REPORT BY

SOUTH AFRICA

ON

THE CONVENTION ON NUCLEAR SAFETY

AUGUST 2004

<u>TABLE OF CONTENTS</u>

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

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 2001 and presented at the 2nd convention review meeting in April 2002. 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 2001 has been carried over. Furthermore in line with the request made in document CNS-RM-2002/02 each Article is preceded by a summary of the major changes made in the report since the last report of 2001.

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 on Koeberg in February 2004.

(ii) Section 6.3.4 has been rewritten to cover modifications made to Koeberg since 2001.

(iii) Section 6.4 refers to Article 14 for the periodic review and the conclusions thereof.

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.

6.2 OVERVIEW AND MAIN RESULTS OF SAFETY ASSESSMENTS PERFORMED

A periodic safety re-assessment completed by Eskom in 1998 is reported in detail in Article 14.

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 February 2004. 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.

The WANO peer review team examined the following:

- Plant Operations,
- Simulator,
- Chemistry,
- Radiological Protection,
- Equipment Performance & Condition,
- Maintenance,
- Work Management,
- Engineering Support,
- Self-Evaluation,
- Operating Experience,
- Training & Qualification,
- Human Performance,
- Organisational Effectiveness.
- The team spent 2 weeks in the field observing selected evolutions, including surveillance testing and normal plant activities. As a basis for the review, the team used the *Performance Objectives and Criteria for WANO Peer Reviews*; Revision 2 dated March 1999. These were applied and evaluated in light of the experience of team members and good practices within the industry.

The following were noted:

- Effective interface and coordination between the station and grid operator enhances grid reliability.
- The station has maintained a clear focus on nuclear plant safety and reliability while undergoing a substantial change in the composition of the workforce.
- Benchmarking and exchange programs with other nuclear stations are used extensively to improve performance.
- A strong commitment to improving plant performance was demonstrated through development and implementation of operator training programs that successfully met industry standards of a rigorous accreditation process.
- Independent oversight activities are providing useful feedback on plant performance that is valued and used by senior management.
- WANO recognised that progress had been made in several areas but identified gaps in performance in several key areas, which included operator performance, resolution of equipment reliability issues and management effectiveness.

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 licence for 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 licence that a valid and updated risk assessment be maintained of the installation.

6.3.2 The licence holder's modification process

Modifications to the installation were implemented by the licence holder 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 assessment, which forms an integral part of the licensing basis, must be evaluated e.g. design bases contained in the Safety Analysis Report, the plant General Operating Rules (OTS, operating principles etc.) This detailed 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 stipulated risk criteria of the regulatory body.

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 regulatory body

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

Any such proposed modification is reported to the regulatory body 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.

The regulatory body, following its preliminary review of the modification concept, indicates to the licensee whether a detailed safety case regarding the modification must be made to the regulatory body for further licensing 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 regulatory body, before final approval for implementation of the modification is given.

The review process of the regulatory body 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 on the Nuclear Installation

Some of the modifications, which have resulted in safety improvements since 2001 are:

- Improved accumulator level measurement
- Upgrade Reactor coolant level measurement
- Increased spent fuel pool cooling
- Upgrade of Spent Fuel Pool crane
- Upgrade of Control Room alarms
- Automatic venting system for high head safety injection pumps
- Pressure Operated Relief Valve nitrogen back-up
- Code repair of stress corrosion cracking on the refueling water storage tank and pipe work of the spent fuel pool, containment spray and low head safety injection systems.
- Upgrade to reverse power protection of the generator.
- CP1 - Protection of high head safety injection regenerative heat **exchanger.**

Most of these modifications were initiated as a result of various factors such as:

- International operating experience feedback e.g. TMI initiatives
- Other international sources to improve nuclear safety or the installation's cost effectiveness
- Potential weaknesses in the design, identified during the Safety Re-Assessment of the nuclear installation, or resulting from the activities reported under Article 14

A suite of modifications identified as safety re-alignment projects (CP1) has been identified (EdF was used as a benchmark). These modifications will be completed by 2010 by utilising a phased approach in terms of implementation. Batch 1 of these modifications has started with implementation and will be completed by 2007.

