, there was no legal way to demand an immediate shut-down of the reactor. It could only be requested.

- Many employees within the organisation are motivated to work safely and care for the safety of others who work with them.
- During the review process there was excellent cooperation by people from all levels of the organisation.

Even so, the INSARR mission confirmed the safety culture problems. Some observations and recommendations made during the review were:

- Observation: Lack of a well-defined safety policy.

  Recommendations: Clearly define the safety mission, policy and goals of the organisations and ensure employee involvement in the development process.
- Observation: Some employees felt that production should sometimes take priority over safety.

  Recommendations: Safety should be a clearly integrated part of the business plan and a comprehensive safety culture training programme should be conducted for all employees.
- Observation: The operator did not have all the powers needed to run the reactor safely.

  Recommendations: Consider making NRG the licence holder.
- Observation: Accountability for safety was not clearly understood by all.

  Recommendations: Conduct an intensive safety campaign to explain the nature of safety culture, and that safety is a universal responsibility.
- Observation:
  - Lack of team support within the senior management group was reducing organisational effectiveness.
  - Complex organisational structures among different stakeholders had created difficulties in communication.
  - Difficulties between ECN and NRG senior management had resulted in several significant organisational changes.
  - Remoteness of JRC management from NRG decision-making on the day-to-day operation of the HFR.

  Recommendations:
  - Initiate facilitation among senior management groups across all stakeholders.
  - Maintain constant effort to facilitate communication between management and the workforce and so incorporate the results of senior management activities.

On the basis of these observed deficiencies, JRC and NRG embarked on a safety culture improvement programme. Safety culture training programmes were provided, and the European Commission decided that the NRG should become the licence holder, with JRC retaining ownership of the reactor and hence responsibility for its decommissioning.

Several months later (summer 2002) a TV programme by a national broadcasting company claimed that the HFR was displaying a number of technical deficiencies, including:

- Subsidence of the reactor pool;
- Decay of the concrete of the reactor pool;
- Leakage of the reactor pool;
- The possibility of a guillotine break in the lowest part of the cold leg of the primary circuit, leading to core uncover within 5 minutes; and even worse,

- The possibility that the reactor could explode like a nuclear bomb.

The programme also claimed that the staff and management of HFR had known since 1992 that such a break would lead to core uncover and that the KFD had never been informed about an internal study concerning the problem.

As a result of the broadcast, the Minister of Housing, Spatial Planning and the Environment had to answer questions in parliament and the KFD, assisted by several independent external consultants, had to conduct in-depth investigations of the allegations.

- **The subsidence of the reactor pool** referred to a mere 1 cm difference in height between opposite sides of the pool and proved to have been unchanged for the last 30 years. The conclusion was that there was no problem.
- **Decay of the concrete** could not be detected by joint in-depth investigations conducted by experts from Delft University of Technology and the KFD.
- **The small leakage of the pool liner** had been known and anticipated since the construction of the reactor. The water is collected by a special drain system and returned to the pool in a controlled manner. The leakage rate was found to be acceptable and within design limits.
- **A guillotine break in the lowest part of reactor inlet** would lead to flow reversal. During the TV programme, a physics professor claimed that this flow reversal could lead to the control rods being lifted again, leading to prompt criticality of a severity such that it could be considered as a nuclear explosion. The licensee and the operating organisation, supported by other professors specialising in reactor-physics, said that this was impossible. Even in the case of prompt criticality, the effects would be minimal. Following questions and motions in the Dutch parliament on this issue, it was decided to hold a scientific debate chaired by an internationally recognised independent expert. The conclusion of this debate was that a nuclear explosion could not occur at the HFR, although an accident of this kind (siphon effect) would lead to core uncover within 5 minutes. New large-break LOCA calculations confirmed that, due to the siphon effect, the reactor would be drained within 5 minutes. However, the installation of an extra vacuum breaker on the cold leg could easily prevent this scenario. Because the cold leg enters the reactor vessel near the top, installation of two redundant vacuum breakers on the vessel head would be an adequate precaution.

The conclusions of these in-depth investigations were communicated to parliament, together with a promise to install the extra vacuum breakers before the end of 2003. A special procedure under the Nuclear Energy Act was necessary to make it possible to install them before the new licence (see above) was validated.

5. Increased oversight by the KFD

All this media and parliamentary interest caused the regulatory body to pay increased attention to the HFR. Before 2000, almost all its attention had been absorbed by the Borssele and Dodewaard Nuclear Power Plants. On average, KFD inspectors visited the HFR only once every two months. This increased to once a week during the autumn of 2001 and even to once a day during the first half of 2002. In early 2003, the frequency of regulatory inspection declined to once every two weeks and that level has been maintained ever since.

