4th NATIONAL REPORT BY

SOUTH AFRICA

ON

THE INTERNATIONAL ATOMIC ENERGY AGENCY

CONVENTION ON NUCLEAR SAFETY

September 2007

TABLE OF CONTENTS

The numbering of the Articles of the Convention has been used
as the basis of the paragraph numbering system adopted in this report.

Page No

INTRODUCTION TO THE REPORT

This report provides an update of the South African activities in compliance with the Articles of the convention of nuclear safety since the last National Report was compiled in September 2004 and presented at the 3rd Convention Review Meeting in April 2005. Although duplication from the last report has been avoided as much as possible, it is inevitable that, for continuity in reporting, some reporting made in 2004 has been carried over. Furthermore each Article is preceded by a summary of the major changes made in the report since the last report compiled in September 2004.

In updating the report the following aspects were considered:

(i) Information to be provided from changes in the national situation such as changes in the legislative and regulatory framework, safety improvements implemented at the nuclear installations, etc. applicable to each article, which have occurred since the compilation of the 3rd South African National Report,

(ii) Information to be provided as requested from the 3rd Review Meeting of the CNS as contained in the observations of the summary report of the previous CNS review meeting,

(iii) Information to be provided stemming from comments and suggestions at the 3rd CNS Review Meeting on the 3rd South African National Report.

ARTICLE 6: EXISTING NUCLEAR INSTALLATIONS

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.

Summary of changes

(I) Section 6.2.1 has been rewritten to reflect the scope and findings of the WANO Peer Review conducted at the Nuclear Installatiosn in November 2006.

(iii) Editorial changes to sections 6.1, 6.3.1, 6.3.3, 6.3.5 and 6.4.

6.1 EXISTING NUCLEAR INSTALLATIONS

South Africa has one twin-reactor unit nuclear power plant (the nuclear installation) and this consists of:

Reactor PRIS code:	ZA-1
Reactor Name:	Koeberg Unit 1
Reactor Type:	PWR
Capacity MW (e) Net:	921
Capacity MW (e) Gross:	965
Operator:	Eskom
NSSS Supplier:	Framatome
Construction Start:	1976-07-01
First Criticality:	1984-03-14
Grid connection:	1984-04-04
Commercial Operation:	1984-07-21

Reactor PRIS Code:	ZA-2
Reactor Name:	Koeberg Unit 2
Reactor Type:	PWR
Capacity MW (e) Net:	921
Capacity MW (e) Gross:	965
Operator:	Eskom
NSSS Supplier:	Framatome
Construction Start:	1976-07-01
First Criticality:	1984-07-07
Grid Connection:	1984-07-25
Commercial Operation:	1985-11-09

Neither of the above nuclear installations was found, by assessment, to require any significant corrective actions under Articles 10 through 19 of this Convention. However safety improvements initiatives have been and still are being implemented at the nuclear installations indicated above since South Africa ratified the Convention in 1996 and its entry in force on 24 March 1997. These safety improvements initiatives are reported in the various Articles 6-19 of this report.

6.2 OVERVIEW AND MAIN RESULTS OF SAFETY ASSESSMENTS PERFORMED

6.2.1 WANO Peer Review

A World Association of Nuclear Operators (WANO) team, comprising experienced nuclear professionals from three WANO regions, conducted a peer review at the Koeberg Nuclear Power Station in November 2006. The purpose of the review was to determine strengths and areas in which improvements could be made in the operation, maintenance, and support of the nuclear units at the Koeberg Nuclear Power Station.

As a basis for the review, the team used the *Performance Objectives and Criteria for WANO Peer Reviews*; Revision 3 dated January 2005. These were applied and evaluated in light of the experience of team members and good practices within the industry.

The team spent 2 weeks in the field observing selected evolutions, including surveillance testing and normal plant activities.

The following was noted:

- WANO recognised that progress had been made since the last WANO review of 2004 but identified gaps in performance in several areas
- The utility has developed action plans to address the areas for improvement.

6.3 OVERVIEW OF PROGRAMMES AND MEASURES FOR SAFETY UPGRADES

6.3.1 The overall modification control process

One of the conditions of the nuclear installation licence (refer 9.1) granted to the nuclear installation, is that a valid plant description and configuration must be maintained and that a modification control process be in place to ensure that modifications to the installation are controlled in an acceptable manner.

Furthermore, it is also a condition of the nuclear installation licence that a valid and updated safety assessment, which must include a risk assessment, be maintained of the installation demonstrating continuing compliance to the safety criteria imposed by the NNR including dose and risk criteria as well as compliance to the conditions of the nuclear installation licence.

6.3.2 The licence holder's modification process

Modifications to the installation were implemented by the licensee from the design to the commissioning stages according to a well-structured and documented process. As part of this process, the impact of the modification on all the elements of the existing plant safety assessment, which forms an integral part of the nuclear installation licensing basis, must be evaluated e.g. design bases contained in the Safety Analysis Report, the plant General Operating Rules (Operating Technical Specifications (OTS), maintenance and inspection programme, operating principles etc.).This detailed safety assessment is summarised in a safety case, which must include a quantitative risk assessment to demonstrate that the installation, with the modification, still complies with the risk criteria of the NNR.

The modification package, which is subjected to a comprehensive review process, must also address all the required changes to the operating documentation of the installation e.g. OTS, operating procedures, maintenance programme, radiological protection programme etc.

6.3.3 The modification review / approval process of the Regulator

As an integral part of the licensee's modification control process, any modifications to the nuclear installation, that could affect the safety case, require prior approval by the Regulator before being implemented. The process to be followed by the licensee to meet the licensing requirements is detailed in a Licence Document, referenced in a condition of the nuclear installation licence. The process can be summarised as follows:

- Any such proposed modification is reported to the Regulator at the conceptual stage. A preliminary assessment of the effect of the modification on the current approved safety assessment is presented together with some preliminary information of the modification concept.

- Following its preliminary review of the modification concept, the Regulator indicates to the licensee whether a detailed safety case regarding the modification must be made for further regulatory review. If so, such a case must be made giving details of the design, expected performance and fitness-for-purpose of the system, sub-system or component.

- All the licence documentation affected by the modification must be identified in the modification package and the relevant changes must be submitted for review and approval by the Regulator, before final approval for implementation of the modification is given.

The review process of the Regulator mainly concentrates on ensuring that all aspects related to the licensing basis have been satisfactorily addressed in the licensee's submission.

6.3.4 Modifications implemented at the Nuclear Installation

Most of the modifications, which have resulted in safety improvements since 2004 fall within the scope of the Koeberg plant alignment to the French CP-1 nuclear power plants family resulting from the Koeberg Safety Re-assessment Project (refer Article 14). These modifications are reported under Article 18.

6.3.5 Periodic Safety Review of Nuclear Installations

The on-going process of modification control at the nuclear installation is being supplemented by 10 yearly Periodic Safety Re-assessments.
The status of the 1^{St} Safety Re-assessment, completed in 1998, is summarised under Article 14 of this report. The next periodic safety review is scheduled for 2008/2009.

6.4 REGULATORY POSITION

The readiness to identify, accept and undergo international peer reviews and evaluations is a clear indication of South Africa's commitment to nuclear safety.

ARTICLE 7: LEGISLATIVE AND REGULATORY FRAMEWORK

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

2. The legislative and regulatory framework shall provide for:

   (i) The establishment of applicable national safety requirements and regulations
   (ii) A system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence
   (iii) A system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences
   (iv) The enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation

Summary of changes

Changes to this Article from the last national report include the following:

Chapter 7.2 has been updated to include:

1) the publishing of the Regulations on Safety Standards and Regulatory practices-R388
2) the publishing of the National Radioactive Waste Management policy and strategy
3) the publishing of regulations on the keeping of a record of all persons in a nuclear accident defined area – R778
4) the publishing of regulations on the contents of the annual public report on the health and safety related to workers, the public and the environment - R716

No other changes were made, since the last report, to the legislative and regulatory framework governing the safety of nuclear installations in South Africa.

7.1 DESCRIPTION OF THE NATIONAL LEGISLATIVE AND REGULATORY FRAMEWORK

The South African Regulatory Body, the National Nuclear Regulator (NNR), was established by the National Nuclear Regulator Act (NNR Act) (Act No. 47 of 1999). The NNR Act came into force on 24 February 2000 and repealed the previous Nuclear Energy Act of 1993. The NNR Act regulates the construction and operation of nuclear installations as well as any other activity involving radioactive material which is capable of causing nuclear damage.

7.2 SUMMARY OF LAWS, REGULATIONS ETC. TO GOVERN THE SAFETY OF NUCLEAR INSTALLATIONS

The establishment, objects and functions of the NNR are encapsulated in chapter 2 of the NNR Act which covers, *inter alia*, its regulatory functions and the functionality of the National Nuclear Regulator. The Regulatory Body is considered in more detail under Article 8. Hereinafter, it is referred to as the NNR.

Those activities which require a nuclear authorization and conditions of authorization are contained in chapter 3 of the NNR Act.

Liability for nuclear damage and the provisions with regard to financial security are dealt with in chapter 4 of the NNR Act. Safety and emergency measures as well as the powers and duties of inspectors are embodied in chapter 5 of the NNR Act.

With regard to the regulation of nuclear installations, section 20 (1) of the NNR Act places a prohibition on the construction or use of a nuclear installation by any person except under the authority of a nuclear installation licence granted, as per section 21 of the NNR Act, to such person by the NNR on application.

Section 23 of the NNR Act empowers the NNR to impose such conditions as it deems necessary or desirable for the purpose of the safeguarding of persons and the environment against nuclear damage, when granting a nuclear installation licence.

In terms of section 36 of the NNR ACT, the NNR formulated national safety standards and regulatory practices which were recommended by the NNR Board to the Minister of Minerals and Energy. The Safety Standards and Regulatory Practices (SSRP) (regulations R 388) were published on 28 April 2006 and these regulations are being enforced on all nuclear authorizations holders in the country. These regulations are based on international safety standards and regulatory practices (more details on the scope and content of these regulations are provided in Article 9).

In order to ensure compliance with the conditions contained in the nuclear installation licence, the NNR Act provides for the appointment of inspectors. The provisions of the NNR Act confer the necessary authority and powers in order for the inspector to, *inter alia*, gain access to sites as well as to information and documentation. The provisions relating to inspectors are comprehensively set out in section 41 of the NNR Act.

Offences and the appropriate sanction for the commission of such offences are contained in the provisions of section 52 of the NNR Act.

The NNR may, in terms of the provisions of section 27 of the NNR Act, revoke a nuclear installation licence at any time. It is furthermore empowered to impose such conditions, as it deems necessary for preventing nuclear damage, upon the holder of the relevant nuclear installation licence, during his period of responsibility as defined.

Other regulations which were published by the Minister, in terms of the NNR Act, since the last South African report to the Convention include the following:

- In terms of section 37(3)(a) of the NNR Act, Regulations 778 on the keeping of a record of all persons in a nuclear accident defined area, were published in August 2006. These regulations require that when a nuclear accident has occurred and the regulator has defined the period and the area of the nuclear accident as contemplated in section 37(2)(b) of the Act the regulator must keep a record of each person who, according to its information, were within the area so defined at any time during the period so defined in the manner as specified in section 3 of the regulations.

- In terms of section 7(1)(j) of the NNR Act, Regulations 716 were published in July 2006, on the contents of the annual public report on the health and safety related to workers, the public and the environment related to all sites on which a nuclear installation is situated or on which any action which is capable of causing nuclear damage is carried out. These regulations require the regulator to submit within five months of the end of a financial year, to the executive authority, a public report on the health and safety related to workers, the public and the environment associated with all sites on which a nuclear installation is situated or on which any action which is capable of causing nuclear damage is carried out. The regulations also provide some aspects which must be included in the annual report

In terms of radioactive waste management the Department of Minerals and Energy (DME) achieved a significant step forward when Cabinet approved the National Radioactive Waste Management policy and strategy towards the end of 2005. The national radioactive waste management policy and strategy lays down options to be considered for managing radioactive waste (including high level waste) as well as the management of spent nuclear fuel.

As already stated in previous national reports the NNRA addresses and comprehensively complies with the provisions of Article 7 of the Convention on Nuclear Safety.

ARTICLE 8: REGULATORY BODY

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 fulfill its assigned responsibilities.

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

Summary of changes

The main changes to this article are as follow:

1. Chapter 8.3 has been updated to reflect the Regulator's initiatives related to organization staffing and capacity building initiatives.

2. Chapter 8.5 on the regulator's technical support by external organization has been updated

3. Chapter 8.6 related to the development of the Regulator's Quality Management System (QMS) has been updated

4. Chapter 8.7 provides information on the regulator self –assessment which was undertaken

5. Chapter 8.8 on Interfaces with government has been updated to reflect the progress in completing cooperative agreements with other organs of states

8.1 MANDATE, AUTHORITY, RESPONSIBILITIES, COMPETENCE, FINANCIAL AND HUMAN RESOURCES AND INDEPENDENCE OF THE REGULATORY BODY

The National Nuclear Regulator (NNR) is the regulatory body responsible for the safety of nuclear installations in South Africa.

The NNR, established as an independent juristic person by the NNR Act, is comprised of a Board, a Chief Executive Officer and staff. Its mandate and authority are conferred through sections 5 and 7 of this Act, setting out the objectives and functions of the NNR.

The NNR is mandated to provide for the protection of persons, property and the environment against nuclear damage. Its mandate is further strengthened by section 23 of the above mentioned Act which empowers it to impose any condition in a nuclear installation licence that it considers necessary for the purpose of achieving its objectives.

The independent authority of the NNR is also established by the NNR Act, subject to the extent that powers are conferred on the Minister of Minerals and Energy to appoint the governing non-executive Board of Directors (up to twelve Directors) of the NNR, together with its Chief Executive Officer. The NNR Act makes provision for a comprehensive appeal process. It should further be noted that the Act specifically forbids any representative of an authorization holder from being appointed as a Board Director

Essentially the powers of the NNR under the NNR Act embrace all those actions aimed at providing the public with confidence and assurance that the risks arising from the production of nuclear energy remain within acceptable safety limits. In practice, this has led to the NNR setting safety standards and regulatory practices including probabilistic risk limits and derived operational standards, conducting pro-active safety assessments, determining nuclear installation licence conditions and obtaining assurance of compliance with these.

The competence of the NNR is ensured through both its autonomous establishment and its funding provisions which consists of money appropriated by Parliament, fees paid to the regulator in respect of nuclear authorisations and donations or contributions received by the regulator

From the above-mentioned sections it is clear that the “de jure” independent status of the regulator is adequately provided for in the NNR Act.

With regard to the “de facto” independence of the regulator the following is noted. The NNR Act provides that if the Minister rejects a recommendation of the board, on the content of regulations to be published, the Minister and the Board must endeavor to resolve their disagreement. Although in the absence of resolution of such disagreement, the Minister has the power to make the final decision, de facto, no failure to resolve disagreement has thus far emerged regarding the relevant recommendations from the board as envisaged in sections 28, 29 (1) or (2), 36 (1) and 38 (4) of the NNR Act. The NNR operates independent from Government, to the extent that it is able to carry out its mandate without undue influence being brought upon it.

8.2 ORGANISATION OF THE REGULATORY BODY

8.2.1 The Structure of the Regulator

(i) The Board of Directors

The Executive of the NNR reports to a Board, which is appointed by the Minister of Minerals and Energy. The Board consists of up to twelve Directors including an official from the Department of Minerals and Energy, an official from the Department of Environmental Affairs and Tourism, a representative of organised labour, a representative of organised business, a representative of communities which may be affected by nuclear activities and up to seven other Directors who hold office for a period not exceeding three years, although they are eligible for re-appointment.

A person is disqualified from being appointed or remaining a director of the Board if he of she, *inter alia,* is a holder of a nuclear authorization or an employee of such holder

(ii) The Chief Executive Officer

The approved staff complement of the NNR is 86 but at August 2007 the complement comprises 73 staff members and is led by the Chief Executive Officer, who is appointed by the Minister of Minerals and Energy and is also a Director of the Board.

The Chief Executive Officer is the accounting officer of the Board and has the responsibility to ensure that the functions of the NNR are performed in accordance with the NNR Act and the Public Finance Management Act.

(iii) The Staff of the NNR

The NNR's organisational structure (figure 8.2.1) is constituted of the following core groups:

a) Assessment Group

The Assessment Group renders technical assessment functions to all the technical divisions.

b) Corporate Support Services

The division has two departments, covering the following functions:

- Human Resources and Administration
- Finance, Information Technology and Information services

c) Nuclear Technology and Natural Sources Division

The division has two departments, namely:

- Regulation of Natural Sources Programme
- Nuclear Technology and Waste Projects Programme

d) Power Reactor Division

The division has two departments, namely:

- Koeberg Programme
- Pebble Bed Modular Reactor (PBMR) Programme

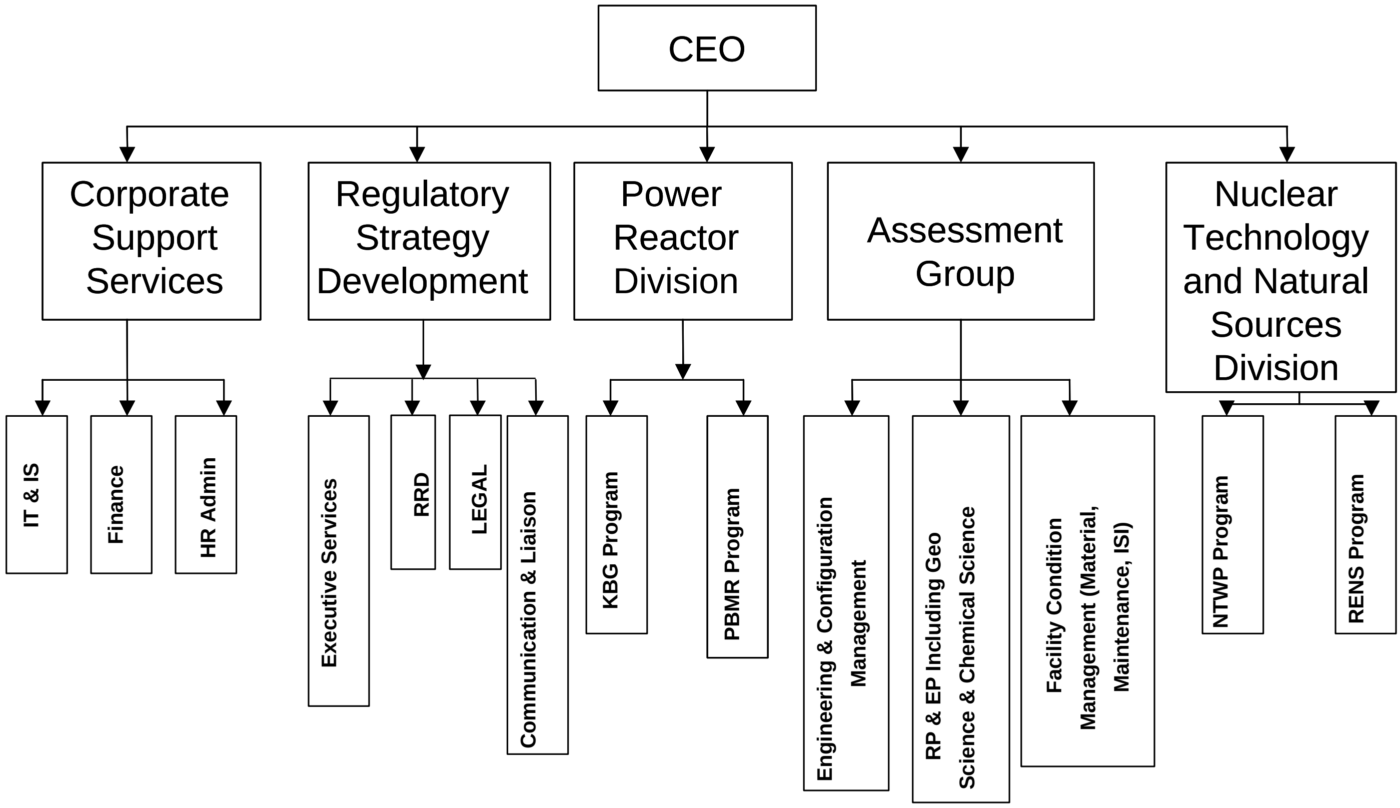
e) Regulatory Strategy Development Division

The division is comprised of a number of specialist services in the following areas:

- Executive services
- Legal services
- Communications and Liaison
- Developmental work in Standards and regulatory practices.

Figure 8.2-1

ORGANOGRAM OF THE EXECUTIVE STAFF OF THE NATIONAL NUCLEAR REGULATOR



8.3 MAINTAINING COMPETENT AND MOTIVATED STAFF

8.3.1 Organisation Staffing

The current staff level is at 73 and all efforts are made to fill various vacant posts. As an integral part of its transformation process the NNR is in the process of optimizing its organizational structure, including increasing its staff complement (mainly in the technical disciplines) to be better able to meet its legislative mandate to protect people, property and the environment. This optimization is near completion.

The NNR provides staff with organizationally funded training and development opportunities both nationally and internationally in order to assist them in keeping their skills updated. The NNR has been continuously updating its Performance Management system so that incentives can be provided to outstanding performers and thus motivate staff to achieve high quality standards

The NNR is challenged in sustaining an appropriate level of in-house technical capacity (engineers and scientists) to deliver on its core business. With the expanding nuclear programme in the country, as well as the safety optimisation of some existing ageing nuclear installations, this challenge will grow. The expanding nuclear programme, introduction of new technologies such as the PBMR and resurgence in uranium mining, brings with it increased competition for scarce skills.

As a matter of priority, the NNR has proactively engaged in strengthening its in-house capacity, identifying strategic initiatives that will enable it to develop the technical expertise of its human resources, and also enhancing its ability to attract and retain scarce talent.

In order to respond to the challenge outlined above, as part of its transformation programme the NNR has developed remuneration and performance management systems that in the short- to medium-term will allow the NNR to attract, develop and retain staff to maximise internal capacity. The NNR has also developed a retention strategy linked to performance management in order to retain key and critical skills within the organisation. Both systems will be fully implemented in the 2007/2008 financial year.

8.3.2 Capacity Building Initiatives

Some of the initiatives implemented to respond to the challenges mentioned above include the following:

(i) Staff Training and Development

The NNR continues to look for ways to train and develop staff to carry out its mandate successfully and regards training and development of staff in a very serious light. Priorities in allocating resources for training and development gave specific emphasis to the accelerated training of staff from the designated groups**.**

In an effort to achieve the training objective, for example, the NNR continued to send some of its employees to attend various courses in nuclear safety and radiation protection abroad and locally, through its participation in the Science and Technology Education Fund (STEF), a skills development and funding initiative, which has culminated in the establishment of a Joint Venture company called ARECSA Human Capital Pty (Ltd) between Necsa and AREVA. Necsa signed on behalf of the South African collective i.e. Necsa, NNR, ESKOM and the Pebble Bed Modular Reactor (PBMR) Company. The overall objective of ARECSA is to provide training in the Republic of personnel, students or other identified people in the field of nuclear, mining, and associated high technologies.

Internal capacity building initiatives for the PBMR Project

Furthermore more specifically for the PBMR technology the NNR has implemented a capacity building programme for its staff which includes a staff secondment programme at the Technical Support Organisations (TSOs), providing technical support to the NNR for the PBMR licensing (refer 8.5 below).

a) Amongst the aims of the secondment of TSO staff members to work in NNR offices are:

- to strengthen the capacity building process in presenting lectures on selected topics to prepare the NNR staff for the review of the PBMR safety case
- to do assessment work locally,
- to support the NNR at technical meetings with Eskom and PBMR (Pty) Ltd,
- to optimise the interface between the NNR and the consultants.

b) Amongst the aims of the secondment of NNR staff members to work in TSO offices are:

- to acquire skills with regards to computer codes applicable to the PBMR
- to acquire skills with regards to various technical topics
- to ensure in-house capacity building and skills transfer from the consultants to our specialists in the technical areas

Staff members of the NNR Assessment Group were seconded to the TSOs offices in Europe and typical elements of the associated work programmes consisted of:

- Short presentations on Gas Cooled reactor technology, specifically with reference to graphite technology
- Introduction to the work of the PBMR assessment teams – what each team does and the interactions between the teams and how this fits into the overall assessment process
- A series of attachments working alongside the TSO staff in the various computer code development and assessment areas, including (but not exclusively) neutronics, thermal hydraulics, structural assessment, containment performance and whole plant performance simulation.
- An attachment to one of the modeling/assessment teams to carry out a self-contained project that is informative for the secondee and of benefit to the modeling/ assessment team. Such projects would be to either improve or develop aspects of the modeling or to apply the models to carry out scoping and sensitivity studies. Such scoping and sensitivity studies are on particular aspects of the information presented so far in the SAR which are of interest to the assessment team.

The NNR will continue this training initiative on the PBMR which has proved valuable in terms of building the internal assessment capacity of the NNR on the PBMR.

(ii) Bursary scheme

In order to develop skills outside of the organisation in order to prepare the regulator for succession and replacement of departing expertise, the NNR continued to provide bursaries to students during the reporting period. All the bursaries were granted to students from the previously disadvantaged group.

(iii) Internship Programme

The NNR has implemented an internship scheme called **NYALUSO** (a Venda name for development). The main purpose of this programme is to provide interns with a nuclear energy safety regulation and protection-based learning experience that combines structured learning with on-the-job experience, thus integrating learning with real-life working experiences.

The programme helps interns to acquire the experience and skills they need to enter and duly participate in the labour market.

It is a programme that the National Nuclear Regulator uses to contribute to the creation of national skills pool in nuclear regulation and control matters in South Africa. The intern intake grew from 3 in 2003 to 10 in 2007; some of these interns having been offered permanent positions at the NNR. The interns cover areas of engineering, radiation protection, chemistry and physics. They have attended various local training programmes and been seconded to the internal Divisions of the NNR to gain practical regulatory experience.

8.4 REGULATORY STRATEGY

The NNR regulatory strategy which recognizes both deterministic and probabilistic principles for the regulatory control and the assessment and verification of safety of the nuclear installations is detailed in Chapter 14 “Assessment and Verification of Safety”.