6.3.5 Periodic Safety Review of Nuclear Installations

The on-going process of modification control at the nuclear installation is being supplemented by a Periodic Safety Review.

The Safety Re-assessment process is seen to be complementary to the current and historical licensing activities and it is summarised under Article 14 of this report.

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.

As reported in Article 14 of this report a major safety reassessment of the Koeberg Nuclear Power Station was completed by Eskom in 1998 (the NNR review was completed in July 1999).

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

No changes have been made to this Article

7.1 DESCRIPTION OF THE NATIONAL LEGISLATIVE AND REGULATORY FRAMEWORK

The National Nuclear Regulator Act (Act No. 47 of 1999), hereinafter referred to as the NNRA) establishes the National Nuclear Regulator and has substituted the Nuclear Energy Act (Act 131 of 1993) (NEA) which was applicable to the erstwhile Council for Nuclear Safety and which Act has been repealed. The NNRA came into force on 24 February 2000. It regulates the construction and operation of nuclear installations as well as any other activity involving radioactive material which is capable of causing nuclear damage. The NEA legislated the activities of both the Atomic Energy Corporation of South Africa and the Council for Nuclear Safety. The promulgation of the NNRA, which deals exclusively with the regulation of the nuclear industry, is the final step in separating the promotional and regulatory functions in the nuclear industry in South Africa.

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

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

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

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

The regulatory body has formulated, with input from the various stakeholders, national safety standards and regulatory practices and the Board of the NNR has made a recommendation to the responsible Minister to encapsulate these in a regulation in terms of the provisions of section 36 of the NNRA. These regulations are based on international safety standards and practices and once published will be referenced in the relevant nuclear authorizations.

With regard to the regulation of nuclear installations, section 20 (1) of the NNRA 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 to such person by the regulatory body on application.

Section 23 of the NNRA empowers the regulatory body 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 order to ensure compliance with the conditions contained in the nuclear installation licence, the NNRA provides for the appointment of inspectors. The provisions of the NNRA 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 NNRA.

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

The regulatory body may, in terms of the provisions of section 27 of the NNRA, 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 licence, during his period of responsibility as defined.

Section 41 (4)(*e*)(i) of the legislation empowers an inspector to direct the discontinuation of any activity, which in the opinion of the regulatory body does not comply with the requirements laid down for the safeguarding of the public against nuclear damage.

The National Nuclear Regulator Act (Act No 47 of 1999) 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 regulatory body and those of any other body or organisation concerned with the promotion or utilization of nuclear energy.

Summary of changes

1. The mandate of the regulatory body has remained unchanged
2. Additional updated information has been provided regarding the "de Jure"and "de Facto" independent status of the regulator
3. The organization of the regulator has been updated (together with the organizational chart) to reflect changes made
4. Organisation capacity building initiatives has been updated
5. The regulator's technical support by external organization has been added
6. The Regulator's international co-operations has been updated
7. The Regulator's communication strategy has been updated
8. Information has been provided related to the development of the Regulator's Quality Management System (QMS)

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 regulatory body, established as an independent juristic person by the National Nuclear Regulator Act, (Act No 47 of 1999) 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 regulatory body.

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 regulatory body is also established by the NNRA, 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 regulatory body, together with its Chief Executive Officer. The NNRA 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 regulatory body 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 regulatory body setting fundamental risk standards and derived operational standards, conducting pro-active safety assessments, determining licence conditions and obtaining assurance of compliance with these.

The competence of the regulatory body 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 NNRA.

With regard to the de facto independence of the regulator the following is noted. The NNRA 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 NNRA. 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

THE STRUCTURE OF THE REGULATOR

The Board of Directors

The Executive of the regulatory body 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.

The Chief Executive Officer

The approved staff complement of the regulatory body is 86 but at June 2004 the complement comprises 76 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 Regulator are performed in accordance with the NNR Act and the Public Finance Management Act.