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	^{o}C
ΔT over core	9-10	^{o}C

	HEU	LEU	dimension
Fuel enrichment	approx. 91	19.25-19.95	%
Number of fuel plates per element	23	20	
^{235}U-mass per fuel element	450	550	g
Uranium density	1.1	4.8	g/cm^3
Material fuel matrix	$U.Al_x$	U_3Si_2-Al	
Over reactivity	8.65	9.25	%
Negative reactivity value of total control rods	18.50	23.42	%
Shut-down margin of total control rods	9.85	14.02	%
Fuel temperature coefficient		-2	pcm/K
Moderator temperature coefficient		-13	pcm/K
Total temperature coefficient	-15	-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 1. 3D Cross section of reactor building

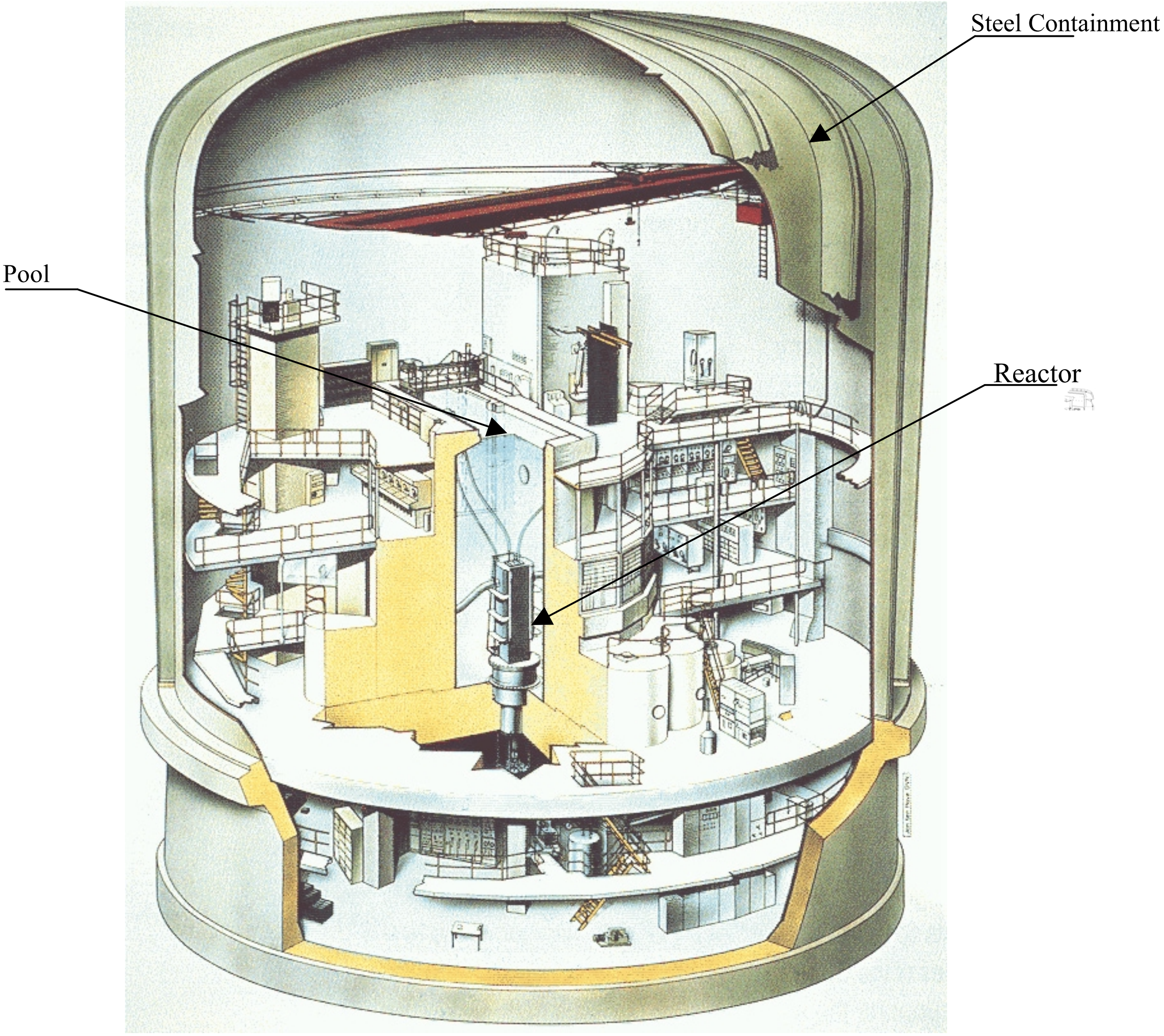

Figure 2. Reactor vessel in reactor pool

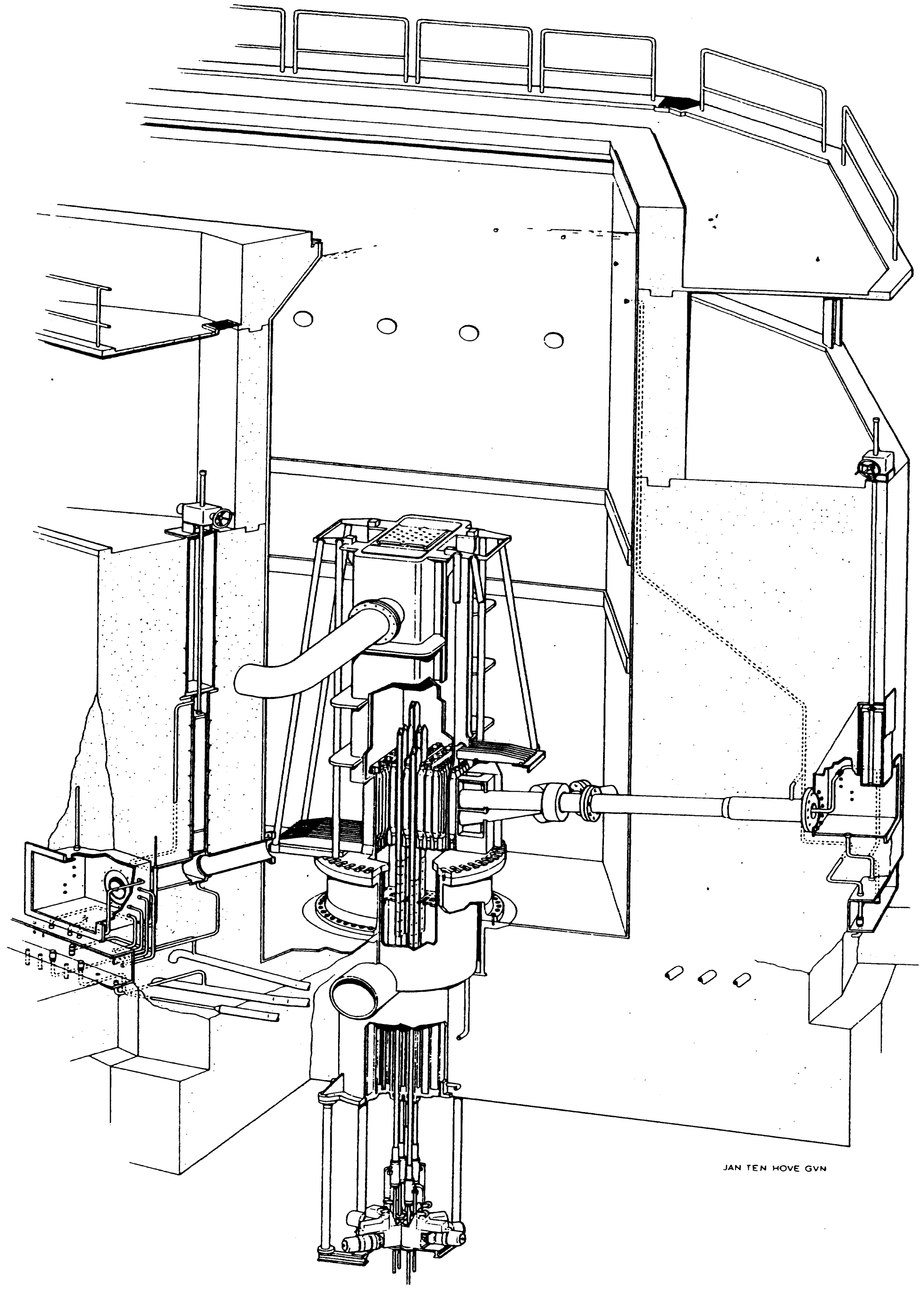

Figure 3. Schematic presentation of the primary, secondary en basin cooling system