8.5 TECHNICAL SUPPORT TO THE NNR BY EXTERNAL SUPPORT ORGANISATION (TSO)

As indicated above in Chapter 8.2 the technical safety assessment function of the NNR is carried out internally within the organization by the Assessment Group. The NNR is not supported by an external Technical Support Organisation (TSO) as is the case for example in some member states regulatory authorities.

However in some cases the NNR technical safety assessment staff does not have the required expertise or/and capacity to carry out specific safety assessments and for these cases the NNR contracts the support of consultants companies (both locally and internationally) to provide technical support. The NNR is very sensitive to the issue of conflict of interest and as such, in the selection process, request to be provided with the assurance and evidence that the companies are not connected with any other organizations e.g. licensees etc. which could result in a potential conflict of interest.

One major area in which the NNR is making use of international consultants for technical support is for the licensing activities of the prospective Pebble Bed Modular Reactor (PBMR) currently undertaken by the NNR.

Two international companies have been providing technical services to the NNR for the review of the PBMR safety submissions. Although as indicated above the NNR is building its internal capacity on the PBMR technology, it will still take many years to phase out the technical support from the TSOs and therefore their services will be retained for future technical support, and capacity building of the NNR, during the various stages of the PBMR licensing.

In addition the NNR has also access to wider technical support on other reactor technologies such as PWRs, from other regulatory authorities with whom the NNR has entered into bi-lateral agreements (refer 8.10 below).

8.6 QUALITY MANAGEMENT SYSTEM

The NNR has initiated a project to review its current internal processes with the objective of implementing a state of the art Quality Management System (QMS). In conducting this Project the NNR is taking cognizance of the IAEA guidelines for management systems as well as investigating the approaches and experiences of nuclear regulatory authorities of other countries such as those from the NERS regulators network.

Although the progress in developing the Quality Management System has been slower than initially anticipated the NNR has mapped the major processes on which the QMS will be developed and implemented. As part of this development the NNR has finalized an important documented process for the Development, Review, Approval, Issuance, Control and Revision of NNR Documents.

8.7 REGULATOR INTERNAL SELF-ASSESSMENT

As part of the need to ensure that the NNR employs international best practices in its processes, the NNR conducted a self assessment of its regulatory infrastructure and practices. This self-assessment was based on the International Atomic Energy Agency's Integrated Regulatory Review Service (IRRS) guidelines. Due to the extensive nature of the exercise, several phases were planned. Only Phase I of the assessment has been completed which focused mainly on the regulatory oversight of power reactors e.g. Koeberg Nuclear Power Station. In the next financial year, the self-assessment will be extended to the remaining areas of the NNR regulatory oversight. The review highlighted a few findings and observations and recommendations for improvements. These are mostly related to the need for consistency of practices and approaches across all divisions of the NNR and the need for clearer procedures for processes related to authorizations, enforcement, inspections, review plans, training/induction programmes. Implementation of the recommendations of the assessment will commence in the 2007/08 financial year.

8.8 INTERFACES WITH GOVERNMENT

Section 6 of the NNR Act requires co-operative governance agreements between the NNR and relevant government departments, with functions in respect of the monitoring and control of radioactive material or exposure to ionising radiation. These agreements are critical to the pursuance of the NNR's responsibilities in fulfilling its mandate as well as to avoid duplication of efforts in ensuring the effective monitoring and control of the nuclear hazard.

Agreements have been completed and/or progressed with several government departments with such functions.

8.9 INTERFACES WITH OTHER NATIONAL INSTITUTIONS

Within South Africa there are currently four organisations and one professional body with interests in the promotion and utilization of nuclear energy. The organisations are: Eskom Holdings Limited (the national electricity utility), the South African Nuclear Energy Corporation (Necsa), the PBMR (Pty) Ltd, the Nuclear Fuels Corporation (NUFCOR) and the professional body is the Institution of Nuclear Engineers (UK) (SA Branch).

Eskom Holdings Limited (the nuclear installation licence holder) owns and operates Koeberg (the nuclear installation), the only nuclear power station within South Africa. Eskom Holdings Limited is also responsible for identifying and investigating options for future power generation, including nuclear energy options. The decision to implement any options rests with Government, and will be consistent with South Africa's Energy Policy.

Necsa is a statutory body established by the Nuclear Energy Act and formally known as the Atomic Energy Corporation (AEC), whose mandate is essentially the development, promotion and commercial exploitation of nuclear and related technologies, management of radioactive waste and implementation of safeguards.

The PBMR (Pty) Ltd is the company involved in the development of the Pebble Bed Modular Reactor.

NUFCOR is a commercial company engaged in the final processing and marketing of uranium concentrates. It is a private South African company whose major shareholders consist of different mining entities involved in the mining and extraction of uranium.

The NNR is organisationally and functionally independent of these various bodies. Eskom Holdings Limited, Necsa and NUFCOR are all holders of authorisations issued by the NNR.

8.10 INTERNATIONAL C0-OPERATIONS

The NNR is a member of NERS (Network of Regulators of Countries with Small Nuclear Programmes) and as such, shares experiences, etc. associated with regulators of having a small nuclear programme.

The NNR has entered into several bi-lateral agreements with other nuclear safety authorities internationally such as the French ASN, the US NRC, the UK Health Safety Executive Nuclear Safety Directorate, the Argentinean (NBNR) etc...

These bilateral agreements provide for exchange of information on different aspects of nuclear safety, visits, exchange of personnel, training etc. and the agreement details differs for different regulators.

The NNR is also part of a group of regulators from countries in which nuclear power stations from Framatome design are operating. This forum is named FRAREG and comprises regulatory authorities of Belgium, China, France, South Korea and South Africa. This forum meets on an annual basis.

The NNR is also represented in the IAEA Safety Committees NUSSC, WASSC, TRANSSC and RASSC (main SA representation being from the Department of Health Directorate: Radiation Control)

8.11 COMMUNICATIONS AND OUTREACH INITIATIVES OF THE NATIONAL NUCLEAR REGULATOR

The NNR Act requires public participation in the authorisation processes .The NNR engages amongst other things in a wide range of processes to ensure meaningful public participation in its review of nuclear authorisation applications as well as to strengthen its communications, liaison and outreach initiatives.

In line with the NNR's communication strategy and its policy of openness and transparency, a number of processes are established. The thrust of processes are to develop and maintain an awareness of matters related to, nuclear, radiation, transport and radioactive waste safety amongst all its stakeholders.

A number of communication forums have been established independently by the NNR such as labour representative working in authorised facilities, communities living around licensed operations as well as Civil Society forums to ensure regular interactions. Communication with the general public is done through both written and electronic media, e.g. when announcing major NNR events etc. The NNR is also involved in the recently established Public Safety Information Forums established as a requirement by the NNR Act compelling holders of nuclear installation licences to establish communication forums with communities living around licensed facilities, in order to inform them about nuclear safety.

As required by section 7(j) of the NNR Act the NNR produce an annual public report on the health and safety related to workers, the public and the environment associated with all sites on which a nuclear installation is situated or on which any action which is capable of causing nuclear damage is carried out.

Furthrermore the NNR publishes its regulatory outcome activities in other publications including quarterly newsletters and other publications such as information brochures to all its stakeholders.
The South African legislative environment regarding open and proactive provision of information is governed by the Public Access to Information Act. The NNR complies with the provisions of this Act.

ARTICLE 9: RESPONSIBILITY OF THE LICENCE HOLDER

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

Summary of changes:

This Article has been substantially updated in sections 9.1 to provide details of the Regulations R388 on Safety Standards and Regulatory Practices (SSRP). The responsibilities of the licence holder, in meeting its responsibility for the safety of the nuclear installations as required by the legislation and associated regulations, are now discussed in 9.2.

9.1 DESCRIPTION OF THE MECHANISM BY WHICH THE REGULATORY BODY ENSURE THAT THE LICENCE HOLDER MEETS ITS PRIMARY RESPONSIBILITY FOR SAFETY

In terms of section 3.7.1 of the Regulations on Safety Standards and Regulatory Practices (SSRP) the holder of a nuclear authorisation is responsible for radiation protection and nuclear safety, including compliance with applicable requirements such as the preparation of the required safety assessments, programmes and procedures related to the design, construction, operation and decommissioning of facilities.

The NNR ensures that the licence holder meets its primary responsibility with regard to safety essentially by:

(i) the enforcement of the legislative requirements of the NNR Act
(ii) the establishment of nuclear Safety Standards and Regulatory Practices,
(iii) the granting of a nuclear installation licence and regulatory directives/letters and demonstration by the licence holder of compliance to the conditions of licence and:
(iv) by providing an independent assurance of compliance with the conditions of the nuclear installation licence through the implementation of a system of compliance inspections, the latter comprising inspections, surveillances and audits as well as various forums for interaction with the licensee.

These mechanisms are described in more detail in sections 9.1.1 – 9.1.4, 10.4, 10.5, 14.4 and 14.5.

9.1.1 Safety Standards and Regulatory Practices

Prior to the publishing of the Regulations (R388) on Safety Standards and Regulatory Practices (SSRP) in April 2006 (refer section 7.2 above) the NNR had established and enforced safety standards and regulatory practices (initially developed during the licensing phases of the Koeberg Nuclear Power Station in the late 1970's) against which any activity or undertaking, involving the use of radioactive material, and posing a radiological risk to the public and/or workforce, had to be assessed for authorisation, operation and decommissioning purposes.

The Safety Standards and Regulatory Practices in Regulations R388 are based on international safety standards and regulatory practices and are being enforced on all nuclear authorizations holders in the country.

Publication of the SSRP implied that the NNR nuclear authorizations and associated regulatory documents (referenced in the authorizations), including the requirement and guidance documents had to be revised in order to ensure alignment with the regulations. In this regard, the NNR developed an action plan that provided time-lines within which the regulatory documents were revised in order to ensure the alignment with the new SSRP.

The SSRP scope and content, as applicable to the regulatory control of nuclear installations, include the following:

(i) **Section 1** provides a list of definition of terms which are not specifically defined in the NNR Act.

(ii) **Section 2** provides some details of the various types of nuclear authorisations which are applicable to the various actions to be regulated. These include:

- **Exclusion of actions** – In this section criteria are indicated for actions to be excluded from regulatory control.
- **Exemption of actions** – In this section criteria are indicated for actions which will required to be issued with a certificate of exemption, by the NNR, in accordance with the NNR Act.
- **Registration of actions** – In this section criteria are indicated for actions which will require to be issued with a certificate of registration, by the NNR, in accordance with the NNR Act.
- **Licensing** – any nuclear installation or nuclear vessel must be subject to the process of licensing as contemplated in section 21, 23 and 24 of the NNR Act. This is the process applicable to the nuclear installations under review in this report.

- **Clearance** –In this section criteria are provided for the clearance of radioactive materials from further compliance with the nuclear authorizations.

(iii) **Section 3** provides details of the principal radiation protection and nuclear safety requirements which apply to actions authorized by , or seeking authorisation in terms of a nuclear installation licence, a nuclear vessel licence or a certificated of registration . These *inter alia* include the following:

- Radiation dose limits to members of the public and workforce arising from normal operations as specified in Annexure 2 of the Regulations
- Probabilistic risk limits addressing mortality risk to the public and workforce as specified in Annexure 3 of the Regulations.
- Optimisation of radiation protection and nuclear safety applying the As Low As Reasonably Achievable (ALARA) principle.
- The requirement for a prior safety assessment to ensure that measures to control the risk of nuclear damage to individuals must be determined on the basis of a prior safety assessment which is suitable and sufficient to identify all significant radiation hazards and to evaluate the nature and expected magnitude of the associated risks, with due regard to the dose and risk limits set out in Annexure 2 and 3 of the Regulations
- Requirement that installations, equipment or plant requiring a nuclear installation licence, a nuclear vessel licence or a certificate of registration and having an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice.
- Requirements for safety culture to be fostered and maintained
- Requirements for accident management, emergency planning, emergency preparedness and emergency response,
- Requirements to apply the principle of defence in depth
- Requirements for a Quality Management programme to ensure compliance with the conditions of the nuclear authorisation.

(iv) **Section 4** provides details of the requirements applicable to regulated actions which include the following

- Requirements for an operational safety assessment which must be must be made and submitted to the Regulator at intervals specified in the nuclear authorisation and which must be commensurate with the nature of the operation and the radiation risks involved. The operational safety assessment must establish the basis for all the operational safety-related programmes, limitations and design requirements.
- Requirements on control and limitations on operation such as the establishment, implementation and maintenance, where applicable, in terms of the safety assessment, of technical specifications. Such operating technical specifications must provide a link between the safety assessment and the operation.
- Requirements for the establishment and implementation of a maintenance and inspection programme.
- Requirements for adequate and qualified staffing.
- Requirements for the establishment and implementation of a radiation protection programme including the optimization of protection measures (application of ALARA principle), determination where applicable of dose constraints specific to the authorised action, determination of annual authorised discharge quantities from a single authorised action, implementation of a radiation dose limitation programme, establishment and maintenance of a health register and dose register.
- Requirements for the establishment and implementation of a radioactive waste management programme as well as an environmental monitoring and surveillance programme.
- Requirements for the transport of radioactive material.
- Requirements for physical security arrangements to be established, implemented and maintained.

- Requirements for a system of record keeping for all records required by the nuclear authorisation to be established, implemented and maintained.
- Requirements for the establishment and implementation of a programme for the monitoring of workers.

(v) **Section 5** provides details of the requirements for decommissioning which include: the requirements for a decommissioning strategy and planning, availability of resources, requirements for decommissioning operations, requirements for release of radioactively contaminated land and obligations under other statues related to decommissioning.

(vi) **Section 6** provides details related to accidents, incidents and emergencies which include: criteria for the definition of a nuclear incident and accident, information to be supplied in case of a nuclear incident or an accident, and emergency or remedial measures.

These safety standards refer directly to the basic concerns of nuclear safety, namely radiological risk to the public and plant personnel and are also intended to imply protection of the environment against radiological risk.

9.1.2 Nuclear Installation Licence

The implementation of the requirements of the NNR Act and those of the SSRP is carried out through the setting of conditions in the nuclear authorizations, e.g. for Koeberg Nuclear Power Station nuclear installation licence NL-1, established by the NNR, in terms of section 23 of the NNR Act, and where appropriate expanded further in regulatory documentation e.g. regulatory requirements or/and regulatory guides, as integrated in the conditions of the nuclear installation licence.

For the Koeberg NL-1 nuclear installation licence the specific conditions applicable to the nuclear installation relate to the plant, the site and environs, the licensee organization and processes, and safety related documentation. These conditions essentially amount to three types, namely, for

(i) the documented safety case including the operational safety assessment and supporting documentation as well as all the operational safety-related programmes, limitations and design requirements which are based on the operational safety assessment

(ii) implementation of compliance assurance related processes, and

(iii) reporting requirements.

9.1.2.1 Documented safety case

The nuclear installation licence requires the licence holder to develop and maintain a documented safety case which demonstrates compliance with the requirements specified in the NNR Act and the SSRP, and which includes as a minimum the following:

- Detailed plant description and site description
- Scope of activities that may be undertaken
- Specifications of all systems, structures components
- Design requirements
- On-site and off-site environmental factors or components relevant to nuclear safety
- The plant operational safety assessment including associated nuclear safety rules, criteria, standards and requirements relevant to the safety assessment
- In support of the plant operational safety assessment, the safety analyses documentation addressing rules, computer codes, models, methodology, input data, analyses, results and conclusions demonstrating compliance with the nuclear safety standards which *inter alia* must demonstrate compliance with the radiation dose limits specified in the SSRP (refer 9.1.1)
- A probabilistic risk assessment to be carried out in accordance with the NNR requirements on risk assessment specified in the condition of the nuclear installation licence, to demonstrate compliance with the probabilistic risk criteria specified in the SSRP (refer 9.1.1)
- Operational safety-related programmes and limitations of operation
- Plant management documentation (i.e. management manual)

- Documented evidence of compliance with all quality objectives relevant to nuclear safety
- Technical bases of the operational safety-related programmes and limitations of operation.

The Koeberg nuclear installation licence includes a requirement that the safety case itself shall be subject to ongoing review and periodic safety reassessment using an internationally accepted reference as a benchmark.

Proposed modifications to the plant or changes to documentation referenced in the licence, with impact on nuclear safety, must be submitted to the NNR for approval prior to implementation along with a prior safety assessment of the impact of the modification on the plant operational safety assessment (refer to the SSRP section 9.1.1 above) including a risk assessment where applicable.

9.1.2.2 Operational safety related programmes - General operating rules

The operational safety related programmes (referred to as General Operating Rules –GORs) are based on the prior and operational safety assessments such that the validity of the safety case is subject to the provisions and undertakings referred to or assumed in the safety case actually being implemented on an ongoing basis through the operational safety related programmes which, in line with section 4 of the SSRP (refer 9.1.1 above), cover the following

- Programme for compliance with the dose & risk limits
- Programme for optimization of radiation protection and nuclear safety applying the As Low As Reasonably Achievable (ALARA) principle.
- Programme for conducting safety assessments (prior and operational)
- Programme to ensure that the nuclear installations are built and operated according to good engineering practices
- Programme to foster and maintained a safety culture
- Programmes for accident management and emergency planning, preparedness & response

- Programme for the application of the defence in depth principle during the design and operational phases of the installation
- Quality management programme
- Controls and limitations on operation
- Maintenance and inspection programme
- Staffing and qualification programme
- Radiation protection programme
- Radioactive Waste management programme
- Environmental monitoring and surveillance programme
- Programme for the transport of radioactive material
- Physical security arrangements
- System of records & reports
- Programme for the monitoring of workers
- Decommissioning programme
- Provisions for accidents, incidents and emergencies

The licensee is required to ensure that all operational safety-related programmes are procedurised and implemented accordingly.

9.1.2.3 Compliance Reporting

In addition to the technical assessment reports referred to above, the nuclear installation licence holder is required, by the NNR Act & the SSRP regulations (R388) and through a condition of the licence, to make available reports and other information to the NNR. These include the following:

- Incidents & accidents are required to be reported in terms of section 37 of the NNR Act and in terms of section 4.10.2 of the SSRP
- In terms of section 4.10.2 of the SSRP operational reports must be submitted to the NNR at predetermined periods and must contain such information as the NNR may require on the basis of the safety assessments.

These reports include:

- o Problem notification, occurrence, quality assurance and audit reports, including close-out reports
- o Environmental monitoring reports
- o Reports on gaseous and liquid effluents from the plant
- o Medical and psychometric testing reports
- o Fuel performance reports
- o Specific Reload Safety Evaluation Reports
- o In-service inspection reports
- o Six monthly Licensing Basis compliance report

9.1.3 NNR Compliance Assurance Process

The Koeberg Programme of the NNR, based near the Koeberg site, comprises four regulatory officers, three operator examiners/operations compliance assessors, and two Process Coordinators. Apart from technical assessment of submissions from the licensee, the main responsibility of this department is to provide assurance that the licensee complies with the conditions of the nuclear installation licence. The NNR compliance assurance programme is described further in section 14.5.

The various monitoring processes implemented by the NNR include, *inter alia*, the following:

1. Inspections and audits conducted in terms of the compliance inspection programme.

2. Technical assessments conducted on submissions by the licensee, mainly for modifications.

3. Reports submitted by the licensee in terms of licence compliance.

4. The licensee safety indicators (performance and safety indicators).

5. Periodic reviews or other proactive assessments conducted by the NNR (including international experience feedback).

9.1.4 NNR/licensee interaction

The NNR has established various regulatory forums with the licensee, at different organisational levels from operational to strategic executive management, at which the findings of the compliance assurance activities (inspections, surveillances, audits) described above and any other nuclear safety issues are tabled, monitored and followed up

9.2 DESCRIPTION OF THE MAIN RESPONSIBILITIES OF THE NUCLEAR INSTALLATION LICENCE HOLDER

As reported above in 9.1 in terms of section 3.7.1 of the Regulations (R388) on Safety Standards and Regulatory Practices (SSRP) the holder of a nuclear authorisation is responsible for radiation protection and nuclear safety, including compliance with applicable requirements such as the preparation of the required safety assessments, programmes and procedures related to the design, construction, operation and decommissioning of facilities.

9.2.1 The NNR Act places some responsibilities on a nuclear installation licence holder which *inter alia* include the following:

(i) Strict liability for any nuclear damage caused by his/her facility or activities.

(ii) Compliance with Regulations (R 388) on Safety Standards and Regulatory Practices

(iii) Compliance with all conditions of a nuclear authorization issued by the NNR and implementation of an inspection programme to ensure such compliance.

(iv) Provision of any information or monthly return as required by the NNR.

(v) Establishment of a public safety information forum to inform persons, living in the municipal area in respect of which an emergency plan has been established, on nuclear safety and radiation safety matters. .

9.2.2 In terms of the nuclear installation licence granted by the NNR, the licence holder's responsibilities are:

(a) To operate the nuclear installation within the design and configuration descriptions set out in the licence.
(b) To conform to the approved fuel designs and performance criteria.
(c) To comply with provisions and processes regarding the control of plant design and configuration.
(d) To comply with provisions and processes in terms of modifications made to the plant or any other change which may impact on the management of or risk due to severe accidents.
(e) To regularly assess safety, including carrying out a probabilistic risk analysis.
(f) To demonstrate compliance with the safety criteria of the NNR by risk assessment.
(g) To respect the limitations of activities pertaining to transport and storage of fuel, handling and loading of fuel, operation of the reactor units, processing of material through solid, gaseous and liquid waste processes and disposal methods.
(h) To control fabricated isotopes for use at the nuclear installations.
(i) To control and limit operation in accordance with an approved Operating Technical Specifications (OTS) document and procedures approved by the NNR.
(j) To adhere to controls on the training, qualification, re-qualification and conduct of licensed operators and candidates.
(k) To provide and control medical and psychological surveillance of licensed operators and candidates.
(l) To conduct in-service inspection of components in accordance with the approved standards and programmes.

(m) To maintain and monitor the installation in accordance with a plant condition monitoring programme as approved by the NNR.

(n) To inspect, survey, test and monitor the containment structures, aseismic bearings (upper and lower raft) and soil cement sub-foundations in accordance with programmes and procedures approved by the NNR.

(o) To establish, maintain and implement an operational radiation protection programme to the satisfaction of the NNR covering inter alia:

i) Radiation dose limitation to persons on site and the public;

ii) A radiation protection organisation structured and staffed to fulfill all the requirements of the NNR;

iii) Production of adequate radiation protection standards, procedures and documentation to cover all aspects to the satisfaction of the NNR;

iv) Maintenance of health and radiation dose registers to the standards of the NNR.

(p) To provide an environmental monitoring programme including a meteorological component to the standards of the NNR.

(q) To comply with provisions relating to the control and discharge of radioactive material in liquid and gaseous effluent.

(r) To comply with the provisions with regards to the generation, processing and disposal of radioactive waste.

(s) To establish, maintain in a state of preparedness and conduct regular reviews and audits of an emergency plan approved by the NNR for on and off-site use.

(t) To provide for the management of severe accidents and mitigative measures to be taken as a result of these in accordance with procedures approved by the NNR.

(u) To adhere to the IAEA Regulations for the safe transport of radioactive materials for transport off-site of radioactive materials and/or contaminated items.

(v) To establish, maintain and operate physical security measures to meet the requirements of the NNR.

(w) To apply Quality Management to all activities embodied in the scope of the nuclear installation licence.

(x) To obtain written prior approval from the NNR for:

i) Movement of fuel in or out of the reactor cores;

ii) Approach to criticality after a refueling outage or shutdown caused by or consequent upon an accident;

iii) Specific reload core designs for each reload

(y) To submit reports in a manner and at a frequency approved by the NNR. These include, but are not restricted to:

a) Accounting and records for fuel inventories, balances, movements and changes;

b) Civil monitoring test reports;

c) Occurrence notifications for incidents, events and quality deficiencies.

(z) To ensure that, notwithstanding the provisions of the nuclear installation licence conditions, the licensee shall not permit any part of the installation to be modified or any procedure to be amended which could increase the risk of nuclear damage, without the prior approval of the NNR.

In terms of the above a distinction can be made between two fundamental types of licensing approaches: a prescriptive licensing approach and a more process-based one.

A prescriptive licence is one which imposes detailed technical requirements relating to nuclear safety. From the NNR regulatory experience the drawbacks are that this approach places the onus on the regulator to identify such requirements and places an unnecessary administrative burden on both the regulator and the licensee in terms of change control and formal licence deviations, which have no real safety significance.

A process-based licence on the other hand would place requirements on the licensee's processes thereby placing the responsibility for technical details with the licensee. The regulator would then monitor the implementation of these processes through its own compliance assurance processes. This would tend to resolve the drawbacks of the prescriptive approach, but implies considerable confidence in the licensee’s processes.

The approach for the regulatory oversight of Koeberg is a combination of these two approaches:

The Regulations R388 on SSRP (refer 9.1.1) places some prescriptive radiation and nuclear safety requirements on the holders and prospective applicants of nuclear authorisations. As indicated above the mean to ensure the implementation of these safety requirements is carried out through the setting of conditions in the nuclear authorization, and the implementation of a compliance assurance inspections programme to ensure compliance to these safety requirements.

The NNR put forward a set of licence conditions (refer 9.1.2). The responsibility was then put on the licensee, Eskom, to produce the necessary processes and documentation within the framework of the conditions of licence to ensure compliance with the safety requirements.

The strategy followed by Eskom was to develop a document called the “Koeberg Licensing Basis Manual” (KLBM) which would include all relevant change control processes for modifications, waivers, procedure changes, etc, and serve as a “roadmap” of the overall safety case for Koeberg including:

- Eskom policies relating to nuclear safety.
- Statutory requirements.
- Nuclear safety criteria, codes and standards.
- Documented processes/procedures to meet these safety standards.
- Monitoring of compliance with safety requirements, including reports to NNR.

The KLBM is an integral part of all the conditions of the Koeberg nuclear installation licence and details the complete set of nuclear safety requirements for Koeberg, the principal safety documentation that demonstrates compliance with these requirements, and all nuclear safety related practices and programmes. This document defines the licensing basis and gives the key mandatory nuclear safety documents that must be complied with to control and demonstrate the nuclear safety of Koeberg. Provisions are also included to cover submission of safety cases, reports and communication standards. Interfaces with the NNR and the establishment of a process to ensure all regulatory requirements are made known, understood and complied with by all applicable personnel at the nuclear installation are also included.

In this manner the responsibilities, accountabilities and assurance mechanisms for the nuclear installation licence are documented and incorporated into an approved process with independent assurance that the nuclear installation licence requirements are complied with and that the ultimate responsibility for radiation protection and nuclear safety rests with the licensee.

ARTICLE 10: PRIORITY TO SAFETY

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.

Summary of changes:

1. The main change to this article was on Safety Culture 10.2 which has been updated

10.1 ESTABLISHMENT AND IMPLEMENTATION OF SAFETY PRINCIPLES

10.1.1 Safety Policies

Nuclear safety policy is addressed at three levels namely the national government, the national nuclear regulator NNR and the operating utility as licence holder.

10.1.1.1 National Policy

At national level the policy to ensure the safety of nuclear installation is addressed in the legislation and associated regulations which have been extensively covered under Articles 7, 8 and 9 above.

10.1.1.2 Policy of the regulator

At the level of the regulator, the policy to ensure the safety of nuclear installation is addressed in the legislation, and associated regulations which have been extensively covered under Articles 7, 8 and 9 above.

10.1.1.3 Policy of the Licence Holder

Within South Africa, Eskom is the major national electricity generator owning and operating the only nuclear power station currently in the country. The company has adopted a corporate policy on nuclear safety and the nuclear generation Portfolio within the company has also developed a policy to comply with all its safety obligations.

At the corporate level a policy has been developed which has been set down in a corporate directive (reference 8). The directive commits to compliance with regulatory requirements and openness to inspection by the NNR and international peer review groups. Good engineering practice is employed in the design and operation of nuclear installations and in any modifications to them, with a thorough root cause analysis of failures or operational anomalies. It undertakes to maintain a valid safety case for operation of its nuclear installation and to feature quantitative risk assessment as a component of the safety case. The necessary technical support is provided and a cadre of competent staff is maintained in all relevant discipline areas. A competent informed management structure is provided with the necessary mechanisms of quality assurance. Radiation doses are maintained as low as reasonably achievable and dose limits are respected. Emergency plans to mitigate the effects of potential accidents are maintained in a state of preparedness. Information exchange and feedback of international operating experience are employed and all relevant aspects of operation are appropriately documented.

Within the generation department of the utility, a policy statement has been drawn up committing to managing the nuclear installation in line with national regulatory and corporate requirements and respecting IAEA standards for quality management. The policy requires that functional responsibilities will be assigned and that all employees should have a clear understanding of their responsibilities, the expectations from them and the potential impacts of their function. This policy is manifested in obligations to meet job requirements, to have systems of error prevention and corrective action, a performance standard of zero deviation and a systematic improvement process.

The scope of activities that the utility is authorised to undertake is specified in the nuclear installation licence, together with plant technical specifications and operational programmes it is obliged to implement. The regulations R388 on the SSRP as well as the nuclear installation licence also details the reports that must be made by the licensee to the NNR.

10.1.2 National Safety Standards and Regulatory Practices

The Safety Standards and Regulatory Practices have been extensively covered above in Articles 7 and 9

10.2 SAFETY CULTURE

One of the principal radiation protection and nuclear safety requirements of the SSRP (refer 9.1.1) in section 3.5 requires that a safety culture must be fostered and maintained at the nuclear installations to encourage a questioning and learning attitude to radiation protection and nuclear safety and to discourage complacency.

10.2.1 Safety Culture Programmes at the nuclear installation

The NNR was involved at an early stage in the development of safety culture programmes as part of the teams formed by the IAEA to progress the International Nuclear Safety Advisory Group INSAG-4 and the Assessment of Safety Culture in Organizations Team (ASCOT) guidelines. Since 1991 this involvement has continued and NNR assistance in IAEA safety culture missions, workshops and assistance programmes has allowed the regulatory activities at the nuclear installation to benefit accordingly and to be suitably enhanced.

The licence holder has also provided staff to participate in international safety culture activities and in 1992 the installation embarked on a safety culture evaluation exercise covering corporate and installation staff. It consisted of interviews using a questionnaire based on the INSAG-4 publication, which was adapted and supplemented to suit the nuclear installation environment. This was an in-house exercise, which although fairly rudimentary in its execution, yielded worthwhile results.

The recommendations from this exercise were made known throughout the nuclear installation and the NNR was actively involved in its follow-up. As a result of the overall success of this evaluation, the licence holder was encouraged by the NNR to pursue the close-out of the survey findings and to continue safety culture climate surveys at the nuclear installation.

The licence holder, with involvement of the NNR, developed a revised safety culture survey tool based on the IAEA INSAG-4 publication, the Institute for Nuclear Power Operators (INPO) INPO TECDOC-1329 and the INPO Principles for Strong Nuclear Safety Culture. A survey was conducted in 2006 involving 643 utility personnel and 382 contracting staff. The results of the survey and the recommendations were shared openly with the installation staff and the NNR.

10.2.2 Safety Culture Monitoring and Feedback

To aid in identifying underlying trends of safety culture, the NNR and the licence holder independently carry out analyses of occurrences from outage work and other activities. The results of these analyses are presented in graphical format for departments and groups and discussed with installation staff at safety improvement sessions and safety culture promotions. In this way, lessons learned from the nuclear installation and from nuclear installations worldwide can be communicated to the relevant staff at the nuclear installation.

Presentations have been given by the NNR to the nuclear installation staff on safety culture topics and the licence holder convenes periodic nuclear safety awareness seminars, which are attended by all staff and include many safety presentations, videos and discussion groups covering a wide range of nuclear safety matters, including safety culture.

Initiatives taken by the NNR and the licence holder to enhance safety culture have included the following:

(i) Establishing dialogue with worker representatives and Trade Unions of safety issues.
(ii) Promoting meetings and visits involving public and local authorities.
(iii) Improving visibility and accessibility of managers to workers.
(iv) Improving NNR/Eskom communications – NNR project concept introduced
(v) SIMON – Safe Intelligent Motivated Observant Nuclear Professional recognition system is in place.
(vi) Regular safety culture and Human Performance newsletters.
(vii) Permanent psychologist on-site.
(viii) Rewards system for recognition of safety issues.

(ix) Nuclear Safety Concern process.

(x) Human Performance drive.

(xi) Outage safety focus and dedicated safety plan.

(xii) A Safety Engineer function supporting operating shift and providing oversight to the stations safety bodies.

The principle that safety is the overriding priority is clearly stated in nuclear installation directives on the responsibility and accountability for nuclear safety. However, the ever-pressing demands for production and cost savings can influence individuals to tolerate potentially unacceptable conditions. As indicated above in Article 9, the NNR has moved to a more process-orientated licensing approach, which demands increased discipline and safety culture from staff of the nuclear installation and increased vigilance from the NNR to detect incipient weaknesses of any deterioration of safety commitment.

10.3 OPERATOR TRAINING AND EXAMINATION

One of the safety requirements of the SSRP (refer 9.1.1) in section 4.4 requires that an adequate number of competent, qualified and trained staff must be responsible for carrying out the functions associated with radiation protection and nuclear safety and for maintaining an appropriate safety culture.

The competence of operating staff and the regulatory measures that are in place are key elements that contribute to ensuring the safe operation of the nuclear installations

Condition 4 “ Controls and limitations on operation” of the nuclear installation licence for the Koeberg Nuclear Power Station places some prescriptive requirements on the control and operations of the reactors which can only be carried out by reactors and senior reactors operators licensed by the regulator.

10.3.1 Operator training enhancement programme at Koeberg

As reported in previous National Reports to the Convention an Operator Enhancement Programme (OEP) was implemented at the Koeberg Nuclear Power station which was followed by an international peer review of operator training.

These initiatives resulted in some improvement to the overall operator training programme at the nuclear installation which included the following:

- A Koeberg Training Manager position was introduced, reporting directly to the PSM. A senior INPO training manager occupied this position for a two year period.
- A nuclear cadet programme was introduced to address the problem of staff shortage at the non-licensed operator level.
- A Systematic Approach to Training (SAT) project was initiated to redefine the operator training needs and ensure that the training process and material were appropriate.
- Additional contract instructors were employed by Koeberg to provide the specialist resources needed to implement an improved training programme.
- Initiation of a project to prepare for and achieve international accreditation of operator training (INPO).

10.3.2 Licensing or reactors operators

In terms of the licensing of reactors and senior operators at Koeberg the NNR regulatory approach is based on that of the USNRC approach and as such a review of all aspects of the operator licensing process was undertaken using the USNRC NUREG-1021 operator evaluation methodology as a benchmark.

This review identified several recommendations which resulted in the development of a new operator initial licensing examination process based on

NUREG-1021. Under the new process, the power station develops an exam plan, develops the exams and administers certain aspects of the exams. The NNR reviews and approves the exam material, performs an oversight role during the exam preparation, approves the exam outcomes and issues licenses accordingly. The Koeberg standard and procedure governing the new process was approved by the NNR and changes are subject to prior NNR approval.

Since introduction, the new licensing process has been successfully applied to both Reactor Operators (ROs) and Senior Reactor Operators (SROs) licensing groups. Some further minor improvements have since been made to the process to further clarify and improve application of the process.

The clarification of standards associated with the licensing exam process has helped to improve the preparation of candidates and the predictability of licensing results has improved significantly. The newly defined competencies for initial licensing have also positively impacted on the re-qualification training of licensed operators.

10.3.3 Implementation of System Approach to Training (SAT)

All operators training material has been redesigned and the administrative training procedures have been rewritten to reflect the requirements and processes of the SAT-based training process. The implementation of SAT has been extended to all areas of technical training at Koeberg.

10.3.4 Operating simulator upgrade

A major project that includes new hardware, operating system and selected software models (core, reactor coolant system and steam generator models) was completed in 2004. The simulator upgrade project addresses many of the previous simulator deficiencies which compromised operator training to varying extents. The new reactor coolant system model extends the scope of simulation beyond its previous limits, covering reduced inventory operations, drain-down and refilling, and extends capability into areas of core damage during accidents that were previously not available.

10.3.5 Accreditation of operator training

At the end of 2003, Koeberg was successful in achieving accreditation for its entire operator training programmes with the USA-based Institute of Nuclear Power Operators (INPO). Koeberg has been the first nuclear power station outside of the USA to achieve this accreditation. The ongoing assessment and periodic re-accreditation provides a high level of assurance that the quality of operator training will be maintained at an international best practice level.

The South African Qualifications Authority SAQA has also independently accredited operator training at Koeberg in accordance with national requirements and standards.

10.4 COMMITMENT TO SAFETY

10.4.1 General

The licence holder's commitment to safety is a fundamental requirement for the continued operation of the nuclear installation. Policies, procedures, forums and projects have been initiated over the life of the nuclear installation to date, having the primary goal of enhancing safety and procuring commitment from the installation's staff. To date, the NNR has followed the practical translation of these initiatives into positive results. Where it has been seen that areas of weakness have occurred these have been addressed by consultation and co-operation between the NNR and the licence holder.

Examples of the licence holder's commitment to safety have been evidenced in the resources and time expended in the establishment of safety assurance functions, a safety assessment capability, an independent nuclear safety department and the periodic safety re-assessment.

The main initiatives implemented by the licensee to strengthen its commitment to nuclear safety are summarised below in chapter 10.4.2 - 10.4.5

10.4.2 Establishment of corporate safety assurance group

Eskom have established a corporate safety assurance organisation "Generation Nuclear Safety and Assurance" (GNS&A) which supplies direction, assurance, licensing and specialist services. This includes the following specific services:

- Safety Assessment and Licensing
- Operations and Operations Licensing
- Engineering and Configuration
- Plant Condition Management
- Radiation protection and Emergency Planning

GNS&A also runs the Nuclear Safety Inspectorate and Quality Assurance functions of the licensee. The establishment of GNS&A is staffed by competent people who are able to provide, in broad perspective, an independent assessment and review of the overall safety case for Koeberg and provide an effective and efficient interface with the NNR.

As a consequence of the oversight safety function of GNS&A, Eskom are preparing and reviewing safety cases, and not merely forwarding the safety analyses of the contractor to the NNR, as was sometimes the case prior to the formation of the GNS&A group within Eskom. This streamlining and integration has contributed to a significant improvement in the quality of safety cases presented to the NNR.

10.4.3 Safety Engineer Function

Koeberg has established four Safety Engineer posts based on the French EdF model. Their responsibilities are as follows:

(i) Safety Function Confirmation

This is performed on a daily basis and is a direct service to the shift manager, their duties include:

- Trending critical plant parameters during normal operation to detect early warnings of potential safety problems.
- Providing an independent level of monitoring of safety system performance and make recommendations accordingly.
- Confirming the availability of safety related systems.
- Confirming the availability of post accident mitigation equipment.
- Approving the plant work plan after a risk evaluation.
- Confirming the compliance to nuclear safety requirements before plant state changes during unplanned shutdowns.

All deviations are either reported immediately to the shift manager, or to the organization concerned, the timing depending on the impact on nuclear safety.

(ii) Plant outage Safety

- Assist and advise during the outage planning phase to ensure compliance to the Operating Technical Specifications (OTS).
- Participate in deterministic risk analyses and propose mitigation methods.
- Confirmation that the equipment is correctly requalified.
- Confirm that the General Operating Rules (GOR) surveillance programme is complied with.
- Confirm compliance to nuclear safety requirements during plant state changes during the outage.
- Preparation of the outage safety plan.
- Confirmation of compliance to the outage safety plan.
- Compile and implement an outage experience feedback process for the continuous improvement of nuclear safety.

(iii) Technical Advice & Recommendations

- During normal operations, provide advice to the shift manager on operability determinations, suitable response to potential unsafe conditions and similar conditions of uncertainty and ambiguity.

- Provide post incident or accident monitoring of the critical safety functions and advise the operators of any unsafe conditions.
- Lead post trip investigations in terms of authorization for the safe restart of a unit.
- Investigate the causes of abnormal events that occur, assess any adverse effects and recommend changes to procedures or equipment to prevent recurrence.
- Provide the Operations Shift and Technical Support Centre with expert assistance regarding beyond design basis phenomena and recommend actions.
- Participate in the implementation of the Severe Accident Management Guidelines (SAMGs).

(iv) Safety Documentation Review & Assessment

- Evaluate the effectiveness of procedures in terms of terminating or mitigating accidents and make recommendations when changes are needed. This will be achieved by managing the compilation and review of the accident procedures and the SAMGs.
- Review changes to the Operating Technical Specifications (OTS) and surveillance requirements.
- Participate in the safety review of plant modifications and safety cases.
- Participate in the Koeberg Review and Safety Committees (KORC and KOSC)
- Participate in appropriate audits and evaluations.
- Provide training related to nuclear accidents and incidents, prevention and mitigation.

10.4.4 Safety Indicators

In addition to the use of World Association of Nuclear Operators (WANO) performance indicators, Koeberg has developed a comprehensive system of safety indicators, involving upper tier indicators and several hundred lower tier indicators. This system has been in use for several years and is computerized, providing a convenient database for linking the indicator levels to specific sets of findings arising from their monitoring programmes.

10.4.5 Operating Experience Feedback

The Operating Experience (OE) Group is responsible for external experience feedback and the total direction and management of the OE system. (Refer to section 12.2.5).

10.5 REGULATORY CONTROL

The NNR has a dedicated team of site inspectors and examiners within close proximity of the nuclear installation. This enables the NNR to maintain improved communication with the licensee's staff, management and off-site bodies and to gauge the level of commitment to safety demonstrated in all aspects of installation operation. The NNR is, therefore, better informed to assure the public that the installation's staff is committed to the pursuit of safety and that the NNR is equally committed to effective vigilance and appropriate action.

The system of regulatory control to ensure that priority to nuclear safety is given and enforced at the nuclear installation has been discussed in previous Articles 7 and 9 but can be summarised as follow:

The NNR ensures that the licence holder meets its commitment to nuclear safety essentially by:

(i) The enforcement of the legislative requirements of the NNR Act

(i) The establishment of nuclear Safety Standards and Regulatory Practices,

(ii) The granting of a nuclear installation licence and regulatory directives/letters and demonstration by the licensee of compliance to the conditions of licence and:

(ii) by providing an independent regulatory assurance of compliance with the conditions of the nuclear installation licence through the implementation of a system of compliance inspections, the latter comprising inspections, surveillances and audits as well as various forums for interaction with the licensee (the compliance assurance programme of the NNR is described further in Article 14)

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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.

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.

Summary of changes:

No major changes were made to this Article since the last report. Changes were as follow:

1. Editorial changes throughout the Articles
2. Chapter 11.4 was updated in respect of reactor operator licensing and also to report on the regulatory oversight of the licensee's staffing and competencies

11.1 FINANCIAL AND HUMAN RESOURCES OF THE LICENCE HOLDER AVAILABLE TO SUPPORT THE NUCLEAR INSTALLATION THROUGHOUT ITS LIFE

Eskom is a very large electricity utility with a tried and tested financial planning process. All planning is based on the principle of Eskom being a financially viable concern. Although financial plans are inclusive of all the Eskom power plants, the nuclear installation is not planned for in isolation. However, the financial plans for the organisation as a whole are inclusive of the nuclear installation's financial requirements.

The main purpose of these plans is to determine Eskom's electricity tariffs which are based on a revenue requirement model.

All the anticipated costs of the organisation, including inflation adjusted depreciation, as well as an expected return on assets are added together to determine the revenue requirement for the organisation.

As the nuclear installation is a strategic asset and a prominent supply option in the integrated electricity production plan of Eskom, the necessary resources are allocated to support this asset now and in the future.

In view of the above, it is clear that there are and will be sufficient resources available to support the nuclear installation. However, the pressures of escalating resource costs, national demands for cheaper power, the need for an expanding nuclear installation programme and social integration will challenge the ability of Eskom to remain competitive. This in turn impacts on the NNR’s responsibility to watch for any signs of safety being affected and instituting timely measures to restore the status quo.

11.2 FINANCING OF SAFETY IMPROVEMENTS MADE TO THE NUCLEAR INSTALLATION DURING ITS OPERATION

The licence holder utilizes a technical planning process to allocate financial resources for improvements to plant. Nuclear safety modifications are in a separate category and specific provision is made for these.

All improvements to the installation are financed centrally by the licence holder's treasury department. The funding requirement of the organisation is derived from the financial plans and is determined annually and reviewed monthly.

The licence holder finances safety improvements in the same manner as any other improvement to plant. Owing to the nature of the industry, improvements are made on a continuous basis throughout the life of the installation and nuclear safety improvements are no exception.

11.3 FINANCIAL AND HUMAN RESOURCES FOR DECOMMISSIONING/ RADWASTE

Decommissioning of the nuclear installation is currently scheduled for after 2035. Financial provision for the decommissioning (and also spent fuel management) has continued to be accumulated on a monthly basis since commercial operation of the installation began in 1984. The financial provision is reflected in the annual financial statements of the licence holder. These financial statements are audited in accordance with South African national legislation.

The amount of decommissioning and spent fuel provision made each month is determined by present valuing future estimated cash flows in terms of decommissioning financial plans. These financial plans are reviewed regularly and annually adjusted with the South African inflation rate.

Financial and human resources for the management of low and intermediate level radioactive waste are part of the normal operations of the nuclear installation and hence included in the business and financial plans.

11.4 RULES/REGULATIONS AND RESOURCE ARRANGEMENTS FOR ALL TRAINING/RETRAINING – INCLUDING SIMULATOR

The training, qualification and continuing training requirements for personnel, who sit on the installation's safety review committees and who perform safety evaluations, are set by the licensee. No direct regulatory involvement is required, as the outputs from these personnel must be approved by the NNR prior to implementation.

The training, qualification and continuing training requirements for the production support groups (maintenance, chemistry, nuclear fuel management and nuclear engineering) are set by the licence holder. It is a requirement of the nuclear installation licence that the efficacy of these training programmes is audited on a regular basis. Participation in these audits is actively undertaken by the NNR. The licence holder follows a practice of formally authorising staff to perform tasks on safety related plant systems, based on formal on-job training and examinations.

The minimum training and qualification requirements for radiological protection personnel and radiation workers are prescribed by the nuclear installation licence. It is also a requirement of the nuclear installation licence that the efficacy of these training programmes is audited on a regular basis. Participation in these audits is actively pursued by the NNR.

As reported above in Article 10.3, it is a condition of the nuclear installation licence that only individuals licensed by the NNR may manipulate the controls of the reactors. To obtain either a Reactor Operator or Senior Reactor Operator licence the individual is required to qualify as follows:

- (i) to pass written examinations set by the NNR in the areas of nuclear power plant fundamental theory and in normal, abnormal and incident plant operation;
- (ii) to pass simulator examinations in normal, abnormal and incident conditions;
- (iii) to pass in-plant walk-through examinations; and, for SRO candidates;

(iv) to pass in-plant examinations in the performance of emergency controller duties.

The licensing standards of the NNR are aligned to be an equivalent of NUREG 1021. The content and scope of examinable subjects, for initial licensed operator training, is driven by the knowledge and abilities as required by the NUREG-1122 catalog. Having obtained an operator's licence, it is a licence condition that the individual attends re-qualification training for a minimum of six, evenly distributed, one week periods per year. The training and evaluation are performed by the licence holder; however, the programme content and standard are monitored and approved by the NNR. Full re-qualification examinations are given regularly. Provided that operators meet all the NNR requirements and remain fit for duty, their operating licences are re-issued for a further 2 year period. Any contravention of the operator licence requirements is immediately reportable to the NNR.

All initial and re-qualification training and performance evaluations are performed on a full scope replica simulator situated on site. The quality of the simulator is prescribed by the nuclear installation licence to a standard equivalent of ANS-3.5. Failure to meet the NNR criteria for simulator fitness-for-purpose results in non-compliance with the NNR training standards and has a direct impact on operator qualification.

The nuclear installation licence requires minimum shift staffing levels and the notification of organisational changes to the NNR. Training and competency standards are monitored by means of training records, auditing, assessment of results and the analysis of occurrences for root causes. The licence holder has progressed and implemented a Systematic Approach to Training (SAT) which now covers all facets of training at Koeberg.

11.4.1 Regulatory monitoring of competency and staffing of the licensee

In accordance with the requirements of section 4.4 of the SSRP for staffing (refer 9.1.1), as requested by the NNR the licensee (Eskom) reported on its staffing and competency levels at the Koeberg Nuclear Power Station, including problems encountered and the skills development and retention strategies to address them. Eskom has indicated problems with high turnover of staff, particularly with regard to engineers, technicians, physicists and project managers. Presently the competency index indicates low coverage in Plant Engineering, Nuclear Engineering and Maintenance. The NNR however is satisfied that all safety related work is performed by competent individuals. However as this issue has the potential to impact on nuclear safety in the long run, the NNR will continue to monitor staffing and competency levels at Koeberg.

ARTICLE 12 HUMAN FACTORS

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.

Summary of Changes

1. Minor changes to Section 12.1.1 Prevention of Human Errors
2. Minor changes to Section 12.1.3 Correction of Human Errors
3. Section 12.4 the Role of the NNR has been updated regarding oversight of safety culture at the plant

12.1 PREVENTION, DETECTION AND CORRECTION OF HUMAN ERRORS

12.1.1 Prevention

As a first line of defence toward minimizing the occurrence of random human errors, the licence holder's Reactor Operator and Senior Reactor Operator licensing process sets a very high standard of required operator competence and qualification. This is achieved through a comprehensive selection and recruitment programme, intensive training and a stringent operator re-qualification process. The selection process incorporates both medical and psychological evaluations. Training includes classroom and simulator training in both technical and “soft” skills. Operator licence re-qualification is achieved through stringent examinations that include written, simulator and plant walkthrough testing by the NNR.

12.1.2 Detection

Identification of human errors and potential human errors is achieved by a combination of various methods. Operational experience is continuously investigated by means of problem report analyses concerning installation incidents and non-conformances. Safety culture assessment on the other hand provides early indications of negative influences that could produce an error-prone working climate. In the control room, on-site operator performance monitoring provides a continuous check on new potential problem areas in, for example, individual behaviour, communication and teamwork. During re-qualification training, thorough operator performance evaluations highlight any operator and/or training deficiencies that might exist. On a six-monthly basis, licensed operators undergo medical examinations and psychological monitoring interviews to identify any personal dispositions that might compromise their performance on shift.

12.1.3 Correction

The identification and implementation of appropriate corrective actions is based on the feedback of operational experience, the results of performance monitoring and upon human error analyses to management, the training department and incident investigation committees of the nuclear installation. Re-qualification training for licensed operators provides on-going correction and enhancement of operating skills. The human factors specialist of the NNR attends simulator and re-qualification sessions and confers with the licence holder's appointed psychologist to produce feedback required to correct any behavioral or interface errors.

12.2 ANALYSIS OF ERRORS, MAN-MACHINE INTERFACE, AND FEEDBACK

12.2.1 Root Cause Analysis and Trending of Human Errors

An electronic problem management system is employed by the licence holder to provide a comprehensive database containing information regarding problems, events and non-conformances. All such incidents are rated according to the International Nuclear Event Scale (INES). Various root cause analysis methodologies are used and these are applied to significant occurrences. The identified root causes are used as further inputs to the analysis of human error and safety culture. Human performance errors are analysed according to specific causal categories, for example, communication, management, skills, rule adherence and knowledge. Each of these is further analysed in various sub-categories to define specific areas of concern. The development of any trend is identified.

12.2.2 Safety Culture Analysis

Selected human performance categories within the root cause analysis process are further scrutinised for possible influences of safety culture. Safety culture is also assessed annually by means of surveys conducted on operating climate and prevailing culture within the installation, utilising the questionnaire method.

12.2.3 Human Reliability Assessment

The probabilistic risk assessment of the nuclear installation includes the assessment of human errors in design-basis accidents. The human reliability analysis methodology used is a three-phased approach based on a combination of the best features of two human reliability analysis techniques. These are the Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications – Final Report and the Accident Sequence Evaluation Program Human Reliability Analysis Procedure (ASEP).

12.2.4 Man-Machine Interface

The discrepancies between human capabilities and the demands of the working environment are investigated and minimised by means of periodic control room design reviews. These cover evaluations of, for example, the layout and functional demarcation of control panels, lighting, and noise and air-conditioning aspects. Also, differences in these aspects between the simulator and the actual control room are identified and minimised. As a minimum requirement, the standards of NUREG 0700 are adhered to. On an installation-wide level the enhancement of user familiarity with plant equipment is actively encouraged. (Refer to Section 18.5 for a further discussion of Man-Machine Interface considerations in plant design changes).