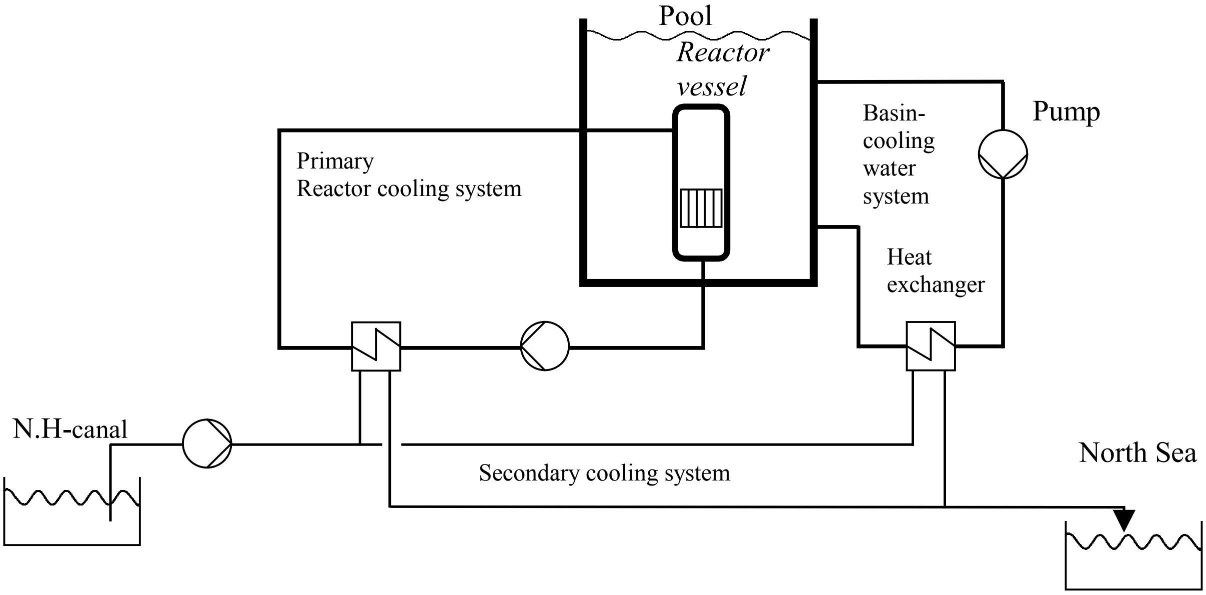

Figure 4. Cross-section of reactor pool and spent fuel storage pools

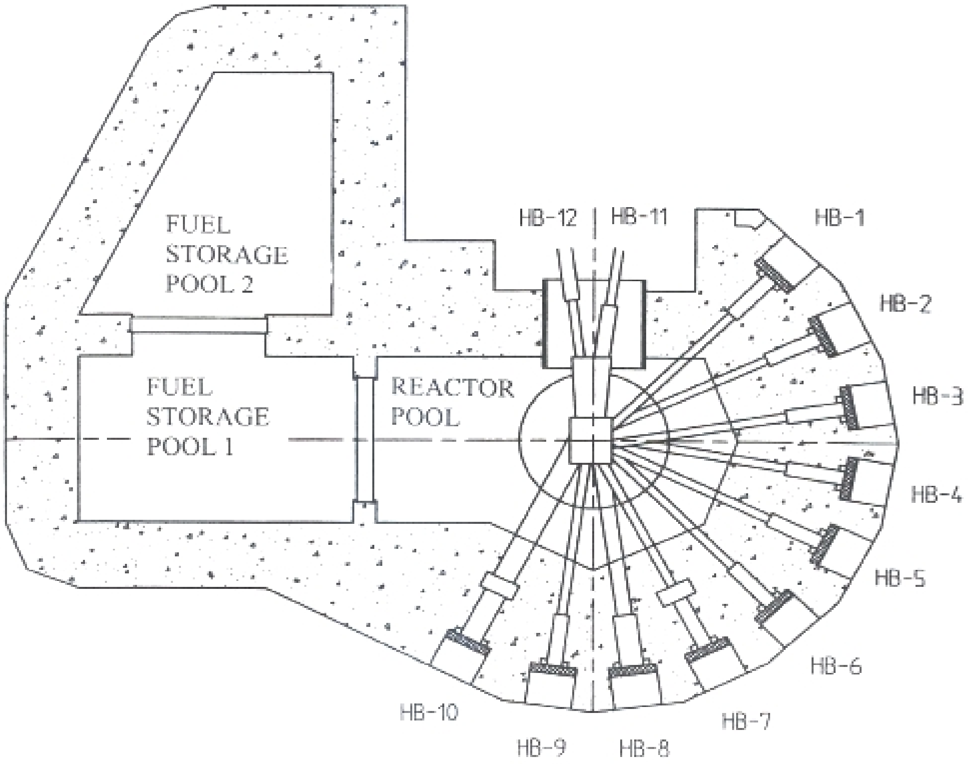

Figure 5. Process flow scheme of primary circuit (after modifications).