12.2.5 Operating Experience (OE) Feedback

Significant changes have been made in terms of processes and organization affecting all groups involved with Operating Experience. The most significant changes were the formation of the OE Group, responsible for external experience feedback and the total direction and management of the OE system.

This system includes:

- WANO cause categorization.
- Off-site reporting guidelines.
- Tiered approach to event investigations
- Formation of an Operating Experience Forum (OEF) to involve line groups and OE representatives.
- Endorsement by station management of all Corrective Actions (CAs) at a Corrective Action Review (CAR) Meeting.
- Prioritization of all CAs.
- Effectiveness review of closeouts identified at time of issuing the CA.

All significant operating event reports (SOERs) received from WANO and INPO are formally tracked and generic studies by EdF processed via the Koeberg Safety Review Committee (KSRC) meeting to formalize a Koeberg position.

Other improvements that have been implemented to ensure the continuous striving for excellence include the following:

- Making OE readily available to staff in a user-friendly system to facilitate inclusion in pre-job briefing, training and procedures.

- Effectiveness reviews on significant event reports like SOERs to ensure the intent of the corrective actions and recommendations are met.

- Ensure implementation of agreed changes to the OE process by conducting regular self-assessments.

12.2.6 Performance objectives & criteria

As an overview, Performance Objectives & Criteria are designed to promote excellence in the operation, maintenance, safety and support of operating nuclear electric generating stations.

Operating Experience criteria are as follows:

- Managers are appropriately involved in promoting and reinforcing the use of operating experience through activities.
- A systematic approach is used to identify and implement effective corrective actions from reviews of in-house and industry operating experience.
- Industry operating experience information is reviewed for applicability, and applicable information is distributed to appropriate personnel in a timely manner.
- Rigorous investigations are performed in response to significant in-house events.
- Operating experience that relates to human performance is effectively communicated to personnel through training, procedures, and work packages.
- Individuals at all levels of the organization use operating experience to resolve current problems and anticipate potential problems.
- Personnel reinforce the use of operating experience, for example, through pre-job briefings, engineering design reviews, and training activities.
- Operating experience information is easily accessible to station personnel.
- An evaluation is periodically performed to determine the effectiveness of the use of operating experience information. Appropriate actions are taken to make needed improvements.
- Timely notification via Nuclear Network is provided to other utilities regarding significant in-house events and equipment problems of generic interest. Criteria for selection of significant in-house events and equipment problems are established and communicated to station personnel.
- Equipment performance and engineering data is maintained up to date and in accordance with established guidance.

12.3 MANAGERIAL AND ORGANISATIONAL ISSUES

The managerial structure of the licence holder is such that the nuclear installation is obliged to operate within a defined envelope of rules and procedures. An independent corporate nuclear safety group holds the responsibility for the overall safety case and determination of the operational rules and procedures, together with a compliance assurance role. In order to fulfill these functions, the corporate group contains a review capability, which monitors indicators derived from the safety case. These include factors influencing human performance and, by way of the occurrence reporting mechanism, failures and deviations arising from shortcomings in human performance. The corporate safety group also has responsibilities in respect of feedback of international experience pertinent to nuclear safety including human factors. Review of human factor information, both externally and internally derived, enables shortcomings to be identified and addressed as necessary.

The corporate nuclear safety group is also responsible for reporting to the licence holder's nuclear safety overview committees on a regular basis. The reporting encompasses all matters relevant to safety including aspects of human factors.

The Eskom independent corporate safety group, the Generation Nuclear Safety and Assurance,(GNS&A), has been operational for approximately seven years and through its activities has positively contributed to the enhancement of the overall licensee nuclear safety governance and to a more efficient and focused interface with the National Nuclear Regulator.

12.4 ROLE OF THE REGULATORY BODY AND THE LICENCE HOLDER REGARDING HUMAN PERFORMANCE ISSUES

Ass indicted above in Articles 10.3 and 11.4 the NNR has the overall independent responsibility for the regulatory functions of licensing the installation's reactor operators to ensure that the safety and reliability aspects of their performance in the execution of required control room duties are of an acceptable level. This, in turn, involves the enforcement and control of specific operator licensing requirements. These are elaborated in several regulatory documents which are integral part of the conditions of the nuclear installation licence (References 1 & 2). The operators are to comply with these requirements at all times.

The NNR maintains the services of consultant medical and psychological experts to provide independent advice, monitoring and evaluation of nuclear installation staff. Annual psychological interviews are conducted with operating staff by the NNR consultants in a climate of openness and confidence with the operators. It enables the NNR to monitor the profiles of individuals and groups periodically to gauge levels of stress, precursors to problems, underlying concerns or other indications of incipient human error initiators over time.

The NNR played a proactive role in developing safety culture indicators. The indicators serve as predictive measures of safety culture for nuclear regulatory purposes by acting as advance warnings of likely future changes in safety culture. Particular attention is paid to those indicators indicative of weak areas in safety culture. Significantly weak areas are addressed as safety concerns, and effectively managed with the aid of a sophisticated safety indicator system.

As a further step in improving safety culture oversight the NNR required the licence holder to develop the necessary processes to enhance safety culture at the plant. The licence holder responded with a comprehensive plan making provision for safety culture enhancement within the context of an integrated management system. The implementation of the plan includes development of policies and procedures, training and orientation of management and supervisors, nuclear safety awareness seminars, as well as a redesigned annual safety culture survey (refer to Article 10.2.1 for the safety culture audit conducted at the plant)

ARTICLE 13 QUALITY ASSURANCE

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.

Summary of changes:

(i) Editorial changes throughout the Article

(ii) The main change to the Article was on Section 13.5 which has been updated to elaborate further on the Quality Management requirements developed for the PBMR.

13.1 QUALITY ASSURANCE (QA) POLICIES

13.1.1 Licence Holder

The licence holder's QA programme, including the Quality Policy Directive, is specified in the Management Manual of its Generation Division underpinned by the QA programmes of the Nuclear Portfolio and the Generation Nuclear Safety and Assurance Department. These are based on the IAEA Safety Code 50-C/SG-Q, the NNR Licence Document LD-1023 and the Eskom Directives.

The responsibility for the implementation of QA policies is that of the General Manager Production (Nuclear Portfolio), and the Generation Nuclear Safety and Assurance Manager who are responsible to the Managing Director (Generation Division) for operating the installation safely within the terms of the nuclear installation licence and monitoring the implementation of the QA programmes respectively.

The licence holder's quality management and operational QA programmes presently satisfy both the international standards and codes and those of the NNR.

13.2 IMPLEMENTATION AND ASSESSMENT OF QA PROGRAMMES

A comprehensive Integrated Monitoring Programme of planned, periodic monitoring for the nuclear installation has been established by the licence holder in conformance with NNR's licensing requirements. This programme is directed by indicators which are generated according to a good-to-bad grading system. The indicators comprise a defined group of activities such as audit findings, inspection non-compliance etc., which collectively indicate the current "health" of the installation. Should an indicator deteriorates over a period, the monitoring programme will be adjusted to focus attention on the assessment of this area by applying one of the monitoring procedures and applying corrective action.

Achievement and maintenance of quality are verified by audits, surveillances, self assessments and peer reviews. These are conducted in accordance with authorised procedures and are performed by certificated auditors using approved checklists.

Personnel performing monitoring activities are independent of direct responsibility for the activity being monitored.

Monitoring reports are issued and reviewed for comment by the monitored organisation. Follow up action is taken to verify that deficiencies or discrepancies have been corrected. The results of monitoring activities and management reviews are maintained as quality assurance records.

The detection, reporting, disposition and correction of non-conformances, deficiencies and deviations from quality requirements are specified in various authorized procedures. Non-conforming items are conspicuously marked and where possible segregated from other items.

Management reviews are conducted on an annual basis. The base material for management reviews is obtained from monitoring activity reports, corrective action reports, quality deficiency reports and other reporting mechanisms. During these reviews an assessment of the adequacy of the current QA programme is performed and changes are made if deemed necessary.

Non-conformances for components are dispositioned as follows: use-as-is, repair, rework, or unfit-for-purpose based on review and evaluation by responsible competent engineers. Non-conformance dispositions are reviewed and accepted by responsible management.

Conditions adverse to quality include failures, malfunctions, deficiencies, deviations, defective material or equipment, incorrect material or equipment. Significant conditions adverse to quality involve programmatic problems, as opposed to individual failures.

Conditions adverse to quality are identified and corrected. Significant conditions adverse to quality are identified, the root cause of the condition determined, and corrective action taken to prevent repetition. Appropriate management is informed.

Permanent QA records are retained for the life of the item to which they refer. Record storage facilities have been constructed to prevent damage or deterioration of records due to fire, flooding, insects, rodents and adverse environmental conditions.

13.3 REGULATORY CONTROL ACTIVITIES

One of the principle nuclear safety requirements of the SSRP (refer 9.1.1) in section 3.10 requires that a quality management programme must be established, implemented and maintained in order to ensure compliance with the conditions of the nuclear authorisation.

This safety requirement, related to the licensee's quality assurance responsibilities, is further entrenched in the conditions of the nuclear installation licence in a regulatory requirement document – LD 1023 (reference 3). In terms of this document, the implementation of a quality management programme is required to provide adequate confidence in the validity of the operational safety assessment and safety assurance processes.

A written policy stating the quality objectives to be attained during various stages of the installation's life is required and has been provided by the licensee.

The QA monitoring programme for Koeberg Nuclear Power station is developed in accordance with the requirements of LD 1023 in consultation with the NNR. It covers, *inter alia*, the following areas:

- Radiological protection programme
- Maintenance programme
- Conformance to Operating Technical Specifications
- In-service inspection programme
- Radioactive waste management and effluent discharge control programme

- Chemistry programme
- Nuclear engineering design and modification programme
- Emergency plan
- Physical security system
- Civil works monitoring programme
- Environmental surveillance and meteorological programme
- Fuel integrity evaluation, storage, handling and transportation
- Fire prevention and protection plan
- Training/Qualification of operating and technical staff
- Quality activities and functions of the management programme (including control of deficiencies and corrective actions)
- Documentation and records system
- Compliance with risk assessment and safety criteria of the NNR
- Corporate Safety Assurance of the Generation Nuclear Safety Assurance (GNS&A) oversight processes

During plant refueling outages, the licence holder generates a dedicated surveillance programme, which is designed, implemented and controlled by its Quality Assurance (QA) Department. NNR inspectors identify those surveillance activities that are of importance to monitor and observe. Results of these surveillances are reviewed by the installation's operations review committee whose duty is to identify and initiate appropriate corrective actions.

The NNR has established a comprehensive compliance inspection programme covering all aspects of the nuclear installation licence for the nuclear installation (refer to Article 14), including the following compliance inspections relating specifically to the QA /Quality Control (QC) process:

- Corrective action close-out
- Incidents and problems notifications (PNs)
- Audit findings
- Non-conformance reports
- Work orders

The findings of the compliance assurance activities conducted by the NNR are classified as follows:

- Observations (based on judgment as to the adequacy of a particular system requirement)
- Findings (non-compliance or shortcomings in implementation of a QA system requirement)
- Licence Issue (non compliance to a condition of the nuclear installation licence requirement)

Audit findings and concerns are used as input to NNR safety indicators, and separately to the utility's safety indicators systems. The indicators are used to prioritise future monitoring activities.

13.4 TRAINING OF AUDITORS

The NNR and the licence holder conduct their own independent auditor training programmes, whilst the licence holder, represented by the Eskom Generation and Safety Assurance (GS & A) Division follows a national and international system of certification for auditors. In both cases specialists from technical and inspection departments are trained as auditors to cover the scope of the audit programme.

Furthermore in terms of the requirements of the NNR Act, NNR appointed inspectors are required to be trained and certificated. This training and certification is carried out according to a modular Inspector Training programme. The modules cover the legislation and associated regulations, basic inspection techniques and reporting and a facility specific training module which is based on the functional area and discipline in which the Inspector is a technical expert.

13.5 OTHER QUALITY MANAGEMENT ACTIVITIES

As reported in the previous report to the Convention, Eskom is exploring the possibility of developing a High Temperature Gas Reactor (HTGR) Pebble Bed Modular Reactor (PBMR).

From the quality management, assurance and control aspects the NNR has developed a regulatory document LD-1094 which details the Quality Management System (QMS) and Safety Management System (SMS) requirements of the NNR for the PBMR project. Eskom, PBMR (Pty) Ltd and the suppliers responsible for design, construction and operation of the Pebble Bed Modular Reactor are required to develop, introduce and maintain a QMS and SMS that complies with the requirements of this document.

This document has been developed based on various international quality assurance codes and standards in order to satisfy the multi-national flavour of the potential purchasers. The IAEA Code 50-C/SG-Q, ASME ANSI NQA-1, ISO 9000:2000 and a selection of other internationally recognised quality standards and codes formed the basis upon which LD-1094 was established.

The quality requirements related to the design include inter alia requirements on the identification and control of design interfaces, independent verification of design, test programmes, design changes, configuration management, selecting and reviewing the suitability of application of materials, parts, equipment and processes that are essential to the defined safety functions of Structures, Systems and Components (SSC), and verification and validation to pre-determined requirements.

ARTICLE 14: ASSESSMENT AND VERIFICATION OF SAFETY

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 with operational limits and conditions.

Summary of changes

1. The section on the periodic safety re-assessment 14.2 has been updated
2. The section on verification of licence compliance 14.3 has been updated
3. The section on Regulatory Control Activities 14.4 has been updated

14.1 THE NUCLEAR AUTHORISATION PROCESS

The regulatory requirements including the nuclear authorization process applicable to the operation of the Koeberg Nuclear Power Station have been extensively discussed in previous Articles.

14.2 SAFETY ANALYSIS REQUIREMENTS

The requirements for prior and operational safety assessments (Safety Analysis Report – SAR) for the Koeberg Nuclear Power Station have also been extensively discussed in previous Articles.

Section 4.1 of the SSRP (refer 9.1.1) requires that an operational safety assessment must be made and submitted to the Regulator at intervals specified in the nuclear authorisation and which must be commensurate with the nature of the operation and the radiation risks involved.
The operational safety assessment must be of sufficient scope and must be conducted and maintained in order to demonstrate continuing compliance with the dose limits, risk limits and other relevant conditions of the nuclear authorisation.
The operational safety assessment must establish the basis for all the operational safety-related programmes, limitations and design requirements.

Documentation relating to compliance with the safety standards is provided in the safety analysis report. For the Koeberg nuclear installations the safety analysis report and installation description is required to be maintained in a current state in line with international norms and practices.

The implementation of these requirements is through the conditions of the Koeberg nuclear installation licence which require that any plant and process changes affecting safety related systems, components and activities are approved by the regulatory body prior to their implementation as per reference 6.
Licensee's modification standards, approved by the regulatory body, are in place that require proper design, review, control and implementation of all permanent and temporary modifications, and require that appropriate review of the safety

analyses have been performed before the installation of modifications are commenced or the changed process is implemented.

The nuclear installation licence requires that all modifications to the installation or any of the operating, maintenance and testing procedures be assessed in terms of both their impact on deterministic aspects of the safety analyses and on risk. By so doing, a dynamic risk assessment is maintained and updated on an ongoing basis. This is applied to the probabilistic safety assessment and to the deterministic aspects of demonstrating compliance with design and operational requirements.

14.3 PERIODIC SAFETY RE-ASSESSMENT

As an integral part of the operational safety assessment in addition to the ongoing assessment, which focuses on immediate aspects of installation and procedural modification, a requirement to undertake a safety re-assessment is also in place. The nuclear installation licence currently in place for the Koeberg Nuclear Power Station (KNPS) requires that the Safety Assessment of the installation must be updated on a regular basis and at a frequency acceptable to the Regulator.

As detailed in previous reports to the Convention, the first Koeberg Safety Reassessment (KSR) project started in April 1995 with the formulation of the NNR requirements. Eskom submitted its Safety Re-assessment Report (SRA) report for NNR review in December 1998 and the NNR completed its review in July 1999. The NNR review and conclusions of the KSR Project are documented in the NNR KSR assessment report.

The SRA report produced by Eskom included a comprehensive listing of findings and recommendations in each of the areas assessed. The report concluded that no deficiencies had been identified that required immediate corrective action. However, some short and medium term measures were required to either justify differences with the safety referential that Koeberg was benchmarked against (the EdF French CP-1 900 MWe plants) or to resolve some of the issues identified. These measures, including modification proposals were classified according to their safety significance (medium or low categories). An implementation programme was implemented by Eskom in order to disposition the findings.

Although many corrective actions are currently at an advanced stage of completion and that significant amount of plant improvements have been made as a result of the first safety reassessment it is apparent that not all corrective actions will be concluded before the start of the second safety reassessment, which is scheduled to commence in 2008. However at the completion of the next two plant refuelling outages (August 2009) all issues, identified as MEDIUM, which require implementation of plant modifications, will be closed.
The delays in implementation are related to the scheduling of batches of plant modifications as well as operating and equipment testing requirements which would further significantly improve the safety of the plant. Nevertheless, the NNR concluded that, provided the further agreed actions are addressed within acceptable timescales, the main objectives of the KSR Project were achieved and that continued operation of the plant was justified.

Progress in implementation of corrective actions is monitored at the Koeberg licensing interface meetings between Eskom and the NNR. The NNR will continue to monitor the implementation of these projects.

14.4 CONTINUED HEALTH OF THE NUCLEAR INSTALLATION TO ENSURE LICENCE COMPLIANCE

The SSRP (refer 9.1.1) require that operational safety-related programmes, limitations and design requirements must be established on the basis of the operational safety assessment.

These operational safety-related programmes include the following for the monitoring of the Plant Condition Management at the Koeberg Nuclear Power Station:

14.4.1 Routine On-Going Safety Review at the Nuclear Installation

The following major elements with respect to the maintenance of plant condition are required as part of the conditions of the Koeberg nuclear installation licence.

These include:

- The maintenance of a valid and updated safety and risk assessment
- Establishment of and compliance with the plant Operating Technical Specifications (OTS) including operating surveillance requirements.
- The maintenance of an in-service inspection programme
- The maintenance of a reactor vessel surveillance programme
- A plant maintenance programme
- A civil monitoring programme
- A physical security programme
- A fire safety programme
- A routine occurrence reporting programme
- A quality management programme

All items of the nuclear installation hardware that have a significant potential for impacting on nuclear safety, either through their lack of availability on demand or their failure during service, are subjected to systematic mandatory programmes covering maintenance, surveillance, testing and inspection. Through these processes, the licence holder is able to verify that the nuclear installation conforms to applicable criteria of reliability, availability and integrity within the original design requirements.

The formulation and control of these programmes takes cognisance of national and international codes and standards and also local safety standards and regulatory practices together with operational limits based on installation design requirements.

Fundamental to these programmes is the feedback of acquired data through a process of engineering evaluations, in order to effectively manage the ageing of the installation hardware. This process includes repairs, replacements, refurbishments, modifications and changes to operational conditions.

Compliance with the conditions set out in the nuclear licence is ensured by the implementation of various monitoring programmes by both the licence holder and the regulatory body. The major elements of these programmes are discussed below.

14.4.1.1 Plant Condition Verification Programmes

(i) In-Service inspection programme (ISIP)

A comprehensive ISIP is developed, implemented and controlled at the nuclear installation. This comprises a programme of examinations and tests conducted on nuclear safety related plant structures, systems and components to identify deviations from the design base, or deviations from the initial pre-service inspection baseline conditions.

The ISIP activities are governed by an In Service Inspection (ISI) standard, which is approved by the NNR and therefore part of the conditions of the nuclear installation licence. The ISI requirements are primarily derived from the US ASME Code, Section XI, Division 1 Rules but also include augmented inspections derived from industry experience, specifically those pertaining to the EdF reference plant. Additional inspections under the Augmented scope of the ISIP may therefore be imposed by the NNR or the licensee where added plant integrity assurance is deemed necessary.

(ii) Reactor vessel surveillance programme (RVSP)

This programme was originally based on French experience and implemented as part of the French surveillance programme through a contractual agreement between the licence holder and EdF. Early in the life of the plant during the seventh fuel cycle of each unit a reduction in operating temperature (ORT) was introduced in order to mitigate the effects of primary water stress corrosion in the steam generator tubing.

Even though the advantages of ORT to the steam generators life management was established, it was recognised however that ORT could have a negative impact on the Reactor Pressure Vessel (RPV) embrittlement due to the reduction in the annealing effect. Accordingly the original capsule removal schedule was altered and a “spare” capsule inserted in the reactors that would see only ORT conditions.

Other changes to operational practice such as the introduction of low leakage fuel management and the use of more enriched fuels has impacted on the programme and a review of the calculation and dosimetry methods for determining pressure vessel neutron fluence will shortly be undertaken and taken into account in an updated pressurised thermal shock study.

Long term primary circuit integrity concerns such as the thermal embrittlement of the austeno-ferritic stainless steel elbows and the neutron embrittlement of the reactor pressure vessels have been in part assuaged and subject to some small scale tests have been re-assessed under plant life management.

(iii) Maintenance and Testing Programme

This programme covers the maintenance of mechanical, electrical, instrumentation and telecommunication hardware and the maintenance of structures on an ‘ad hoc’ basis in accordance with the relevant monitoring programmes. Condition-based maintenance is implemented in parallel with fixed time-based preventative maintenance programme for items required for safety.

Maintenance functional control areas are managed through a higher tier maintenance policy document and each functional control area has at least one maintenance standard which defines the applicable rules/controls and is supported by relevant administrative procedures, guides, lists and working procedures as appropriate.

A major emphasis of an optimisation process that is ongoing is to determine and to document the basis for maintenance for all Structures Systems and Components (SSCs) important to nuclear safety and to ensure a dynamic maintenance programme, with changes being controlled. This process, which is focusing on maintaining the safety related functional capabilities of SSC's important to nuclear safety, is based on the Reliability Centered Maintenance (RCM) philosophy and principles. As part of this approach every change in the maintenance basis (maintenance scope or frequency) is to be based on a justification utilising sound engineering practice. The entire process is to be monitored by a system/component failure and reliability monitoring programme which is to provide data for the maintenance optimisation process and for the nuclear installation's dynamic PRA reliability/availability database. Failure analyses will be conducted and corrective actions implemented, following any functional/potential functional failures.

The requirements of the Operating Technical Specifications shall not be compromised as a result of maintenance activities. During the process of planning and executing maintenance work, an assessment of the total plant equipment that is out of service is to be taken into account in order to determine the overall effect on the performance of safety functions, to ensure that the installation is operated in conformance with the defence-in-depth and ALARA principles, and within the safety criteria of the regulatory body. Maintenance effectiveness shall be assessed by reviewing the trends of functional failures that can be prevented through maintenance.

14.4.1.2 Assurance Programmes

- **Occurrence and Incident Reporting Programme**

A system of recording and reporting is required by the SSRP (refer 9.1.1) and a condition of the nuclear installation licence. This system encompasses amongst other all potential occurrences from events indicating minor deviations to more serious incidents or accidents.

All the occurrences reported at the nuclear installation are recorded in a database. They are analysed in order to monitor trends, timeously indicate potential safety concerns, and update the safety and risk assessment using plant specific data obtained from the analyses. These trends are also compared with international databases. Further information is provided under Article 19.

- **Quality Assurance Audits**

A systematic programme of audits is carried out by the licence holder and independently by the regulatory body. Areas to be audited are selected on the basis of operational feedback and safety significance in terms of compliance with the safety standards and regulatory practices and installation safety. The outcome of the audits may result in corrective action by the licence holder and also feedback into the risk assessment process. Refer to Article 13 for more details.

14.4.1.3 Risk Insights in Decision Making

As indicated in previous Article it is a principal radiation protection and nuclear safety requirement that the nuclear installation demonstrate compliance with the risk limits of the SSRP (refer 9.1.1).
It is also a requirement of the conditions of the nuclear installation licence for the Koeberg nuclear power station that the safety assessment must include a

probabilistic risk analysis (PRA) for demonstration of compliance with the risk limits.

In compliance with the regulatory requirements Eskom has developed and maintain a PRA for the Koeberg nuclear installation.

A comprehensive comparison of the Koeberg Probabilistic Risk Assessment methodology against internationally recognised standards was completed as part of the Koeberg Periodic Safety Reassessment reported above in 14.3. This process identified a list of improvements to be made to the Koeberg Probabilistic Risk Assessment (PRA) to align it with current international standards and practices and enhance its use as an "operational" tool. In consequence the Koeberg PRA model has been significantly upgraded.

Eskom makes extensive use of PRA in decision making impacting on nuclear safety.

The safety cases for any proposed plant change must include a probabilistic safety assessment. Operating Technical Specification changes are also reviewed from a PRA perspective. Risk insights are being used to develop the new risk-informed Upgraded Technical Specifications (UTS).

Risk trade-off analyses are also performed, typically for optimising outage work schedules. On a routine basis, precursor analyses are performed and reviewed by Eskom safety review committees. The PRA is also used for prioritisation of safety issues, including plant safety modifications.

Given the importance and prominence of PRA in safety decision making, the PRA will be subjected to a peer review later in the year as part of the confirmation process that the quality and scope of the PRA is appropriate for its use in risk-informed decision making.

14.5 REGULATORY ACTIVITIES

In terms of the National Nuclear Regulator Act, the NNR has the authority to restrict operation of the plant or to shut down the plant given adequate grounds. The SSRP (refer 9.1.1) and the conditions of the nuclear installation licence requires the licensee to report events or incidents. Depending on the level of severity the NNR may conduct inspections or investigations accordingly. The NNR also exercises regulatory control by means of approvals required in terms of the nuclear installation licence, and compliance assurance inspections programmes outlined below.

14.5.1 NNR Approval Process

The nuclear installation licence requires that the safety case be submitted by the licence holder for approval by the NNR and that it be of sufficient scope and be established, conducted and maintained in order to demonstrate ongoing compliance with the nuclear safety standards and NNR requirements.

The nuclear installation licence also dictates that NNR approval is required for fuel unloading, fuel loading and return to criticality. Proposed modifications to the plant or changes to the licensing basis documentation referenced in the licence must be submitted to the NNR for approval prior to implementation. These changes must be supported by a safety case that includes a quantitative risk assessment. Some of the numerous modifications which have resulted in safety improvements are indicated in Article 19.

14.5.2 Surveillance and Compliance Inspection Programme

A comprehensive surveillance and compliance inspection programme has been developed by the NNR to ensure compliance with the safety standards and the requirements of the conditions of the nuclear installation licence and to identify any potential safety concerns. The NNR compliance assurance inspection programme, is independently implemented by the inspection staff of the NNR and is discussed below

The NNR compliance assurance inspection programme for Koeberg has been largely based on consideration of a set of safety goals linked to the safety case for the plant. In the development of such a system, safety goals were established by the NNR first with a view to addressing all significant safety factors enveloping the overall safety case for the licensed facilities, including those aspects of the licensee organisation relating to safety, in a top-down approach designed to provide assurance of safety in broad perspective in terms of the safety requirements of the NNR.

(i) Basis for the programme

As indicated above the NNR compliance assurance inspections programmed is based on safety goals developed from the principal radiation protection and nuclear safety requirements of the SSRP (refer 9.1.1) covering dose and risk to the workers and the public arising from normal operations and potential accidents, quality management requirements, defence-in-depth, comparison with and assessment against acceptable international benchmarks, the ALARA principle, and emergency planning requirements.

The above safety requirements imply numerous provisions, undertakings and assumptions, which underpin the safety assessment. These are to a large extent covered by the conditions of the nuclear installation licence in terms of the licensee's safety assurance processes, the plant design, operational safety-related programmes, operating technical specifications, and the procedures themselves. In line with the objective to provide a focus on all safety assessment and assurance activities, relevant safety goals were established to address these factors, as far as practicable.

Safety indicators have also been established in correspondence with the safety goals to provide indication of the extent to which the safety goals are being achieved or could be challenged.

The use of safety indicators helps to focus attention on weak areas and to provide information in a format which can be trended and which is readily reportable and comprehensible to the licensee management, public and different levels of the various regulatory and government organisations.

A system of ranking the level of safety concern and enunciating the status of each indicator is used.

The NNR compliance assurance inspections programme has been established to provide assurance of the state of health of the plant, processes, organisation and environment in terms of the identified safety goals.

(ii) Application of the programme

A baseline inspection, audit and surveillance programme was developed and implemented and linked to the safety indicators.

The various monitoring processes implemented by the NNR include, inter alia, the following:

1. Inspections, audits and surveillances conducted in terms of the compliance inspection programme.
2. Technical assessments conducted on submissions by the licensee, mainly for modifications.
3. Reports submitted by the licensee in terms of licence compliance.
4. The licensee safety indicators (performance and safety indicators).
5. Periodic reviews or other proactive assessments conducted by the NNR (including international experience feedback).

The NNR inspector responsible for a finding arising from any of the above processes performs a provisional classification of the finding. A qualitative process is used as a first level of screening in all cases. This may be complemented by a quantitative PRA analysis if it is believed that a finding challenges the validity of assumptions or data used in the safety case.

The findings, along with their provisional classifications, are discussed at project meetings, attended by inspection and technical staff, generally held on a weekly basis, or on an ad hoc basis should the severity of the finding demand an earlier response. A final classification is then established.

Depending on level of concern follow-up actions are initiated between Eskom and the NNR within timescales and level of seniority within the organizations (from operational to Executive management level).

(iii) NNR compliance assurance safety Indicators

As indicated above a safety indicator system is used by the NNR to record and grade findings arising from the compliance assurance programme, inspections and assessment activities. The regulatory concerns are ranked according to a colour-coded system in terms of their severity –

- red being unacceptable;
- orange being tolerably high;
- yellow being tolerably medium;
- blue being tolerably low and
- green being below regulatory concern.

14.5.3 Licensing of Control Room Reactor Operators

As indicated in Article 10 the licensing of reactor and senior reactor operators is subject to NNR approval prior to commencement of duties.

14.5.4 International Experience Feedback Analysis

International experience feedback on safety issues e.g. incidents, events etc. is an important component of the continuing safety review of the nuclear installation and is monitored by the NNR.

The relevant safety issues are analysed for their applicability and possible impact on the safety assessment of the nuclear installation. Where necessary these issues are referred to the licence holder with a view to the implementation of appropriate corrective action. Refer to Article 19 for more details.

ARTICLE 15: RADIATION PROTECTION

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.

Summary of changes:

- Section 15.1 has been updated to reflect the publishing of the Safety Standards and Regulatory Practices and the associated dose limitation system
- Section 15.2 has been updated to reflect a modification implemented to reduce the volumes of solid radioactive waste
- Section 15.2.2.1 and 15.2.2.2 include developments to optimize occupational and public exposures
- Section 15.3 reflects developments in regulatory control and oversight, also specifically with respect to process-based licensing and design basis accident consequences
- Section 15.4 has been updated to include recent occupational doses, public doses, activities released and direct exposure statistics as a result of licensee operations

15.1 SUMMARY OF LEGAL REQUIREMENTS

Legislative Framework

The Regulations R 388 on Safety Standards and Regulatory Practices (SSRP) (refer 9.1.1) contains specific requirements for all radiological protection aspects including compliance to radiation dose limits. The regulations ensure that criteria are in place for all radiation protection oversight and authorisation activities. In Section 4.5 of the regulations requirements and criteria are in place for all radiation protection oversight and authorisation activities

Section 4.6 of the SSRP requires that a radioactive waste management programme must be established, implemented and maintained.

These requirements of the SSRP are implemented through the conditions of the Koeberg nuclear installation licence.

15.1.1 Dose Limits

In achieving the objectives for the control of occupational exposure, the NNR requires that no individual shall receive an annual dose in excess of the dose limits and that all exposures are as low as is reasonably achievable.

The dose limits applicable to the Koeberg Nuclear Power Station and prescribed by the NNR are applicable to both members of the public and the occupationally exposed population. These limits are referenced in Appendix 2 of SSRP, the conditions of the Koeberg nuclear installation licence in the Koeberg Licensing Basis Manual, regulatory requirements document, licensee radiological standards and are summarised below:

1. **The occupational exposure of any worker** arising from normal operation shall be so controlled that the following dose limits are not exceeded:

(i) an (average) effective dose of 20 mSv per year averaged over five consecutive years;

(ii) a (maximum) effective dose of 50 mSv in any single year;

(iii) an equivalent dose to the lens of the eye of 150 mSv in a year; and

(iv) an equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

(v) Furthermore the SSRP specifies dose limits for apprentices and students, women, for emergency workers and for visitors and non-occupationally exposed workers at sites.

2. Public exposure

The annual effective dose limit for members of the public from all authorised actions is 1 mSv.

For the Koeberg Nuclear Power Station the dose constraint, applicable to the average member of the critical group with the exposed population, is 0.25 mSv per year.

In achieving the radiation protection objectives, it is necessary to evaluate the facets of radiation protection design against the dose limits, and then establish complementary operational programmes which are sufficiently comprehensive to ensure compliance with those limits. These are augmented by operational verification programmes on aspects relating to radiation protection in design in order to ensure that the parameters of the safety assessment remain current and to aid in ensuring that the operational programmes are not compromised. The Koeberg licensing basis manual (discussed in Article 9) makes reference to the principles upon which these verification programmes and facets of the operational radiation protection programme are established. All of these principles are embodied in the conditions of the nuclear installation licence and the licensee's licensing basis manual as well as corporate standards on Radiological Protection.

15.2 FULFILLMENT OF CONDITIONS FOR RADIOACTIVE MATERIALS RELEASE

15.2.1 Radiological Effluents

15.2.1.1 Establishment of annual authorized discharge quantities

Section 4.5.3 of the SSRP (refer 9.1.1) specifies that the Regulator may, for the purposes of controlling radioactive discharges from a single authorised action, determine a source-specific annual authorised discharge quantity (AADQs) in the nuclear authorisation, which must take into account the dose constrain which for Koeberg nuclear power station is 0.25 mSv per year applicable to the average member of the critical group with the exposed population.

The establishment and the bases of the AADQ system to control effluent discharges and as such, ensure public dose compliance, has been addressed in previous CNS Reports. The status quo in this regard is the same and experience in this regard is well monitored by the Regulator. This relates to both design and operation.

15.2.1.2 Operational control over discharges

In the operational phase of the radiological effluent management programme, controls on the release of radioactivity in liquids and gases are such as to ensure compliance with the AADQ's for individual radionuclides and therefore, compliance with the dose limit for members of the public.

The discharge pathways from the nuclear installation can be classified as either batch or continuous. All analytical and on-line monitoring equipment is subject to an approved schedule of periodic testing in order to ensure sufficient accuracy and sensitivity. Requirements pertaining to on-line monitoring and analytical equipment are documented in the licensee Operational Technical Specification (OTS).

15.2.1.3 Control over installation and environmental parameters of influence to the Annual Authorised Discharge Quantities (AADQ's)

The AADQ's for the Koeberg plant have been updated with the current operational safety assessment assuming a defined plant configuration and suitably conservative operating parameters. In addition, certain assumptions regarding environmental parameters have been made to establish the nature of the critical group. This latter issue is addressed under the section on environmental surveillance.

In order for the AADQ's to remain valid, it must be ensured that the nuclear installation does not operate outside of the envelope established by the operational safety assessment.

In this regard, the operational safety assessment is linked to the activity migration model, and for any change to the plant configuration, the impact on the model should be assessed.

15.2.1.4 Radioactive Wastes

15.2.1.4.1 Establishment of annual waste produced

In terms of the SSRP (refer 9.1.1) radioactive wastes "*means any material, whatever its physical form, remaining from an action requiring a nuclear installation licence, nuclear vessel licence or certificate of registration and for which no further use is foreseen, and that contains or is contaminated with radioactive material and does not comply with the requirements for clearance in 2.5"* of the SSRP. The safety assessment regarding the production of radioactive wastes is complementary to that of radioactive effluents. The quantities of radioactive waste produced annually by the nuclear installation are estimated but these do not constitute limits. The nuclear installation license requirements stipulated by the NNR refer to the operational radioactive waste management programme which is discussed below. This approach is consistent with that defined in the IAEA Basic Safety Standards for "Protection against ionising Radiation and for the Safety of Radiation Sources".

15.2.1.4.2 Operational control over radioactive wastes

Operational control over radioactive wastes is exercised through the radioactive waste management programme as required by the SSRP and the conditions of the Koeberg nuclear installation licence. In line with the principle of the National Radioactive Waste Management Policy and Strategy, this programme allows for the identification of all sources of waste, the minimisation and optimization of waste production, collection, handling, treatment, conditioning, quantification, storage, and transport. Eskom has introduced a modification to by-pass the evaporators in the liquid waste system to increase efficiency as regard to waste activity concentration with a demineraliser. It is envisaged that waste activities will be more concentrated resulting in a decrease of a volume of radioactive waste which is line with current international trends to minimize waste volumes.

15.2.1.4.3 Quantification of radioactivity in produced wastes

The methods of quantification of the radioactive inventory associated with wastes vary according to the waste type. For process wastes comprising spent filters, and spent resins, the beta/gamma emitting radionuclide inventory is determined in the drum by measurement of dose rate and assignment of radionuclide-specific inventory by use of proportionality constants. These constants are derived from measurements of primary coolant activity for a certain period and can only be applied to wastes produced during that period. For concentrates, a sample is taken and analyzed for source term specification by gamma spectrometry. The assignment of non-beta/gamma emitting activity is performed using generic scaling factors. The licensee has adopted the

French EdF accredited scaling factors. This has been reported in previous CNS reports and the status quo still remains.

15.2.1.4 Clearance from regulatory control

Section 2.4 of the SSRP (refer 9.1.1) specifies that radioactive materials which fall within a Nuclear Installation Licence, Nuclear Vessel Licence or Certificate of Registration may be cleared from further compliance with the requirements of the nuclear authorisation provided that such materials meet the considerations for exemption as detailed in section 2.2 of the SSRP or that approval has been given by the Regulator on a case-by-case consideration.

The licensee generates annually small quantities of low-level volumetric contaminated waste such as contaminated oil, contaminated concrete, contaminated sewage sludge and slightly contaminated equipment. For the disposal of the slightly volumetric contaminated material, the licensee is required to comply with not on only international standards but also with those of the SSRP indicated above.

For the licensee, the materials not unconditionally cleared are stored on-site. A portable Multi Channel Analyser monitor/instrument has been procured for measurements/analysis to clear volumetric contaminated material from regulatory control. The sensitivity of the instrument is such that activity concentrations of contaminated material can be measured with activity concentration of less than 0.2 Bq/g which is lower than the national limit for exclusion of artificial nuclides. The licensee has completed further clearance assessments pertaining to volumetric contaminated equipment and materials for regulatory approval.

15.2.2 As Low As Reasonably Achievable (ALARA) Steps Taken

The SSRP (refer 9.1.1) requires that the magnitude of doses to individuals, the number of people exposed and the likelihood of incurring exposures must be kept as low as reasonably achievable, economic and social factors being taken into account (ALARA).

15.2.2.1 Occupational Exposure

In terms of ALARA, the NNR requires the implementation of an effective operational radiation protection programme of which the ALARA programme forms part. Although all parts of the operational radiation protection programme are important, the ALARA programme is singled out for attention because it provides a systematic method for the optimisation of protection, and provides for the formalised system of feedback. The most critical features of the ALARA programme are as follows:

- The integration of the ALARA check-point into the normal system of operational radiation protection
- A tiered approach to pre-task review based on the anticipated collective dose
- The integration of dose reduction methods and practices recommended as a result of the pre-task ALARA review into the normal system of operational radiation protection
- The feedback of the effectiveness of the dose-reduction practices into a database for future use

All tasks to be performed inside the controlled zone are subject to review by the ALARA process to ensure radiological review at the required level.

Operational practices which have been implemented at the nuclear installations to reduce occupational exposure ALARA are as follows:

(1) Operation at reduced temperature (ORT) (discussed earlier in Article 14) where operation at high pH reduces corrosion and therefore the formation of activated corrosion product radionuclides in the primary circuit.

(2) Primary circuit oxygenation which is performed at hot shutdown conditions prior to refueling with the purpose of bringing insoluble nuclides, which are plated out on surfaces of the primary circuit internals, into solution.

(3) Reactor cavity decontamination which reduces the potential for exposure due to re-suspension by ventilation air currents causing an internal contamination hazard

(4) Reactor building contamination control during outage which involves dezoning of the reactor building prior outage work, confining the contamination to point-of-origin using the “step-off pad principle" and an appropriate dress-out policy.

(5) Nuclear auxiliary building/fuel building contamination control which includes an aggressive decontamination policy coupled to a “valve-tracking” programme which identifies leaking valves, implements corrective action, and tracks the effectiveness of the corrective action. The floor surface contamination areas of the Nuclear Auxiliary Building (NAB) and Reactor Building have been reduced from 13% to 1%. This is as a result of major attempts of reducing leaks in the plant.

(6) Zn injection where Koeberg is investigating the practice of injecting Zn into the primary circuit to alleviate/displace ^{60}Co contamination in the primary circuit materials. Although an apparent positive impact on occupational dose and ALARA could be evident in the medium or long term, the impact of Zn injection on fuel is being investigated which includes fuel clad failure possibly affecting the source term in the primary circuit.

(7) Hot spots management in the plant where a serious hot spot reduction programme has been adopted by all Koeberg Departments. This entails recognizing various methods i.e. flushing, cutting, shielding and their consequences and means of improvements.

(8) Training where a full radiation worker training simulator has been established at the training center at Koeberg which entails full practical training requirements for radiation workers encompassing step-off pads, waste handling, instruments, access control, dosimetry, etc.

(9) Completion of the implementation of the SI unit project which could have had some effect on exposures at the workplace.

(10) Replacement of the Whole Body Counter which was necessary due to the change of obsolete components for newer ones. This upgrade will ensure that more accurate measurements are done, based on the latest international references.

15.2.2.2 Public Exposure

As mentioned in the previous CNS Report, it was deemed appropriate to revisit both the off-site consequence modeling to establish dose conversion factors (Sv to a member of the critical group per 1 Bq discharged to air and water) for each transport pathway and for each radionuclide discharged, and to review the adequacy of the activity migration model (AADQ) from which the annual radiological effluent discharges were computed.

In terms of ALARA for public doses, the regulatory body required that ALARA targets for normal operation be implemented. Historical information was consulted in this regard and ALARA public dose targets were established as annually 10 µSv for one outage and 15µSv for two outages. These are formalized in licensee procedures.

15.2.3 Environmental Surveillance

Section 4.7 of the SSRP (refer 9.1.1) requires that an appropriate environmental monitoring and surveillance programme must be established, implemented and maintained to verify that the storage, disposal or effluent discharge of radioactive waste complies with the conditions of the nuclear authorisation.

The environmental surveillance programme established at the nuclear installation is complementary to the radiological effluent management programme. The annual authorized discharge quantities which have been established within the framework of the latter provide an envelope for operational discharges such that the dose limit to members of the public is respected.

The operational environmental surveillance programme provides for the monitoring of any long-term trends in environmental radioactivity, as a result of normal reactor operation, and specific increases in radioactivity which may be caused by unplanned releases. While the former aspect addresses the possibility of discerning any undesirable trends in environmental radioactivity levels at an early stage, the latter deals with the means for observing changes caused by unplanned releases. Accordingly, a conservative philosophy was followed in the selection of samples. Sampling sites, as well as the frequency of sampling/reporting levels for all relevant radionuclides, have been set for all media which may form part of the pathways through which the population may be exposed as a result of operation of the nuclear installation.

The licensee is currently performing a first step habitation study in the vicinity around the plant to update current eating habits and pathways of exposure and environmental source term. This would result in an updated and more accurate public dose assessment in future.

15.3 REGULATORY CONTROL ACTIVITIES

The overall regulatory requirements, safety standards and regulatory practices applicable to the operation of the Koeberg Nuclear Power Station have been extensively discussed in previous Articles.

Regulatory control related to radiation protection is achieved through the conditions of the nuclear installation licence which constrain the licensee to operate according to defined protocols, processes and procedures. Operational feedback is obtained by the requirement on the nuclear installation to submit periodic reports in an agreed format on all aspects relating to radiation protection, as well as thorough problem notification follow up and the NNR compliance assurance inspections programmes including the safety indicator system (refer Article 14). Additionally, Single Process Contact (SPC) meetings with the licensee are scheduled on a quarterly basis and also through counterpart interfaces (frequently) at which operational problems and the effectiveness of the operational programmes are discussed.

The NNR ensures that licensee Radiation Protection staff is involved in the planning stages of modifications and that competent persons have reviewed changes to

Radiation Protection standards, modifications and procedures. All changes to Radiation Protection standards are reviewed by the regulator.

The regulatory body participates in the licensee scheduled quality assurance audits each year. In addition, the regulatory body also implements a series of audits and inspections in accordance with an established programme. Together, these feedback mechanisms provide sufficient information for the regulatory body to focus future assurance activities on particular areas. Through the last 3 years, NNR audits have been performed on emergency planning and solid radioactive waste management, and the NNR has participated in licensee audits on Radiation protection Programme.
In addition, audits, inspections and licensee reports for compliance serve as input to the NNR Safety Indicators to provide a measure of the extent to which the safety goals are achieved.

Issues under discussion at Single Process Contact level, over the reporting period included modifications to reduce occupational doses, tracking of the change-over to SI Units of all radiological quantities, operational AADQ targets for public exposure, minimisation of solid radioactive waste, results of methodology of design basis accident consequence calculations, activity assessment methodology, the review and finalisation of the revised documentation framework, habitation study, and the update of the Activity Migration Model.

15.3.1 Process based licensing for Radiation Protection

As reported in Article 9 the process based licensing process framework would ensure that more emphasis is placed on the licensee to ensure that processes are in place to comply with regulatory requirements, as well as lessen the regulatory burden in terms of minor changes and administrative changes to licensee documents.
The radiological aspects in the licensing basis manual had undergone a number of reviews, and the regulator has ensured that significant radiological protection changes are captured and submitted to the regulator. This applies to the licensee

radiological standards, projects and modifications where the licensee has to ensure that radiation protection staff is involved from the planning stage. Provisions have been made in the licensee documentation to follow the correct process for interfacing with the regulatory authority and also the required review of the authorization process.

Lower level procedures are now reflecting the requirements that were deemed not appropriate for the corporate licensee radiation protection standards. The licensee has to ensure that qualified and competent personnel are responsible for effecting changes to lower level documentation, and that an appropriate review and approval process is in place. The regulator verifies this through audits and inspections pertaining to the technical areas.

15.3.2 Design Basis Accident consequence calculations

In terms of the evaluation of the radiological consequences of design basis accidents using an off-site consequence code to assess the maximum dose to an individual located downwind of the unit at the site boundary, a framework document was reviewed by the NNR followed by independent verification of the results of calculations performed by the licensee. Differences in inputs and assumptions are currently being progressed between the two parties.

15.4. Protection of the Worker and Public Assured

15.4.1 Occupational Exposure

15.4.1.1 Control of Occupational Exposure

Effective control of occupational exposure requires compliance with the dose limits together with a system that ensures that all exposures are kept ALARA. Table 15.4-1 provides information on the occupational doses received at the plant. Trends in recent collective doses may be attributed to the increased work scope, completion high volume material inspection programme as part of the of 10 year In Service Inspection Programme recently, implementation of modifications, rework on active components due to procedure non-compliance and component replacements and additional maintenance due to plant ageing.

Table 15.4-1

Summary of Koeberg occupational exposure data from 1999 to 2006

Year	No of Individual exceeding 20mSv	Annual Collective Dose man-mSv	Average annual Dose to the occupationally exposed worker mSv
1999	1	1726.4	0.983
2000	0	848.54	0.448
2001	0	2308.38	1.020
2002	0	1585.39	0.750
2003	0	2044.3	0.998
2004	0	860.69	0.471
2005	0	2260.4	0.908
2006	0	1595.5	0.658

15.4.1.2 Compliance with the ALARA objective

The numerical indicator selected against which the effectiveness of the ALARA programme is evaluated is the average annual dose to the occupationally exposed workers. The numerical objective is that the average annual dose to the occupationally exposed workers does not exceed 4 mSv. Table 15.4-1 provides data for the variation of this quantity from 1999 to 2006.

Experience with occupational exposure at the nuclear installation indicates that approximately 70 % of the annual collective dose is accrued during outages. It is at this time that the system of operational dose control is under the greatest pressure. The nuclear installation nevertheless performs well, in keeping collective dose for outages reasonably low.

15.4.2 Public Exposure

15.4.2.1 Control of Public Exposure

Public exposure is deduced from the product of the radionuclide-specific annual discharges in liquid and gaseous effluent and the radionuclide-specific dose conversion factor for each pathway. Such modeling is applicable to a member of the critical group, and as such, provides a suitably conservative measure of possible public exposure. The variation in the public dose by year is provided in Table 15.4-2.

Table 15.4-2

Summary of annual public projected doses due to Koeberg operational discharges from 1999 to 2006

Year	Gas (µSv)	Liquid (µSv)	Total (µSv)
1999	0.170	0.394	0.564
2000	0.111	0.384	0.495
2001	0.288	0.36	0.648
2002	0.190	0.34	0.53
2003	0.339	11.874	12.213
2004	1.062	7.6640	8.726
2005	0.484	5.5025	5.9869
2006	0.413	3.6006	4.013

It is evident that the annual projected dose arising from effluent discharges from the plant during 2003 was 4.8% of the NNR dose limit compared to less than 1% for previous years. The reason for the increase in projected dose compared to the previous year(s) can be attributed to a more accurate and realistic method of modeling doses to the public during normal operations. The revised system is based on the latest international guidelines in modeling releases from first principles.

The variation in the total activity discharged by pathway in each year from 1999 to 2006 is detailed in Table 15.4-3.

Table 15.4-3

Total activity discharged from Koeberg by year [GBq]

Year	Activity in Gaseous discharges	Activity in Liquid discharges	Total Activity discharges
1999	1.05 E+04	1.78 E+04	2.83 E+04
2000	6.51 E+03	2.16 E+04	2.82 E+04
2001	2.11 E+04	1.33 E+04	3.44 E+04
2002	9.81 E+04	2.69 E+04	1.25 E+05
2003	2.63 E+04	2.08 E+04	4.71 E+04
2004	1.01 E+05	2.122 E+04	1.22 E+05
2005	2.81 E+04	1.963 E+04	4.77 E+04
2006	2.26 E+04	1.34 E+04	3.6 E+04

Experience of discharges from operation to date indicates that the largest contribution to public dose from discharges for both liquids and gases arises from tritium.

From results obtained from the environmental surveillance programme, activity has been detected in lobster, abalone, white and black mussels. The radionuclides detected include ^{54}Mn, ^{58}Co, ^{60}Co and ^{110m}Ag. The activity concentration is dominated by ^{110m} Ag.

In terms of direct radiation, Table 15.4-4 shows representative average measurements of monthly external exposure at the site boundary by year from 1992 to 2006. The data reflect the total external dose recorded at the site boundary, primarily from natural environmental sources, e.g. the thorium and uranium decay series, environmental ^{40}K, and cosmic radiation, as well as any external contribution due to the nuclear installation. However, trend analysis has not revealed any significant changes in the dose rate at any location since the start of operation. Effluent modeling confirms a relatively insignificant external contribution from the plant.

Table 15.4-4

Average monthly TLD exposure measurements at site boundary

Year	Exposure(Sv)
1999	43.4 E-06
2000	25.8 E-06
2001	24.1 E-06
2002	22 E-06
2003	26.9 E-06
2004	33.545 E-06
2005	34 E-06
2006	33.727 E-06

It should be noted that the decrease in the measured values since 2000 is due to a changed methodology in which contributions measured inside a substantial lead shield ("self-irradiation" and some cosmic-ray), were subtracted from the gross recorded values in the field.

Sewage sludge from a sewage plant in the vicinity of the nuclear installation proved to be a very sensitive indicator of the presence of radioactivity in the environment. Owing to the physical and chemical characteristics of the sludge, radioisotopes are efficiently scavenged from the liquid phase during sewage treatment. Small amounts of ^{54}Mn, ^{60}Co and ^{110m}Ag are usually detected in the sludge. Possible mechanisms include transfer of low levels of activity through the controlled zone boundary on personnel clothing, and the fallout of activity discharged via the gaseous pathway. In spite of considerable effort, these pathways could not be identified unequivocally. Above-normal quantities of ^{131}I have been found on a number of occasions in the sludge. Although this nuclide can also originate from operations at the nuclear installation, it was concluded that the iodine was excreted by patients undergoing nuclear medical treatment, who were resident in the area served by the sewage plant. In order to validate this conclusion, the regulator has required the licensee to perform an investigation using data from hospitals in the vicinity to establish whether the assumed link exists.

It is concluded that the projected public dose resulting from discharges is well within the required limits, as estimated by dispersion modeling and confirmed by environmental surveillance.

ARTICLE 16: EMERGENCY PREPAREDNESS

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 NNR.

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.

3. Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

Summary of changes

1. An update was done in section 16.1 following the implementation of the Disaster Management Act, promulgation of the Regulations (R 388) on Safety Standards and Regulatory Practices, as well as other specific regulations published.
2. Section 16.3.1 was updated to reflect emergency preparedness and response developments at a national level since the last report.
3. In section 16.3.2 the regulatory oversight and activities were included.

4. The Koeberg integrated nuclear emergency plan and all its facets are included and where relevant updated under section 16.3.4
5. Section 16.7.2 was updated to include a summary of the NNR emergency exercise conducted at Koeberg Nuclear Power Station in 2006.
6. Section 16.8 was updated to include the various liaison forums for emergency preparedness and response.

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16.1 LEGISLATIVE PROVISION FOR ACCIDENTS – REQUIREMENTS FOR ON- AND OFF-SITE EMERGENCY PREPAREDNESS AND RESPONSE

The NNR Act and the regulations R388 on the SSRP (refer 9.1.1) specifically specifies the requirements on emergency planning to ensure the preparedness and response to deal with nuclear accidents.

The NNR Act requires that, where the possibility exists that a nuclear accident affecting the public may occur, the NNR must direct the relevant holder of a nuclear installation license to enter into an agreement with the relevant municipalities and provincial authorities to establish an emergency plan and cover the cost for the establishment, implementation and management of such emergency plan, insofar, as it relates to the relevant nuclear installation. Such emergency plan must be submitted by the holder of the nuclear installation licence for approval by the NNR.

The NNR must ensure that such emergency plan is effective for the protection of persons should a nuclear accident occur. The emergency plan includes a description of facilities, training and exercising arrangements, communication with off- site authorities, command and control as well as relevant international organizations and emergency preparedness provisions.

Furthermore, the Minister of Minerals and Energy may, on recommendation of the NNR's board of directors and in consultation with the relevant municipalities, make regulations on the development surrounding any nuclear installation to ensure the effective implementation of any applicable emergency plan. When a nuclear accident occurs, the holder of a nuclear authorization in question must implement the emergency plan as approved by the NNR.

As reported in Article 7, specific regulations have been published, since the last report of September 2004, related to emergency preparedness and response.

(i) The Safety Standards and Regulatory Practices (SSRP) as contemplated in Section 36 of the National Nuclear Regulator Act have been enacted in April

2006. Section 6 of the SSRP includes criteria for the definition of incidents and accidents, information to be supplied, and emergency or remedial measures.

(ii) Regulations 778 on the keeping of a record of all persons in a nuclear accident defined area were published on 4 August 2006.

In terms of other relevant legislation applicable to emergency planning the Disaster Management Act was promulgated on 15 January 2003.

This Act provides for:

- an integrated and coordinated disaster management policy that focuses on preventing or reducing the risk of disasters, mitigating the severity of disasters, emergency preparedness, rapid and effective response to disasters, and post-disaster recovery
- the establishment of national, provincial and municipal disaster management centres
- disaster management volunteers
- matters relating to these issues.

The national disaster management framework comprises six key performance areas (KPA's). Each KPA is informed by specified objectives and, as required by the Act, key performance indicators (KPIs) to guide and monitor its implementation.

(i) KPA 1 focuses on establishing the necessary institutional arrangements for implementing disaster management within the national, provincial and municipal spheres of government and describes some of the mechanisms for funding disaster management.

(ii) KPA 2 addresses the need for disaster risk assessment and monitoring to set priorities, guide risk reduction action and monitor the effectiveness of our efforts.

(ii) KPA 3 introduces disaster management planning and implementation to inform developmentally-oriented approaches, plans, programmes and projects that reduce disaster risks.

(iii) KPA 4 presents implementing priorities concerned with disaster response and recovery and rehabilitation.

(iv) KPA 5 describes mechanisms for the development of both non-accredited and accredited education and training for disaster management and associated professions and the incorporation of relevant aspects of disaster management in primary and secondary school curricula. It also addresses priorities and mechanisms for supporting and developing a coherent and collaborative disaster risk research agenda.

(v) KPA 6 presents processes for evaluation, monitoring and improvement of disaster management as envisaged in the implementation of the Act. It introduces a range of mechanisms for measuring and evaluating compliance with the national disaster management framework and the Act. These include performance audits, self-assessments, peer reviews, reviews of significant events and disasters, and rehearsals, simulations, exercises and drills.

In terms of the decision-making arrangements regarding a nuclear accident, the authority to implement on-site protective actions rests with the nuclear installation emergency controller. In terms of the Disaster Management Act, the off-site authorities are required to verify and implement off-site protective actions as recommended by the authorization holder in the event of a nuclear accident according to the procedures laid down in the emergency plan.

The affected authorities at national, provincial and local level have nuclear emergency response plans in place that are exercised on a regular basis as part of the Koeberg exercises. In terms of section 38(1) of the NNR Act, the licensee has to enter into agreement with the relevant municipalities and provincial authorities to establish an emergency plan. A new Memorandum of Agreement between the three parties was signed in 2004 which specifies provisions for responsibilities, cooperation, inventories of resources and financial arrangements.

16.2 IMPLEMENTATION OF MEASURES INCLUDING THE ROLE OF THE REGULATORY BODY AND OTHERS.

The parties involved with emergency planning are primarily the nuclear installation, the local authorities within the region, the provincial authorities, the national government and the NNR.

The role of the nuclear installation is that of accident recognition and quantification, reporting to the NNR and to any other person described in that nuclear authorization, projection of off-site consequences, assessment of off-site impact, determination of necessary protective measures and recommendation to off-site local authorities to implement such protective measures. In accordance with the relevant conditions of the Memorandum of Agreement between the three parties, the license holder has to provide the necessary facilities, equipment, response teams, training and exercising which relate to nuclear accidents.

In terms of the Disaster Management Act the local authorities are then required to mobilise their civil protection capabilities, to implement protective measures as recommended. The provincial and national governments are required to provide co-ordinated support and direction as necessary. Similarly, the relevant local and provincial authorities have established the necessary resources including emergency control centre capabilities commensurate with their required roles, compatible communication facilities, appropriate monitoring instrumentation and procedures for contamination control at isolation points and mass-care centres and training and exercising programmes.

In terms of the Disaster Management Act, each national organ of state indicated in the national disaster management framework must prepare a disaster management plan, co-ordinate and align the implementation of its plan with those of other organs of state and other institutional role-players and regularly review and update its plan.

When a nuclear accident is reported to the NNR, the NNR is required by the NNR Act to immediately investigate such accident and its causes, circumstances and effects; define particulars of the period during which and the area within which the risk of nuclear damage connected with the accident exceeds the safety standards as determined in the SSRP; direct the holder of the nuclear authorization in question to obtain the names, addresses and identification numbers of all persons who were within that area during that period.

Accordingly the NNR must keep a record of the names of all persons who, according to its information, were within that area during that period.

In addition, the NNR is required to exercise its regulatory responsibility of monitoring the response of parties concerned and of requiring corrective action in the event of inadequate or inappropriate response. In terms of fulfilling its regulatory responsibilities proactively, the NNR also provides a forum for liaison and communication between the parties concerned with emergency planning in order to ensure that the concerns of any party, in respect of the overall provision of emergency planning and preparedness, are addressed.

16.3 REVIEW OF KOEBERG EMERGENCY PLANNING

16.3.1 Overall national emergency preparedness

Although the aim of regulatory requirements is to ensure that the formal emergency planning arrangements of the licence holder and local authority would be able to cope with the early and intermediate phases of a major nuclear accident, it is recognised that a national disaster management organisation would be required to cope with the late phase owing to the need for multiparty/multidisciplinary co-ordination of protective and recovery measures at national level. In the case of a major nuclear accident requiring national response, the relevant Minister would declare a national state of disaster as provided for in the Disaster Management Act.

In terms of the Disaster Management Act the National Government Department of Minerals and Energy (DME) is the "National Organ of State" for coordination and management of matters related to nuclear disaster management at national level. As per Section 25 of the Disaster Management Act, each national organ of state indicated in the national disaster management framework must prepare a disaster management plan setting out providing the concept and principles of disaster management. The DME plan was finalized and approved on 5 October 2005. In terms of the integrated Koeberg nuclear emergency plan, the DME will deploy staff to the national and local disaster management centers.

16.3.2 Regulatory Control

(i) As indicated above in 16.1 the NNR Act and the regulations R388 on the SSRP (refer 9.1.1) specifically specifies the requirements on emergency planning to ensure the preparedness and response to deal with nuclear accidents

The implementation of these requirements is carried out through a condition of the Koeberg nuclear installation licence in a regulatory Requirement Document RD-014 "Emergency preparedness and Response at nuclear installations" to Koeberg Nuclear Power Station. The requirements in this document are based on IAEA GS-R-2 "Preparedness and Response for a nuclear or radiological emergency" and the licensee is required to comply and demonstrate compliance to the requirements of with this document. Compliance to NNR requirements was verified during 2006 through reviews and audits by the NNR.

(ii) In terms of section 38 (4) of the NNR Act the Minister of Minerals and Energy has published Regulations in March 2004, after recommendation from the NNR Board and in consultation with the relevant municipalities, on the development surrounding any nuclear installation to ensure the effective implementation of any applicable emergency plan.

These regulations require that the NNR shall lay down, where appropriate, specific requirements relating to the control and/or monitoring of development within the formal emergency planning zone surrounding a specific nuclear installation, after consultation with the relevant provincial and/or municipal authorities.

In accordance with the regulations, the NNR has finalized these requirements, which were issued to the relevant provincial and local authorities for implementation.

(iii) The NNR has conducted its own emergency exercise in 2006 at the utility to ensure that the emergency plan is effective. As part of the evaluation thereof, a process developed to determine the significance of findings and observations has been applied.

(iv) Continuous review of the integrated Koeberg nuclear emergency plan has been performed by the NNR.

(v) The NNR has put arrangements in place to meet the requirements in the NNR Act on its role and involvement during a nuclear accident.

16.3.3 Safety Assessment

As part of the last periodic safety re-assessment process for Koeberg (refer to Article 14), the implementation of the technical basis for the emergency plan was taken forward.

The basis for the emergency planning zones, new terminology and protective actions as derived from the technical basis were included in the Koeberg Safety Analysis Report. It was also used to update the licensee procedures, and included in the integrated Koeberg nuclear emergency plan. For effective implementation of the plan action times were specified for the different protective actions. In this regard a traffic model was developed, to ensure that zones could be evacuated appropriately. An update of the traffic model as part of the evacuation model which is also required for population development purposes was reviewed and is being progressed.

16.3.4 Integrated Koeberg Nuclear Emergency Plan

In terms of the requirements in the NNR Act, and the implementation of other national legislation such as the Disaster Management Act, the NNR required the licensee to review its emergency plan and develop an integrated emergency plan.

It was decided that roles and responsibilities in the agreement between the licensee and the relevant municipal and provincial authorities with regards to an emergency plan as well as the late phase aspects currently in place in the Koeberg emergency plan should be revisited. Amongst others, the plan aims to establish an organised emergency preparedness and response system capability for timely, coordinated action of intervening organisations in an event of a nuclear accident, and to describe the capabilities, responsibilities and authorities of intervening organisations and a concept for integrating the activities in the interest of public health and safety.

16.4 CLASSIFICATION OF EMERGENCY SITUATIONS

A system of classification of emergency situations is in place at the nuclear installation based upon the severity of the event. Depending upon the severity, the actions taken are varied and could range from activation of the licence holder's emergency control centre, to notification of the local, provincial and national governments. Emergency situations, for which the classification system caters, are defined according to the following categories.

- Unusual Event
- Alert
- Site Emergency
- General Emergency

16.4.1 Unusual Events

An abnormal occurrence which indicates an unplanned deviation from normal operations; the actual or potential consequences of which require the partial or limited activation of the emergency plan.

Releases of radioactive material requiring off-site response or monitoring would not result unless further degradation of safety systems occurred. Only notification to the NNR would be required in such a case and there would be no automatic initiation of the emergency response organisation. Systematic handling of subsequent information would then identify the need to elevate the classification to a higher level.

16.4.2 Alert

An Alert would be declared as a result of events that involve actual or potential significant degradation in the level of safety of the installation. Minor releases of radioactive material are possible during such events. However, any release that occurs is expected to result in a very small fraction of the annual dose limit for members of the public. Events which lead to situations which necessitate the declaration of a Site Alert also have the potential to develop into those requiring declaration of a Site Emergency or a General Emergency. Therefore, specific actions and notifications are necessary for the purpose of bringing emergency personnel to a state of readiness. For example, activation of the on-site emergency control centre by the licence holder's emergency response organisation, notification of the NNR and all off-site civil protection organisations would be necessary. These notifications would ensure that;

- Emergency personnel are readily available to respond if the situation warrants it
- Personnel are available to perform confirmatory radiation monitoring if required
- Current information can be provided to off-site agencies

16.4.3 Site Emergency

A Site Emergency would be declared as a result of events that involve actual or likely failure of the installation's safety functions required for the protection of the public. The potential of significant releases of radioactive material exists. However, these releases are expected to pose a serious radiological hazard only within the site boundary. At and beyond the site boundary, these releases are not expected to result in the annual dose limit to members of the public being exceeded. Severe core damage has not occurred, but extensive off-site radiation monitoring and protective actions may be required. In addition, public notification through the off-site organisations may also be required.

16.4.4 General Emergency

The highest level of classification is the General Emergency, and this would be declared as a result of events which involve actual or imminent core damage with the potential for the loss of containment integrity. The release of radioactive material can be expected to result in serious radiological consequences beyond the site boundary. Extensive off-site radiation monitoring with projections of doses to the public, and the implementation of protective actions are likely to be required. All on-site and off-site agencies are activated. The public will be notified and, if necessary, the on-site emergency response organisation will recommend the implementation of protective measures for members of the public. The on-site emergency organisation will be required to provide continuous monitoring of environmental radioactivity levels and meteorology to ensure that the appropriate protective actions are recommended.

In terms of the classification of the different type of emergencies, the licensee is currently in the process of aligning the criteria for the different categories with those specified in the Safety Standards and Regulatory Practices.

16.5 ON-AND OFF SITE PLANS AND ARRANGEMENTS

16.5.1 Identification and Activation of emergency organization

The identification of emergency situations which pose a potential or actual threat to the installation is performed from the licensee control room where the on-shift emergency controller, normally the supervisor in charge of the operating shift, is responsible for the initiation of emergency response. This is conducted in accordance with emergency procedures and involves the notification of other members of the emergency organization to muster at the emergency control centre of the installation and at the environmental surveillance laboratory. Owing to the potential for the rapid evolution of events from Alert condition to General Emergency, mustering and activation at the emergency control centre should happen within one hour of initial notification. In addition, the notification to off-site authorities is also given at this time and mustering of their respective emergency organizations will take place concurrently.

16.5.2 On-Site Response

Management of the emergency in the early phase is performed by the on-site emergency organization at the Emergency Control Centre (ECC). The team consists of an emergency controller, supported by staff from a range of disciplines to advise on aspects such as meteorology, radiation protection, engineering, plant operation, reactor physics, and media liaison. Survey team members, to assist in providing data from the installation and the environment, are required to muster at given locations in the installation and at the environmental surveillance laboratory. Other activities amongst others by the licensee include classification, prognosis, public notification, communication with on-site and off-site responders and organizations, participation in press releases etc. The licensee Emergency Control Centre directs the off-site survey teams to provide field measurement data to be taken into consideration in determining adequate protective actions.

Upon mustering at the Emergency Control Centre, the on-site emergency team organization recommends protective actions for implementation. The verification and implementation of recommended protective actions is performed by the local authorities. In the case where there is a need for urgent protective actions in the public domain, and where the local authority is not yet in a position to order such protective actions, the on-shift emergency controller should as a priority act in the interest of the public by recommending such urgent protective actions. If time permits this should be done in consultation with the standby Disaster Manager of the City of Cape Town.

A further requirement is that an Alternate Emergency Control Centre must be available for use if the plant Emergency Control Centre becomes untenable owing to the accident consequences.

16.5.3 Off-site emergency situation

16.5.3.1 Identification and Activation

The managing of an off-site nuclear emergency affecting the public is the responsibility of the Government authorities under the Disaster Management Act. The off-site emergency organizations involved are emergency organizations from the Local and Provincial Governments and the National Government.

Initial notification of an Alert or Site/General Emergency at the Koeberg Nuclear Power Station is communicated to the City of Cape Town (CoCT) Disaster Operating Center (DOC) from the on-site Emergency Control Centre. The declaration of a General Emergency as per the Licensee procedure KAA-811 “The Integrated Koeberg Nuclear Emergency Plan” implies a threat to the public which requires the implementation of off-site protective actions by Government authorities. From the Disaster Management Centre notification of the responders from all three spheres of Government takes place. The decision-making team (Disaster Co-ordination Team) is comprised of the Head of the Disaster Management Centre, City of Cape Town and representatives from Provincial Government of the Western Cape (Disaster Management) and the Department of Minerals and Energy.

16.5.3.2 Implementation of Protective Actions

The Koeberg Nuclear Power Station Operating Shift Manager and/or the Standby Koeberg Emergency Controller recommend protective actions in accordance with a Protective Action Form to the Disaster Co-ordination Team. The Disaster Co-ordination Team participates in joint decision making, joint co-ordination and joint management of a nuclear emergency.

The joint co-ordination team recommends a declaration of a national disaster to the National Disaster Management Committee (NDMC) following the declaration of a General Emergency at Koeberg Nuclear Power Station. The Disaster Co-ordination Team may review the recommended protective actions and the technical basis thereof, against protective actions addressed and procedures approved by the NNR, followed by the implementation of protective actions as required. In principle the Head of the Disaster Management Centre (CoCT) may implement the recommendations from the Koeberg Emergency Controller in the absence of representatives from the national and provincial governments.

16.5.3.3 Late Phase Plan

As part of the continuous improvement of emergency preparedness, the late phase aspects of the emergency plan have been enhanced and developed further. The “late phase” aspects of the emergency plan typically commence several days after the accident when work commences to reduce radiation levels in the environment to permanently acceptable levels, and covers aspects such as food bans and decontamination of the environment. The late phase aspects have now been embedded in the integrated nuclear emergency plan. This includes the requirements, processes and responsibilities applicable to late phase nuclear emergency response. The aspects have been compiled in conjunction with the relevant municipalities and provincial authorities in accordance with international standards and guidelines. The integrated nuclear emergency plan is supported by a suite of operational procedures specifically for late phase, which are sufficiently detailed to identify resources, infrastructure, and actions that may be required during the late phase response. A tabletop exercise was conducted in 2003 on late phase aspects, and this was further tested during the NNR emergency exercise in February 2006. Although in general the outcome of the exercise was positive, a number of deficiencies were identified. Eskom, in conjunction with the local authorities in Cape Town, has completed the project to improve upon the late phase aspects of the Koeberg emergency plan. This formed an integral part of the integrated nuclear emergency plan that was approved by the NNR in October 2006. Further work is being done on selected late phase aspects, namely infrastructural decontamination, which through international experience feedback is currently being benchmarked and finalised.

16.6 MEASURES FOR INFORMING THE PUBLIC AND AUTHORITIES

After initial notification once the licensee Emergency Control Center (ECC) is activated further communications is established with the City of Cape Town Disaster Management Organization.

Prior to the activation of the Emergency Control Centre the Shift Manager becomes the acting Emergency Controller (EC) and will operate from the High Voltage Control Room until the stand-by Emergency Controller (EC) declares that the ECC is manned. During a nuclear emergency notification, communication from the ECC takes place by means of a telephone call, which will be followed by a fax, to the off-site Disaster Management Centre. The fax will also be copied to the Regional Nuclear Emergency Manager (part of licensee response) situated at the Joint Alternative Emergency Control Centre (AECC). The fax message includes details of the emergency situation, the classification of the emergency, the time, and the recommended protective action(s). The off-site Disaster Management Centre staff will then disseminate information to other sub-zones at regular intervals to update them on the implementation of protective actions.

Following the declaration of a General Emergency, notification of the public within 16 km from the installation is achieved by siren tones followed by an informative and/or instructional message. Provision of this notification is achieved by:

- 2400 Watt Siren systems installed in areas close to the installation
- 100 Watt Siren units installed on farms or in farming areas situated between 5 km and 16 km
- Vehicles equipped with sirens and public address systems to cater for informal settlements
- Broadcasting of messages via local radio stations

Within the site and out to 5 km, notification is required to be effected within 15 minutes or better, throughout 360 degrees. From 5 to 10 km, notification is required to be effected with 30 minutes, through a 67.5° downwind sector. From 10 – 16 km, notification is required to be effected within a period of 45 minutes through a 67.5° downwind sector.

The Public Warning System Upgrade Project was initiated to include a newer digital communications and telemetry system, and a number of new sirens have been added to the south-eastern sector, where the residential areas have shown substantial growth over the last few years. Some additional sirens were also added to the Protective Action Zone (PAZ) and the residential area north east from the plant as well as installed on Robben Island to cater for visitors and residents of the island. The system now comprises 51 Farm Sirens and 42 Omni Directional Sirens, and is controlled from 1 of 4 locations, namely Koeberg High Voltage Control Room, Koeberg Emergency Control Centre, the Alternative Emergency Control Centre and the Disaster Operations Centers.

A dedicated Joint Media Center (JMC) is available where representatives of Eskom and the intervening organizations meet to finalize information that will ultimately be sent to the media for informing the public about the emergency. Representatives of the media will assemble at the JMC to receive briefings on the status of the emergency based on data provided by the Emergency Control Centre at Koeberg.

Briefings will be provided by the Regional Nuclear Emergency Manager assisted by the Regional Communications Officer and technical staff from the Alternate Emergency Control Centre. Press releases will finally be sent to the South African Broadcasting Corporation (SABC) for broadcasting to the public at large.

Upon the declaration of a nuclear emergency the licensee must notify the NNR who in turn will notify the relevant Governmental structures.

In terms of the international convention on the early notification of a nuclear accident and the convention on assistance in the case of a nuclear accident, the licensee may also notify (depending on circumstances) the International Atomic Energy Agency (IAEA) via the South African Nuclear Energy Corporation (Necsa) the responsible South African institution in this regard.

16.7 TRAINING/EXERCISES

16.7.1 Training

Training in emergency planning is geared to target a specific group of professionals, with a view to enhancing efficiency in responding to an emergency situation. Hence, for the purpose of maximum benefit to the emergency personnel, training courses are grouped according to the functions that must be accomplished in an emergency situation.

Under the Emergency Planning Committee (EPC), a Training Working Group (TWG) has been established to see to the needs of all intervening organisations of the Koeberg Emergency Plan. A matrix of current estimated needs has been identified for each organisation, and has been added to Koeberg emergency preparedness and response training procedure. The Training Working Group has drawn up a strategic plan, which addresses an education process for both senior off-site responders and cascading down each organisation as further training needs are identified by each line department. Each Line Department has been actioned to appoint a Training Coordinator, who will attend the TWG meetings, and will bring the needs of his department to the attention of the TWG.

16.7.2 Nuclear emergency exercises

As part of emergency preparedness, emergency exercises form an important component in the rehearsal of the emergency plan. The effectiveness of the emergency plan using an exercise is determined by evaluation of the performances against defined objectives. These objectives take into account the necessity to test either distinct elements of the emergency plan, or the entire emergency plan. Because the testing of the entire plan necessarily requires the participation of off-site organisations as players, each full scale exercise involves large costs and diversion of resources. Such exercises conducted by the NNR are therefore not frequent, currently being held at eighteen month intervals, and therefore reliance has to be placed on more frequent but less extensive licensee exercises with the objective of testing discrete parts of the emergency plan.

The assurance that the emergency plan will function coherently and according to procedures is gained through a mixture of limited scope and full scale exercises. The NNR, however, relies on the full scale exercise in order to test overall acceptability.

16.7.2.1 2006 Koeberg Emergency Exercise Summary

The NNR conducted an emergency exercise at Koeberg Nuclear Power Station on 15 February 2006.

The findings from the previous exercises, inspections findings and occurrences, together with assessment activities were used to formulate the exercise objectives. Changed procedures or processes related to emergency preparedness and response aspects that might require testing were also considered. The overall objective of the 2006 exercise was to test the response of both the on-site and off-site organizations. Specific objectives of the exercise included testing of certain aspects of the newly integrated emergency plan of the nuclear installations, namely the recognition and classification of the emergency, communication and liaison between the intervening organizations, available resources, the treatment of contaminated injured workers at the Tygerberg hospital near Cape Town, the simulated evacuation of the population to a mass care center, and some specific protective actions to be implemented during the late phase of the plan.

The NNR deployed a number of umpires according to expected responses at specific locations that must be evaluated. Umpires were selected with consideration of NNR staff expertise and experience in emergency exercises, and their familiarity with processes at Koeberg nuclear power plant or related off-site locations. For all the on-site and off-site locations identified prior to the exercise, the NNR umpires recorded detailed observations and associated findings.

For this exercise the NNR invited observers from local and international institutions to witness and observe the activities, responses and actions of the various organizations that were involved in the exercise. Representatives from the South African Nuclear Energy Corporation (Necsa), NNR Board directors, Department of Environmental and Tourism (Northern Cape), Koeberg Alert, Earthlife Africa, Institut de Radioprotection et de Sûreté Nucléaire (IRSN, France) and National Union of Mineworkers attended the exercise as observers. The post exercise debriefing session involving umpires and observers was held on the day after the exercise where initial impressions on the responses, lessons learned and potential areas for improvements were discussed.

The NNR validated all the findings by umpires and observers and compiled an exercise report that was discussed with the licensee and intervening organizations. The NNR concluded that the overall response of Eskom and the intervening organizations has shown that the Koeberg nuclear emergency plan is viable; however specific areas were identified for improvement.

The NNR has developed a significant determination process which uses specific factors where appropriate, to assist the NNR staff to determine the safety significance of exercise findings. This process aims to provide all stakeholders with a common framework for understanding and communication of the safety significance of exercise findings, and a basis for timely assessment and enforcement actions associated with an exercise finding. Following issuance of the final report, Eskom was required to ensure that appropriate corrective actions are identified and implemented to address the findings as a matter of urgency in accordance within identified timescales. At this point most of the findings have been closed out to the satisfaction of the NNR.

16.8 LIAISON

The following forums have been established, with the authorities and the public in the vicinity of the Koeberg Nuclear Power Station, for liaison on emergency preparedness, planning and response.

(i) Nuclear Emergency Preparedness Regulatory Oversight Committee

The NNR has established the Nuclear Emergency Preparedness and Regulatory Oversight Committee (NEPROC) which focuses on oversight of regulatory issues in the form of regulations, assessments, and issues related to population developments etc. These meetings are chaired by the NNR, audience comprise of representatives from the licensee, and the local and provincial authorities. The meetings take place on a quarterly basis.

(ii) Emergency Planning Steering and Oversight Committee

The Emergency Planning Steering and Oversight Committee (EPSOC) provides direction, steering and oversight relating to development and implementation of emergency preparedness and response plans for Koeberg. The committee meets on a quarterly basis. The meeting is chaired by a representative from the organ of state (Department of Mineral and Energy –DME) responsible for nuclear activities.

(iii) Emergency Planning Committee

The Emergency Planning Committee (EPC) is a working committee instituted by Koeberg and the relevant Local and Provincial Authorities to address implementation of the Koeberg Emergency Plan and which reports to the EPSOC on progress. It is chaired by a representative of the local authority, and meetings are held on a quarterly basis.

(iv) Public Safety Information Forum

As indicated above in Article 9.2 the NNR Act requires that the holder of a nuclear installation licence must establish a public safety information forum to inform persons, living in the municipal area in respect of which an emergency plan has been established, on nuclear safety and radiation safety matters.
The established Koeberg Public Safety Information Forum meetings take place on a quarterly basis and constitute a forum where the queries of the public are addressed. The meeting is chaired by a member of the public and is attended by all major role-players involved in the integrated nuclear emergency plan and members of the general public.

16.9 INTERNATIONAL ARRANGEMENTS

South Africa has signed and ratified the following International Conventions that are pertinent to emergency preparedness.

- Convention on Early Notification of a Nuclear Accident
- Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency

As the Koeberg Nuclear Power Station is very far from international borders no agreements have been signed with neighbouring countries specifically on matters relating to notification in the case of a nuclear emergency or the provision of assistance in such a case.

The licence holder is a member of Enatom and, in terms of the associated early notification agreement, would inform affected States either directly or via the IAEA.

ARTICLE 17: SITING

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 evaluating all relevant external man-made and natural hazards likely to affect the safety of the nuclear installation for its projected lifetime;

(iv) For re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (iii) so as to ensure the continued safety acceptability of the nuclear installation;

(v) 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.

Summary of changes

1. Chapter 17.3.2 on development around the nuclear installation has been updated taking cognizance of the finalization of the NNR’s requirements.

2. Chapter 17.4 was updated to taking cognizance of the review of internal hazards carried out during the periodic safety re-assessment of the nuclear installation and associated studies which were undertaken or in the process of being carried out.

17.1 LEGISLATION AND LICENSING PROCESS

In terms of the National Nuclear Regulator Act, nuclear authorizations are required for the siting of nuclear installations.

In terms of reviewing the suitability of a specific site, the applicant must submit to the NNR a site safety report which will sufficiently characterize the site such as to demonstrate that the safety standards of the NNR could be met in respect of the plant design. Typically the site safety report would address the following topics: description of site and environs, population growth and distribution, land-use, adjacent sea–usage (if applicable), nearby transportation, civil and industrial facilities, meteorology, oceanography and cooling water supply, impact of natural hazards, impact of external man made hazards, hydrology, geology and seismology, fresh water supply, site control, emergency services, radioactive effluents, ecology.

Although all these topics need to supported by up to date validated data, one important factor in determining the suitability of the site is that the projected population growth and distribution around the site has to be such to provide the assurance that emergency planning and preparedness arrangements for the site could be maintained viable throughout the lifetime of the nuclear installation.

Should the NNR conclude that the proposed site is not viable and suitable for licensing the applicant will need to consider other alternative sites.

As part of the Koeberg Safety Re-assessment Project (addressed in Article 14) a review and update of the Koeberg Site Safety Report was carried out using up to date data.

17.2 CRITERIA FOR EVALUATING SITES

The criteria applied to the consideration of potential sites are the risk criteria used as a basis for licensing, (addressed under Article 14), which include the analysis of all the topics of the site safety report indicated above with the specific emphasis on projected population growth distribution around the site related to emergency planning, for which specific guidelines are provided by the NNR.

17.3 IMPACT OF THE NUCLEAR INSTALLATION ON THE SURROUNDING ENVIRONMENT

The NNR requires the licence holder to provide adequate source term data to demonstrate that the projected dose to the critical group of the members of the public owing to normal operating conditions comply with the dose limits as specified in the Safety Standards and Regulatory Practices (refer 9.1.1). Furthermore the licence holder is required to calculate accident source terms to demonstrate compliance with the risk limits specified in the Safety Standards and Regulatory Practices. The dose and risk calculations are performed by the licensee.

The NNR has further stipulated limits on urban developments in the vicinity of the installation and holds regular meetings with the licence holder and the local authorities in this regard. The licence holder is required to maintain an effective emergency plan. The emergency plan is regularly exercised by the licence holder and independently by the NNR (every 18 months to two years) (as reported in Article 16).

17.3.1 Accident Conditions

In conformance with licensing requirements, the licence holder has developed a full-scope plant-specific probabilistic risk assessment including severe accident source terms. These are used by the NNR to determine risk to the public and compliance with the above-mentioned risk limits. The licence holder also demonstrates, through deterministic safety analyses, that the nuclear installation meets appropriate nuclear safety criteria for a suite of design basis accidents. These analyses are routinely updated using new codes and methodologies and also in the light of operational experience feedback.

17.3.2 Developments in the vicinity of Koeberg

As reported in Article 16 ,in terms of section 38 (4) of the NNR Act the Minister of Minerals and Energy published Regulations in March 2004, after recommendation from the NNR Board and in consultation with the relevant municipalities, on the development surrounding any nuclear installation to ensure the effective implementation of any applicable emergency plan.

17.4 HAZARDS AGAINST WHICH SPECIAL PRECAUTIONS WERE REQUIRED FOR THE INSTALLATION

During the initial licensing of the nuclear installation all hazards (external and internal) were analysed and assessed and appropriate measures were implemented in the design and in operating procedures to manage the impact of these hazards on the nuclear installation.

As indicated in Article 14 a periodic safety re-assessment of the nuclear installation (Koeberg Nuclear Power Station) was undertaken. As part of this re-assessment some of the major internal hazards were re-assessed as follow:

(i) The hazard from a high or medium energy pipe break was re-assessed during the periodic safety re-assessment. The conclusion was that further assessment would be carried out in accordance with the French EdF methodology. These studies will be carried towards the end of 2007.

(ii) Shortcomings in the fire safety case were identified in the Koeberg periodic review. In response to these findings Eskom reassessed the fire hazard safety case using both deterministic and probabilistic analysis. Upgrades to the fire protection and fire fighting systems have been made. The PSA model is also being updated, by the licensee, to account for the fire hazard.

(iii) The hazard from non-seismic qualified equipment falling and damaging safety-related equipment during a seismic event was also identified during the periodic safety review of Koeberg. The scope of the analysis has been defined and plant walkdowns will be undertaken in the forthcoming plant refueling outages.

(iv) The hazard from internal flooding was also re-assessed; plant walkdowns as well as a deterministic assessment were carried out. Plant changes have been identified for implementation. The integration of internal flooding in the plant PSA has also been completed by the licensee.

(v) In addition to the above the hazard from aircraft crashes has been re-assessed.

17.5 INTERNATIONAL ARRANGEMENT REGARDING SITING

South Africa has not entered into any arrangements with neighbouring countries regarding the siting of nuclear installations.

ARTICLE 18: DESIGN AND CONSTRUCTION

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

Summary changes:

1. Sections 18.1.2, 18.2.2, 18.3.2, 18.4.2 and 18.5.2 were included to elaborate the licensing approach and requirements for the Pebble Bed Modular Reactor (PBMR) project under licensing review, in terms of the topics under discussion

2. Section 18.3.1 was updated to reflect the improvements in hardware, Severe Accident Management Guidelines and the General Operating Rules on the operating plant

   The Article describes the licensing process on design and construction for the operating nuclear installation as well as for the Pebble Bed Modular Reactor that is currently in the design phase. The Pebble Bed Modular Reactor (PBMR) project is being investigated by Eskom as an alternative energy source.

18.1 LEGISLATION AND LICENSING PROCESS ON DESIGN AND CONSTRUCTION

The requirements of the NNR Act and the principal safety requirements formulated in the Regulations R 388 (refer 9.1.1) on Safety Standards and Regulatory Practices form the basis for the stipulation of the regulatory requirements for design and construction of nuclear installations.

18.1.1 Operating Plant (Koeberg Nuclear Power Station)

(i) Regulatory requirements

The regulatory requirements applicable to the operation of the Koeberg Nuclear Power Station have been extensively discussed in previous Articles.

The licensing process which was applied at the time of the Koeberg plant design and construction was extensively covered in the previous three South African national reports to the Convention and is not repeated here.

In summary the licensing process adopted at that time was that the design of any nuclear installation to be constructed should be based on one that was licensed in the country of origin and that utilised design codes and criteria that were broadly recognised internationally. In addition, the design was required to be subject to a quantitative safety assessment making use of probabilistic risk assessment techniques which demonstrate compliance with the quantitative risk criteria laid down by the regulatory body.

The design of the nuclear installation to be constructed was assessed to comply with all the safety requirements of the regulator and a nuclear licence was granted for the construction and subsequent operation of the nuclear installations (refer Article 6).

The operating nuclear installations are now subjected to the regulatory requirements which have been extensively discussed in previous Articles.

18.1.2 New nuclear installation licence application

(i) Regulatory requirements

The requirements of the NNR Act and the principal safety requirements formulated in the Regulations R 388 (refer 9.1.1) on Safety Standards and Regulatory Practices form the basis for the stipulation of the Licensing Requirements for the Pebble Bed Modular Reactor (PBMR).

Unlike the Koeberg Nuclear Power Station the NNR has not granted a Nuclear Installation Licence for the PBMR, which is still in a design phase, and the implementation of the requirements of the NNR Act and those of the SSRP is carried out through the development of specific regulatory documentation e.g. regulatory requirements or/and regulatory guides.

The scope of regulatory assessment for licensing of the PBMR is based on the licensing requirements and safety criteria defined by the NNR in appropriate requirements documents. In addition, guidance is provided on selected issues in appropriate NNR licence guides. The requirements comprise, besides the general requirements to respect good engineering practice, ALARA and defence-in-depth principle, specific radiation dose limits. These are categorised for normal operation and operational occurrences as well as for design basis events for workers and the public. The safety criteria also stipulate occupational risk limits for the workers as well as risk limits for the public for all possible events that could lead to radioactive exposure.

The dual nature of the regulatory safety standards implies that the safety analyses for demonstration of compliance of the Safety Case with the safety standards have to comprise both deterministic and probabilistic analyses. Additional requirements and recommendations are stipulated by the NNR on safety important areas like quality and safety management, supplier and component qualification, qualification of the nuclear fuel and the core structures, core design, verification and validation of computer codes and others as indicated in the table below:

NNR document #	Rev	Title
LD 1091	3	Requirements on licensees of nuclear installations regarding risk assessment and compliance with the safety criteria of the NNR
RD 0018	0	Basic Licensing Requirements for the Pebble Bed Modular Reactor
RD-0016	0	Requirements for licensing submissions involving computer software and evaluation models for safety calculations
LD 1094	3	Quality and Safety Management Requirements for the Pebble Bed Modular Reactor
LD 1096	0	Fuel qualification requirements for PBMR
LD 1097	0	Qualification Requirements for the Core Structure Ceramics of the Pebble Bed Modular Reactor
RD 0019	0	Requirements for the Core Design of the Pebble Bed Modular Reactor
RD 0016	0	Requirements For Authorisation Submissions Involving Computer Software And Evaluation Models For Safety Calculations
RD 0014	0	Emergency Preparedness and response requirements for nuclear installations
LG 1041	0	Licensing guide on safety assessments for nuclear power plants
LG 1045	0	Guidance for licensing submissions involving computer software and evaluation models for safety calculations

Multi Phase Licensing Process

In view of the complexity of this project and acknowledging the developmental nature of the PBMR Demonstration Power Plant (DPP), a multi-staged licensing process has been adopted by the NNR; a similar process was adopted for the licensing of the Koeberg Nuclear Power Station, which proved successful.

The nuclear licensing process is proceeding, with the resolution of a set of Key Licensing Issues (KLI) between the South African National Nuclear Regulator, the licence applicant (Eskom), and the developer of the technology, PBMR (Proprietary) Limited. In 2004 strategies for each of the issues were agreed although changes in the design and new issues that have arisen mean that certain Key Licensing Issues (KLI) strategies still remain unresolved.

The PBMR overall licensing process and planning can be summarised as follows:

In order to demonstrate that the PBMR design will meet the above safety standards and licensing requirements a structured process to develop the PBMR safety case has been developed and implemented. This process also provides a logical link between the various steps of the design process, the safety assessment and the development of operational support programmes. The Safety Case Philosophy underpinning the safety case has been agreed in general between the NNR, applicant and developer, as has the identification of Key Licensing Issues that are to be progressed as a precursor to the Safety Case submittal.

18.2 DEFENCE-IN-DEPTH

18.2.1 Operating Plant (Koeberg Nuclear Power Station)

(i) Regulatory requirements

One of the principal nuclear safety requirements of the SSRP (refer 9.1.1) in section 3.9 requires a multilayer (defence in depth) system of provisions for radiation protection and nuclear safety commensurate with the magnitude and likelihood of the potential exposures involved shall be applied to sources such that a failure at one layer is compensated for or corrected by subsequent layers, for the purposes of:

(a) preventing nuclear accidents;

(b) mitigating the consequences of any such accidents; and

(c) restoring sources to safe conditions after any such accident

In accordance with the safety requirements of the SSRP the principle of defence in-depth, as applied in the design, construction and subsequent operation of the nuclear installation is based on the IAEA INSAG-10 and in its broadest context is upheld by the following requirements of the NNR such that the licence holder is required to demonstrate compliance with the safety standards indicated above.

The licence holder is required to present a safety case for the proposed activity (or change to an existing activity), demonstrating compliance with the above safety standards.

(ii) Defence-in-depth in plant design and operations

a) Implementation of defence in depth in the nuclear installation design

In terms of its implementation in the initial design, the defence-in-depth principle was based on the concept first developed by the USNRC in its document WASH 1250 in which consideration is given to three levels of defence.

Subsequently the application of the defence in depth as indicated in IAEA INSAG 10 is applied at the Koeberg Nuclear Power Station in which fourth and fifth levels of defence have been implemented following the introduction of Emergency Operating Procedures and Severe Accident Management Guidelines on how to cope with beyond design base accidents, and with the existence of the Emergency Plan.

b) Implementation of Defence in depth in the Koeberg Nuclear Power Station operations

The principle of defence-in-depth is upheld in the design basis and operational safety assessment of the nuclear installation and its related operational safety-related programmes (general operating rules).

The implementation of defence-in-depth has been significantly enhanced as a result of the probabilistic risk approach required by the NNR. It has been shown to support the design basis and to identify important improvements in safety at the nuclear installation, including the following:

- Additional off-site power supplies
- Development of shutdown Operating Technical Specifications
- Moratorium on mid-loop operation with fuel in the reactor
- Fast dilution modification
- Requirements on risk management
- Protection against marine oil spills

The need to implement a system of risk management, (to be approved by the NNR) which includes, *inter alia*, the following requirements, is considered an essential enhancement in support of the principle of defence-in-depth:

- To ensure plant configuration control practices are taken into account in the operational safety assessment
- To ensure adequate levels of redundancy of safety trains and support systems
- To impose a risk limit on any twelve-month window including past and planned activities

Presently the licence holder complies with the above requirements through implementation of its Operating Technical Specifications (OTS) (which include the shutdown OTS) and by a process of verifying the validity of the risk assessment against the prevailing plant configuration during shutdown.

Violation of the single failure criterion for short periods of time (e.g. on-line maintenance of safety related equipment) is currently not permitted, regardless of any risk assessment.

Another important aspect of ensuring defence in depth in the operation of the nuclear installation is the comprehensive independent surveillance and compliance inspection programme implemented by the NNR, to verify compliance with the nuclear installation licence requirements and to identify any potential safety concerns, which is complementary to the licence holder's monitoring programme,

18.2.2 New nuclear installation licence application

In line with the principal safety requirements formulated in the Regulations on Safety Standards and Regulatory Practices, and as per RD-0018 "Basic Licensing Requirements for the Pebble Bed Modular Reactor" the principles of Defence-in-Depth (DiD) must be applied to the PBMR design in a manner consistent with the DiD processes described in the appropriate international safety standards and related documents (e.g. Safety Reports produced by the IAEA) so that there are multiple layers of PBMR Functions provided by the Structures, Systems and Components (SSC), and procedures, (or a combination thereof) to ensure that the Fundamental Safety Functions (FSF) of Heat Removal / Reactivity Control / Confinement of Radioactivity are met. Event prevention and event mitigation are natural consequences of the DiD principle.

Normal operation and initiating events (IE) either singly or in combination are grouped into three categories (categories A, B and C) which are defined in terms of annual frequency of occurrence; category A grouping normal operations, category B grouping IE for design basis accidents and category C grouping all IE of categories A and B and those beyond category B (beyond design basis accidents). The frequency of events either singly or as combined events must be assessed accordingly and allocated to the appropriate category. The design provisions for category A and B events, which defines the deterministic framework of the PBMR safety case, must be part of the DiD application. Category C events define the probabilistic framework of the safety case.

Safety Functions

According to the DiD principle, PBMR Safety Functions separate to the operational control and limitation functions must be identified and measures provided to cope with the consequences of category B events (design basis accidents conditions) and to ensure that the FSF are not violated. No credit must be taken in the analyses for category B events from early operator actions or Event Management.

The most limiting Single Failure must be applied to the functional systems of Structures Systems and Components (SSC) providing the required safety functions and taken credit for in the analyses. Any exception to the application of the Single Failure Criterion needs detailed and individual justification.

Levels of Defence

The DiD principle requires that various lines of defence are provided by design and appropriate procedures to ensure the FSF.

Detailed analysis and assessment of the design of the facility and the various systems and procedures are required to ensure that the lines of defence or barriers are of satisfactory quality and independence, taking into account all the facility provisions and operating procedures.

The safety philosophy is aimed primarily at the prevention of events but also gives attention to the mitigation of the consequences of events that could give rise to radioactive releases. The aim is to reduce both the probabilities of the events and their associated radiological consequences (inside and outside the facility).

The use of the following well established principles of defence in depth (as in IAEA INSAG 10) is required:

- Prevention of deviation from normal operation
- Detection of deviations from normal operation and provision of means to prevent such deviations leading to category B events (design basis accidents).
- Provision of engineered safety features (active and passive to control and mitigate the category B events (design basis accidents).
- Prevention and mitigation of beyond category B events (beyond design basis accidents) through the consideration of events or combinations of events with an annual frequency $<10^{-6}$. Emphasis must be put on prevention of beyond category B events. Realistic assumptions and best estimate methods may be used to analyse these conditions against the Probabilistic Risk Limits of the SSRP (refer 9.1.1).
- Mitigation of radiological consequences of significant releases of radioactive materials by means of off-site emergency response.

Barriers

A second complementary aspect of the defence in depth principle is the concept of multiple, independent physical barriers to the uncontrolled release of radioactive material to the environment. The demonstration of the adequacy of these barriers is an important part of the safety analysis.

These barriers must be designed on the basis of the facility's lifetime, both for steady states and transients occurring in any operational conditions and accident conditions.

The nuclear installation must be designed so that:

- Sufficient independent barriers for confinement of fission products are provided.
- The confinement of the fission products is ensured by these barriers with sufficient margins for all category A events.
- The integrity of nuclear fuel is maintained for all category A and B events and fuel failures due to accidental conditions are minimised even for beyond category B events.
- The integrity of the Primary Pressure Boundary (PPB) is maintained for all category A and B events except for the failure assumptions to be set for the PPB itself.
- The overall radioactivity confinement function of the civil structures forming the confinement functional design must be ensured with sufficient margins for all category A events.
- The integrity of the civil structures forming the confinement functional design of the building must be ensured for the category B events. Provisions must be made to minimise the damage of the civil structures for beyond category B events.
- For beyond category B events at least one confinement function must be adequately maintained in such a way that no cliff edge effects occur.

18.3 PREVENTION/MITIGATION OF ACCIDENTS

18.3.1 Operating Plant (Koeberg Nuclear Power Station)

The prevention of accidents and limitation of their consequences is ensured through the following levels of defence:

- Global safety design
- Quality of manufacture and construction
- Safety of operation

Structures, systems and components important for safety are designed with consideration for:

- The importance of the safety function to be performed
- Normal operating, maintenance and testing conditions
- Conditions created by postulated accidents
- Consequences of natural phenomena and human activities

Structures, systems and components important to safety are designed, fabricated, erected and tested to engineering and quality standards commensurate with the importance of the safety function to be performed. A deterministic study of accidents with potential radiological affects on the operators and general public is made on the following bases:

- The most penalising normal operating regime of the unit is considered prior to the accident for accident consequence
- The single failure criterion
- The most severe design base accident studies take place in the most severe environmental conditions (i.e. Loss Of Coolant Accident (LOCA) following safe shutdown earthquake with loss of external power supply)

The following are examples of improvements which have been implemented at the nuclear installation on the basis of the plant-specific risk assessment or on the basis of international experience feedback:

(a) Hardware modifications

The 79 modifications included in the CP1 Alignment Project resulting from the first Koeberg Safety Re-assessment (refer to Article 14) can be categorized under the following theme headings:

(i) Periodic Safety Reassessment Close Out and General Operating Rules (GORs) alignment issues

These modifications originated from the closeout report of the safety reassessment (SRA) performed in 1998 (refer to Article 14), or were identified as improvements to the plant to align the general operating rules.

(ii) Containment Safety Enhancement

This category of modification will improve the containment of potential radioactive release to the public. The modifications will improve system isolation potential, ventilation system, measuring of activity and improvements in system leak tightness.

(iii) Equipment Qualification

This category of modification improves the seismic and/or environmental qualification of equipment identified as essential during an incident, to ensure safe shutdown of the reactor.

(iv) Reliability Enhancement

This category of modification improves the reliability of the plant systems by, improving system start-up times, improving the control function of the systems, and by automating critical actions to avoid functional failure in an accident scenario.

(v) Plant Operating Under Accident Conditions

This category of modification improves the operating condition of the power plant under accident, and in some instances under normal operation, by installation of additional plant/operator interface equipment, installation of safety parameter display console, installation of equipment to prevent accident conditions from arising, and installation of equipment to prevent human error that may have adverse consequences.

(vi) Protection against Hazards

This category of modification includes improvements to protect against high-energy pipe breaks, against internal flooding, against earthquakes for passive equipment and against fire.

(vii) Modifications identified by the French utility EdF during heir second Safety Reassessment

These modifications have the same improvement themes as the categories above, but were analysed as a separate group of differences derived from the batch of French modifications referred as VD-2.

(b) Improvements to operational safety-related programmes (general operating rules) and operator training

- Development of shutdown Operating Technical Specifications is ongoing
- Revision of accident procedures and compilation of relevant background documentation
- Implementation of a Systematic Approach to Training and subsequent Institute of Nuclear Power Operations (INPO) accreditation

(c) Severe Accident Management Guidelines (SAMGs) were implemented in 2000 and have subsequently been updated. Additionally shutdown SAMGs have been developed and are in the process of being assessed by the NNR.

(d) Rules for accident analysis

As reported in previous reports to the Convention, Eskom has completed a project to develop a concise set of rules for the safety case currently in force and upheld in the Koeberg nuclear installation licence. The scope of the project included the following:

- Establishment of fundamental rules for the Koeberg Safety Analysis Report (similar to the equivalent French 'RCCP' document)
- Rules for accident analysis and management
- Close-out of severe accident management issues and incorporation of severe accident procedures into the licensing framework
- Rules for component classification for maintenance purposes
- Identification of a programme of work to align Koeberg with current international practice.

18.3.2 New nuclear installation licence application (PBMR)

Prevention of Accidents

In respect of the principle of defence-in-depth and accident prevention the design must ensure that exposures to the personnel and the public exceeding the category A dose limits are unlikely to occur during the lifetime of the nuclear installation.

Fuel element design, fabrication and inspection, and the conditions under which the fuel is operated must be such as to ensure a high degree of integrity.

The integrity of the reactor coolant system as well as that of the systems connected to it must be ensured by the design with adequate margins.

Attention must be paid to the requirements for inspections, testing, on-line monitoring and maintenance, also in their potential to prevent accidents.

The controls must maintain the reactor within the parameters set for normal operation. The objective must be to reduce the number of challenges to the reactor protection system.

If deviations from normal operation conditions occur which cause specific limits to be exceeded, the operational control systems must detect such conditions and prevent them from leading to category B or beyond category B events.

Mitigation of Accidents

Notwithstanding all preventive features to prevent radiological consequences of events, mitigative measures must be provided to minimise the radiological consequences through the barriers.

For the design basis the confinement system of the building must be designed to meet the radiological targets specified to meet the Basic Licensing

Requirements. The maximum allowable source terms from the confinement (including leakage rates and depressurisation) must be defined to satisfy the Basic Licensing Requirements for the various Initiating Events (IE), and the means to monitor and maintain such leak rates and releases must be provided.

The engineered safety features providing the PBMR Safety Functions to control the development of accidents must be shown to meet the Basic Licensing Requirements.

The use of inherent characteristics and the simplification of systems are seen as important design aims. Passive safety features must be used where appropriate and of overall safety benefit. Adequate time scales are required for any operator actions. Simplification of systems design should facilitate elimination of adverse system interactions.

Measures must be addressed to prevent fuel damage or to mitigate the consequences of event sequences that go beyond the deterministic framework of category B, using appropriate design rules. Such measures must be implemented taking account of probabilistic safety analyses where such sequences make a significant contribution to risk.

18.4 MEASURES REGARDING APPLICATION OF PROVEN TECHNOLOGIES

18.4.1 Operating Plant (Koeberg Nuclear Power Station)

(i) During initial design, construction and commissioning

As reported in the previous two National reports to the Convention the nuclear installation was built between 1976 – 1984 by a French consortium, with Framatome having responsibility for the nuclear island, Alsthom Atlantique for the conventional island, Spies Batignoles for the civil work and Framateg for overall project co-ordination.

The plant, as designed and built, was assessed to comply with credible international norms and practices prevailing at the time. All these design requirements, as well as the specifications contained in the various codes and standards, were validated by extensive Research and Developments (R&D) experiments and testing around the world by credible companies, such as Framatome and Westinghouse, who held specific interests as vendors of nuclear installations.

Furthermore, an extensive testing and commissioning programme was implemented at the nuclear installation, which verified some of the assumptions made in the design of the reactor and associated systems. At each step of the commissioning programme the results of each test were compared to acceptance criteria derived from the safety analyses.

(ii) Current practices

Since the commissioning and commercial operation of the nuclear installation, the same principle pertaining to the use of proven technologies has been applied.

For example, when a modification is carried out on the plant, the design and its implementation has to comply with the requirements of the SSRP (9.1.1) that installations, equipment or plant requiring a nuclear installation licence, a nuclear vessel licence or a certificate of registration and having an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice. This implies that *inter alia* current international norms and standards including an acceptable nuclear quality assurance programme must be utilized. Where computer codes are utilised as a means of justification for the implementation of a new design, the user is required to provide extensive benchmarking evidence of the code used against experimental data; this includes a rigorous quality assurance programme.

For selected designs on more critical safety related plant, independent design verifications are required to be carried out. This ensures that proven technologies, codes and standards are applied during the design phase.

18.4.2 New nuclear installation licence application (PBMR)

As indicated above in terms of the requirements of the SSRP, the nuclear installation must be designed, constructed, commissioned, operated, maintained and decommissioned according to good engineering practice.

Compliance with the PBMR Basic Licensing Requirement – RD 0018 (refer 18.1.2 above) must be demonstrated by way of formalised safety analyses with reference to proven technology and in accordance with international practice (IAEA INSAG-12).

Experience feedback from nuclear operating power facilities and, as applicable, from other industrial facilities must be extensively and systematically used in the design process. Proven components are to be preferred unless alternatives provide clear advantages in one or more specific areas (e.g. safety, cost, reliability) without significantly affecting the others.

Regulatory document, LD 1094 (refer Article 13 on Quality Assurance) details the Quality Management System (QMS) and Safety Management System requirements of the NNR for the PBMR project. Eskom, PBMR (Pty) Ltd and the suppliers responsible for design, construction and operation of the Pebble Bed Modular Reactor are required to develop, introduce and maintain a QMS and SMS that complies with the requirements of this regulatory document.

The quality requirements related to the design include inter alia requirements on the identification and control of design interfaces, independent verification of design, test programmes, design changes, configuration management, selecting and reviewing the suitability of application of materials, parts, equipment and processes that are essential to the defined safety functions of Structures Systems and Components (SSC), and verification and validation to pre-determined requirements.

Where a test programme is used to verify the adequacy of a specific design feature in lieu of other verification or checking processes, it must include suitable qualification testing of a prototype unit under the most adverse design conditions. The test programme must be defined in writing and make provision for signoffs as the test programme conditions are met.

Furthermore, validation of the output of the design and development processes must be performed to ensure that the resulting product is capable of meeting the requirements for the specified use and all design changes affecting safety functions must be submitted to and approved by the NNR prior to introduction with respect to the safety classification of the affected SSC.

18.5 REQUIREMENTS ON RELIABLE, STABLE AND EASILY MANAGEABLE OPERATION WITH SPECIFIC CONSIDERATION OF HUMAN FACTORS AND MAN-MACHINE INTERFACE

18.5.1 Operating Plant (Koeberg Nuclear Power Station)

One of the conditions of the Koeberg nuclear installation licence requires that any design changes affecting safety related systems, components and activities are approved by the NNR prior to their implementation. Procedures, approved by the NNR, are in place to provide standard instructions for modification control compliance, as documented in Reference 6. Departures from established design bases must not only meet technological criteria but where man-machine interfaces are involved adequate measures to address these aspects must form part of the justification for change.

Changes to hardware must have accompanying revisions to working procedures, and the process has to incorporate the commensurate adjustments to training and qualification of staff. This includes modifications to the full scope simulator at the nuclear installation and the necessary upgrading of systems and equipment to keep abreast of internationally accepted norms and practices in NPP operation. The licence holder's organisation is structured to accommodate the development of operational improvements, the feedback of lessons learned and operating experience.

All incidents, occurrences and non-conformances are subjected to trend analysis for human factor aspects and this analysis is used as a basis for structured corrective actions to reduce human errors and/or improve the ergonomic aspects of the operations at the nuclear installation.

Many such improvements have been incorporated into the installation's design and operation since construction and the nuclear installation has benefited significantly from the French Pressurized Water Reactors (PWR) experiences over the years in this respect. (Refer also to Section 12.2.4)

18.5.2 New nuclear installation licence application (PBMR)

The importance of prevention of accidents as the main basis of the safety is emphasised. The design must aim to provide a nuclear installation that is simple to operate and maintain. At the design stage, consideration must be given to the performance capabilities of the personnel who will operate and maintain the facility. The designer must supply information and recommended practices for incorporation into operating procedures. The design must aim for simplicity, adequate margins and forgiving characteristics to minimise the consequences of operator errors.

The design must not place reliance on early operator actions. No credit must be taken in the deterministic safety analysis for such action. However operator error must be considered in the accident analyses.

Adequate time scales are required for any operator actions. Simplification of systems design should facilitate elimination of adverse system interactions.

ARTICLE 19: OPERATION

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

(i) The initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

(ii) Operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

(iii) Operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

(iv) Procedures are established for responding to anticipated operational occurrences and to accidents;

(v) Necessary engineering and technical support in all safety related fields is available throughout the lifetime of a nuclear installation;

(vi) Incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

(vii) Programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations 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.

Summary of changes:

1. Sections 19.3 and 19.4 have been updated to reflect the new completion date of the Safety Related Surveillance Manual (SRSM) and Upgraded Technical Specifications (UTS) projects.
2. Section 19.5 has been updated to reflect that the background of the Emergency Operating Procedures (EOP's) has been completed in 2006.
3. Section 19.5 has been updated to reflect that the upgrade of the Severe Accident Management Guidelines (SAMG's) has been completed, awaiting NNR approval.
4. Section 19.9 has been updated in line with the publishing of the National Radioactive Waste Management policy and strategy

19.1 LEGISLATION

The legislation and associated regulations have been extensively covered under previous Articles

19.2 HOW INITIAL AUTHORISATION TO OPERATE WAS ACHIEVED

The process of how initial authorisation to operate was achieved has been extensively covered in previous Articles

19.3 OPERATIONAL LIMITS/CONDITIONS BASED UPON ANALYSIS

The SSRP (refer 9.1.1) requires that the operational safety assessment (Safety Analysis Report – SAR for Koeberg) must establish the basis for all the operational safety-related programmes, limitations and design requirements.

In order to respect safety limits dictated by the Safety Analysis Report (SAR) the plant is operated in accordance with an Operational Technical Specifications (OTS) document. The current OTS is at Revision 6.
The Limiting Conditions for Operation (LCO) requirements were originally primarily established following a deterministic approach.

With the updating of the SAR, it has become apparent that the link between the two documents is not as comprehensive as desired. To clearly re-establish and document this link, a project to produce an Upgraded Technical Specification (UTS) has been initiated. A clear UTS philosophy and a rigorous material production process were established. The UTS will be based mainly on deterministic processes and criteria, and derived requirements. This will be cross-checked and moderated using various other consistency mechanisms. Included amongst these will be an extensive use of the power station’s PSA models to verify that the deterministically derived requirements are appropriate in terms of risk criteria. Completion of the project is scheduled towards the end of 2008.

To manage the issue of degraded safety equipment, the licensee in consultation with the NNR, introduced an operability determination process in addition to the existing event reporting process and the non-conformance process. The operability determination process provides a clear mechanism by which equipment that is degraded is evaluated in terms of operability by both operating staff and engineering staff. The safety evaluation process is used to quantify the safety risk, and operational recommendations are made back to the licensed operators.

19.4 OPERATION, MAINTENANCE, INSPECTION AND TESTING OF THE NUCLEAR INSTALLATION

The SSRP (refer 9.1.1) requires that an appropriate maintenance and inspection programme must be established.

The maintenance and inspection programme must be implemented to ensure that the reliability and integrity of installations, equipment and plant having an impact on radiation and nuclear safety are commensurate with the dose limits and risk limits.

Inspection and testing is performed at Koeberg on systems, structures and components, whose failure to operate on demand, failure to function during service and/or loss of integrity, either during normal and/or during accident conditions, has a potential impact on the nuclear risk to installation operators and to the general public. Inspection and testing activities are performed in accordance with approved administrative and technical procedures. The surveillances, testing and inspections of equipment are presently distributed amongst a number of programmes.

A project was initiated to produce a Safety Related Surveillance Manual (SRSM) which will contain the functional testing and surveillance requirements, and including the associated bases. The intention is that the SRSM will replace the existing surveillance requirements contained in the Operating Technical Specifications (OTS). Completion of the SRMS project is scheduled for the end of 2008, in line with the completion of the UTS project (referred above).

19.5 PROCEDURES FOR INCIDENTS AND ACCIDENTS

The SSRP (refer 9..1.1) requires that where the prior safety assessment or operational safety assessment (SAR for Koeberg) has identified the reasonable possibility of a nuclear accident, accident prevention and mitigation measures based on the principle of defence in depth and which address accident management procedures including emergency planning, emergency preparedness and emergency response must be established, implemented and maintained. The principle of defence in depth must be applied as appropriate.

Measures for emergency planning, emergency preparedness and emergency response were extensively addressed in Article 16.

Although not member of the Westinghouse Owners Group (WOG), the licence holder utilizes the WOG Emergency Operating Procedure (EOP) package, including both Optimum Recovery Procedures and Function Restoration Procedures. Changes required aligning the licensees package with the generic EOP revision 1C suite was completed during 2002.

A project to update and replace the set of background documents for the EOPs has been completed in 2006.

A comprehensive set of severe accident management guidelines (SAMGs) have been written by Westinghouse for the licence holder. These were authorized by the NNR for implementation in December 2000. A further project to upgrade the SAMGs and to include guidance for severe accidents initiating during shutdown conditions has been completed, awaiting NNR approval.

The original suite of Koeberg incident operating procedures was reviewed and rewritten into the same format as the EOPs. This suite of procedures mainly focuses on at-power incidents. A project has been initiated to review the status of incident procedures during shutdown conditions and to make recommendations on how to improve or replace the suite of procedures. These recommendations need to take into account the intended modifications to the spent fuel pool cooling system and the collection of safety improvement modifications (refer to the French plant CP1 alignment modifications).

19.6 ENGINEERING AND TECHNICAL SUPPORT AVAILABLE

To comply with the conditions of the nuclear installation licence the licensee needs to have sufficient resources in order to address the full scope of requirements imposed by the NNR. Through its continual monitoring of activities associated with the operation of the nuclear installation, the NNR is in a strong position to determine compliance with licence conditions and ensure that the root cause of any non-compliant situation is investigated. Consequently, any deficiency in engineering or technical support would be identified by the NNR, from whence it would be directed to the licence holder for rectification.

In order to be pro-active in this respect, the licence holder has established its own departments at the nuclear installation to handle the wide range of support activities. Where these are not fully staffed from internal resources, the licence holder engages the services of consultants. In addition, the licence holder has entered into technical co-operation agreements with Electricité de France and other utilities in order to be advantageously positioned through having adequate support to address the range of competencies required in any given situation.

Looking to the future, the licence holder is following closely how Electricité de France decommissions its older nuclear plants. Eskom's decommissioning strategy including financial provision is currently based upon that of EdF, but other international practice is also being monitored.

19.7 EVENT REPORTING

As reported in previous Articles in terms of the SSRP (section 4.10.3) a reporting mechanism must be established, implemented and maintained for nuclear incidents, nuclear accidents or any other events that the Regulator may specify in the nuclear authorization.

Monitoring the safety status of the nuclear installation requires that all deviations from the required standards and approved operating regimes are reported, graded and addressed. A condition of the nuclear installation licence is that the licence holder must establish and maintain a problem management and reporting system to the satisfaction of the NNR. This system includes any event, problem, non-conformance, quality assurance finding, quality control deficiency or occupational safety event which constitutes a threat to, or could have an impact on nuclear safety, equipment availability and/or radiation protection. This is documented in Reference 7 which defines the reporting requirements regarding events associated with the nuclear installation.

In order to comply with these requirements, the licence holder has established an approved procedure. The process is tracked using an Electronic Problem Management System (EPMS) which can be summarised as follows:

- Identification and reporting of the event by any installation staff member
- Prioritisation, classification, initiation of action and notification by the shift manager
- Review, verification of the classification and nomination of a lead group, to undertake investigation and root cause analysis according to severity level of the event. This includes the IAEA International Nuclear Events Scale (INES) rating of the event, which is performed by a committee.
- Preparation of a report on the event for nuclear installation management and the NNR
- Agreement on corrective actions and prioritisation within the nuclear installation.
- Checking outstanding corrective actions and notifying the responsible group
- Completion of actions and enter comments on EPMS
- Tracking and reviewing of the actions, updating the database and feedback of relevant information to the management of the nuclear installation and the NNR
- Printing a summary of the event and archiving for records and trending

The system in place at the nuclear installation enables any member of staff to generate a problem report that can be processed in a speedy and standard manner into the EPMS. In order to rapidly define the priority for notification and action, the NNR has laid down strict reporting criteria in accordance with the severity of the event. All events are classified, analysed and collated to provide information for indication of areas requiring further investigation and/or immediate attention to prevent recurrence.

Analysis of events has to cover the four main areas of NNR concern, namely,

a) Protection of the fuel
b) Control of reactivity
c) Containment of radioactive materials
d) Limitation of exposure

Therefore, it is considered important that measures be instituted to redress any shortfalls in the established systems, by means of appropriate corrective actions, in the case of actual events occurring or to identify precursors and trends for minor but recurrent events.

The EPMS reports are received by the NNR and the information is screened for statistical evaluation and analysis. This information is used as one of the tools to gauge compliance with the safety requirements and the conditions of the nuclear installation licence.

Additionally this information is utilised in the following areas:

- To amend the compliance inspection programme to reflect areas of weakness for further attention
- To influence the scope of audits to focus on apparent shortcomings
- To input plant-related data to the probabilistic risk assessment
- To emphasise training and competence in identified areas of operator licensing examinations
- To assist in the identification of human factors as root causes during human performance evaluation

- To highlight information for media transmittal and explanation of events including INES notification via the IAEA

Trending of events is heavily dependent upon the quality of reported data and the integrity of the staff reporting it. To monitor both these factors, the NNR conducts follow up investigations on selected events to verify the facts and to glean additional information for a more complete picture of the event. The objective is to detect problems before they arise and to minimise the consequences of events. This is often achieved by reference to events and 'lessons learned' from other nuclear power plants in the world. The International Atomic Energy Agency Incident Reporting System (IRS) data base, which is supplied to member states to highlight occurrences/incidents to the nuclear community, is supplied to South Africa and is reviewed by the NNR and the licence holder. This system has indicated situations that have needed attention at similarly designed plants and allows corrective actions to be identified before a problem manifests itself universally.

The nature of the NNR's event reporting requirements for the nuclear installation are such that events are categorised, graded and reported to the NNR in a manner related to their impact on the risk. This means that the reporting of any non-compliance is directly related to its safety significance and is dealt with by the licence holder and the NNR accordingly. At all times, the NNR ensures that non-compliant situations are identified, reported and dealt with in the shortest possible timescale. The criteria for non-compliance is clear to the licence holder and the reactive measures are well tried and effective. Any member of staff at the nuclear installation can report problems of any nature without fear of sanction or reprisal. The licence holder has fostered a healthy reporting climate and this is evidenced by the depth and scope of events reported and also by the transparency of the system. Reporting of problems, anomalies or concerns can also be effected through the licence holder's system called "notification of concerns", whereby any matter of concern can be recorded and sent to the nuclear installation management and the NNR anonymously if preferred.

Events are an important source of regulatory data and can yield extensive information for aiding further investigation by the NNR and the licence holder. The analysis, however, has to be undertaken as a component of the total regulatory system for, like all indicators, they must be treated with circumspection to obviate misinterpretations and false assumptions.

19.8 INTERNATIONAL AND NATIONAL OPERATING EXPERIENCE FEEDBACK (OEF)

Events that are significant to safety are reported by the licence holder to the NNR according to a condition of the nuclear installation licence in a regulatory document which contains commensurate reporting timescales which are relative to the safety significance of the event.

The licence holder has formed a group known as the Koeberg Event Group (KEG), which is charged with the analysis, evaluation and trending of events. Events are independently analysed and trended according to accepted methodologies (HPES, ASSET, Kepner Tregoe) by both the licence holder and the NNR. The results of these analyses are formulated into corrective actions by the licence holder, and these are continually followed up by inspections and audits of the NNR. Close-out reports of the events are produced by the licence holder and these reports are subsequently reviewed by the NNR for adequacy. These reports are also discussed with staff from the pertinent disciplines within the nuclear installation to ensure that the appropriate national feedback is given with respect to the dispositioning of the event.

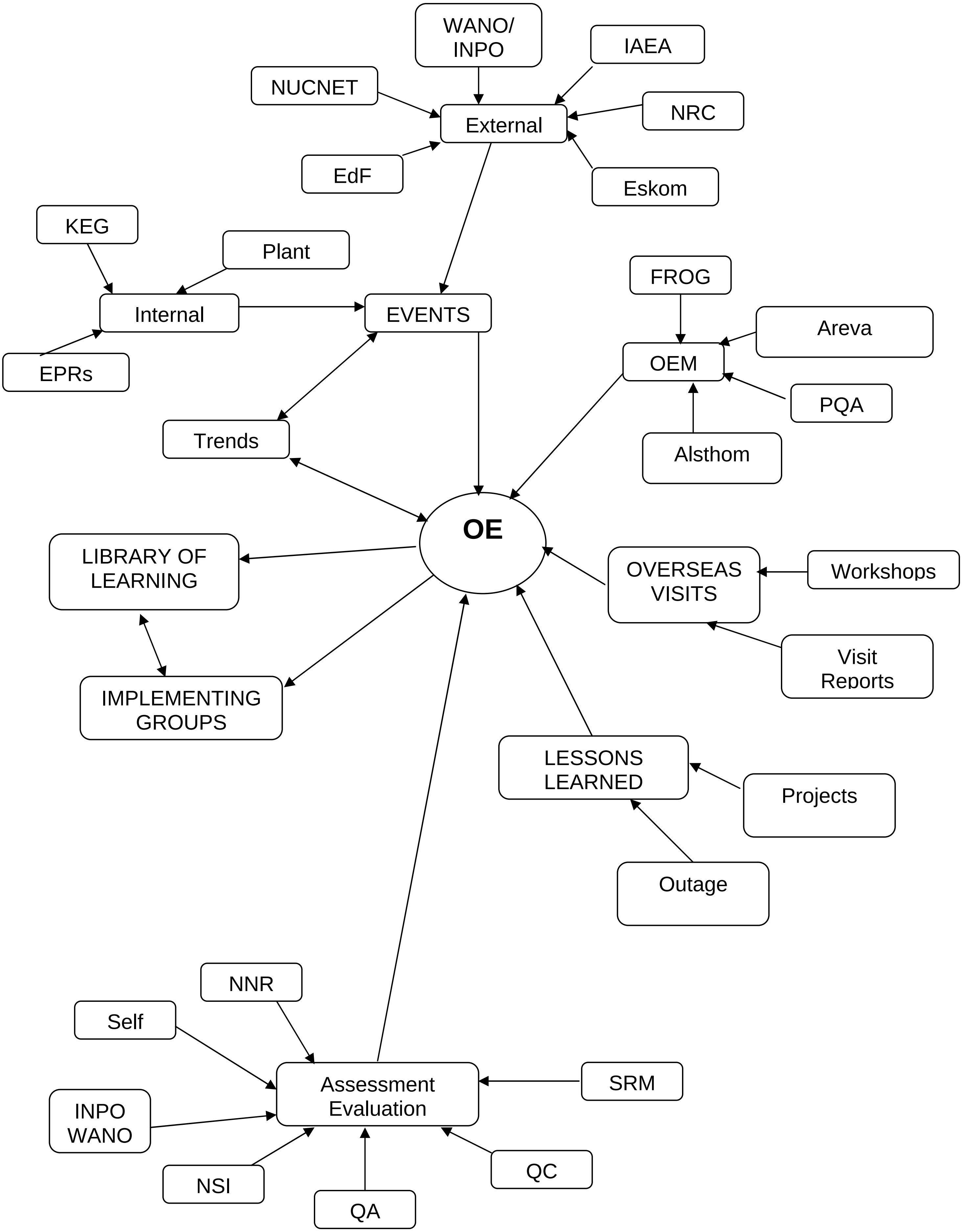
The licence holder reports nuclear safety significant events to WANO, and the NNR also reports events to the IAEA-IRS (Incident Reporting System) for international OEF. The IRS database is made available to all staff within the NNR and has proved to be an extremely useful tool. The database is also made available to the nuclear installation. An important mechanism for South Africa to receive OEF is through the attendance of the NNR at the annual joint IAEA-NEA IRS meeting. Not only are specific recent events reported and discussed in detail, but valuable personal contacts are made to broaden the sphere of international communications.

As reported in Article 8 the NNR has entered in various international bi-lateral agreements with other regulator authorities and these forums are important in terms of OEF.

A Corporate Directive (Reference 8) was produced by the Chief Executive Officer of the licence holder, which stated that, *inter alia,* 'The root causes of significant incidents are determined and appropriate action is taken to prevent recurrence. Experience at similar plants is monitored and utilised'. To implement and satisfy this Directive in conjunction with the requirements of the NNR, the licence holder's management at the installation produced various procedures to formalise and document its operating experience feedback mechanisms.

These procedures identify the licence holder's requirements for collecting, analysing and communicating information on significant industry operating experience. They aid in evaluating the information for applicability and tracking of the resulting corrective actions to completion. They also pro-actively guide the user to utilise national and international lessons learned to improve nuclear safety in an effective manner and applies to the review of industry technical information originating from external sources such as Electricité de France, the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, Framatome Owners Group, the Original Equipment Manufacturer and the United States Nuclear Regulatory Commission. Refer to Figure 19.8-1 for sources of operating experience information.

FIGURE 19.8-1


WANO/ INPO
IAEA
NUCNET
External
NRC
EdF
Eskom
KEG
Plant
Internal
EVENTS
FROG
Areva
OEM
EPRs
PQA
Trends
Alsthom
OE
LIBRARY OF LEARNING
OVERSEAS VISITS
Workshops
Visit Reports
IMPLEMENTING GROUPS
LESSONS LEARNED
Projects
Outage
NNR
Self
Assessment Evaluation
SRM
INPO WANO
NSI
QA
QC

19.9 RADIOACTIVE WASTE AND SPENT FUEL MANAGEMENT

19.9.1 Radioactive waste management

The operational radioactive waste management programme implemented at the Koeberg Nuclear Power Station has been extensively covered in Article 15.

19.9.2 Spent Fuel Management

As reported in previous reports to the Convention the spent fuel at Koeberg is stored at the power station in the following manner:

1) In spent fuel pool which have been re-racked from the initial design to ensure physical storage place for spent fuel for the 40 year operating life of both units.

The increased storage of spent fuel in the spent fuel pool has necessitated upgrading of the pool cooling system. A first stage of upgrading has been completed, a second phase which includes improved instrumentation commenced during 2004, and a third phase which increases the cooling capability is presently scheduled for completion in 2008.

2) In four dry storage casks in which a total of 112 spent fuel assemblies are stored.

As indicated in the National Radioactive Waste Management policy the storage on the site is finite and the practice of storing used fuel on a reactor site is not sustainable indefinitely. Government shall ensure that investigations are conducted within set timeframes to consider the various options for safe management of used fuel and high level wastes in South Africa. Included in the options for the investigations shall be the following:

Long-term above ground storage on an off-site facility licensed for this purpose

A) Reprocessing, conditioning and recycling in South Africa or in a Foreign Country

B) Deep geological disposal

C) Transmutation

But in the interim Used Nuclear Fuel is and shall continue to be stored in authorized facilities within the generator's sites.

REFERENCES

1. Licensing Document : LD - 1077
   'Requirements for medical and psychological surveillance and control.'

2. Licensing Document :LD - 1081
   'Requirements for operator licence holders at Koeberg Nuclear Power Station.'

3. Licensing Document :LD - 1023
   'Quality management requirements for Koeberg Nuclear Power Station.'

4. OPS-7030
   'Plant Operating Technical Specifications (OTS)'

5. Licensing Document : LD – 1020
   'Radiation dose limitation at Koeberg Nuclear Power Station.'

6. Licensing Document :LD - 1012
   'Requirements in respect of proposed modifications to the Koeberg Nuclear Power Station.'

7. Licensing Document: LD - 1000
   'Notification requirements for occurrences associated with Koeberg Nuclear Power Station.'

8. EVD-1047
   Eskom Corporate Directive – 'The safe operation of nuclear power stations.'

9. KSA - 071
   Eskom Standard – 'Experience feedback.'

10. KGA-035

Eskom Procedure – ‘Provision of support through the EdF corporation agreement and other sources’.

11. KAA - 688

Eskom Administrative Procedure – ‘The reporting and investigation of problems, events, occurrences, deficiencies and non-conformances’.