The Staff of the Regulator

The NNR's organisational structure (as indicated in Figure 8.2.1) is constituted of the following core groups:

a) Assessment Group

The technical assessment function previously performed by the Reactor Assessment Department and the Scientifics and Technical Assessment Department have been grouped together in one Assessment Group. The assessment Group renders technical assessment functions to all the 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 Nuclear Power Station Programme
- Pebble Bed Modular Reactor Programme

e) Regulatory Strategy Development Division

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

- Legal services
- Communications
- Board Secretariat
- Developmental work in Standards and regulatory practices.

8.3 MAINTAINING COMPETENT AND MOTIVATED STAFF

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. There is a revised Remuneration System that the NNR is developing in order to enhance its attraction and retention capabilities.

8.3.1 ORGANISATION STAFFING

The current staff levels is at 76 and all efforts are made to fill various vacant posts in engineering. The current status with regards to staff distribution is as indicated below.

Staff Category

Chief Executive Officer	1
Senior Management	4
Programme or Departmental Management	8
Process /Functional Sub-group Coordination	9
Regulatory Officers and Specialists (all levels)	31
Administrative, Secretarial and Support staff	23

Demographic representativity - total staff

Total NNR composition

White males	26	(34.20%)
Black males	24	(31.57%
White females	12	(15.78%)

Black females	12	(15.78%)
Disabled	2	(2.63%)

8.3.2 CAPACITY BULIDING INITIATIVES

The continual ageing of the existing workforce, the growing pressures that are exerted on the viability of the future of nuclear power in many countries, including South Africa, the previous exclusion of other population groups from participating in the nuclear power professions and the apparent lack of interest of new professionals from designated groups to engage in the nuclear field are some of the factors which represent a capacity building and development constraint for the NNR. In order to respond to this challenge the NNR has put in place different capacity building interventions indicated below.

(i) Staff Training and Development

The success of the NNR will require well-trained, effective employees. as a result it regards training and development of staff in a very serious light and has this is why it has allocated approximately 2.87% of its personnel budget to staff training and development. priorities in allocating resources for training and development gave specific emphasis to the accelerated training of staff from the designated groups**.**

To achieve this objective, for example, the NNR, through its participation in the Science and Technology Education Fund (STEF), a skills development and funding initiative by Necsa (The South African Nuclear Energy Corporation), NNR, ESKOM (the South African electricity utility, the Pebble Bed Modular Reactor (PBMR) Company and AREVA (France), sent 18 of its employees to attend various courses in nuclear safety and radiation protection in France. The training which was offered by Framatome in France was in the following areas:

- Reactor Safety Analysis, Neutronics and Accident
- Accident analysis simulation codes

- Dose assessment/Methodology and Models-European Radiation Protection

(ii) Bursary scheme

In order to develop skills outside of the organisation in order to prepare the industry for succession and replacement of departing expertise. The NNR provided bursaries to six students during the reporting period. All the bursaries were granted to students from the previously disadvantaged group. Bursaries were allocated as follows:

1) Civil engineering 1x University of Cape Town
2) Radiation Science 5 x University of North West

(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 learners 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 will help learners 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. Three interns have been accepted into the programme. These interns have attended training programmes in the Framatome (Areva) Training Programme in France as indicated above.

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. 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 licenses 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.

At the onset of the Project in terms of the capacity of the NNR, it became evident that in order to undertake the necessary licensing work associated with the PBMR reactor technology it would be necessary to bolster the NNR staff, who were more experienced in licensing of Light Water Pressurized Water Reactors, and to develop in-house expertise in gas/graphite reactor technology.

Thus a campaign of identifying potential local and international technical support in this reactor technology was started. It was concluded that at that time there were no local institutions that could provide such specialized services.

Two international companies have been providing technical services to the NNR for the review of the PBMR safety submissions. It is envisaged that their services will be retained for future technical support, and capacity building of the regulator, during the various stages of the PBMR licensing.

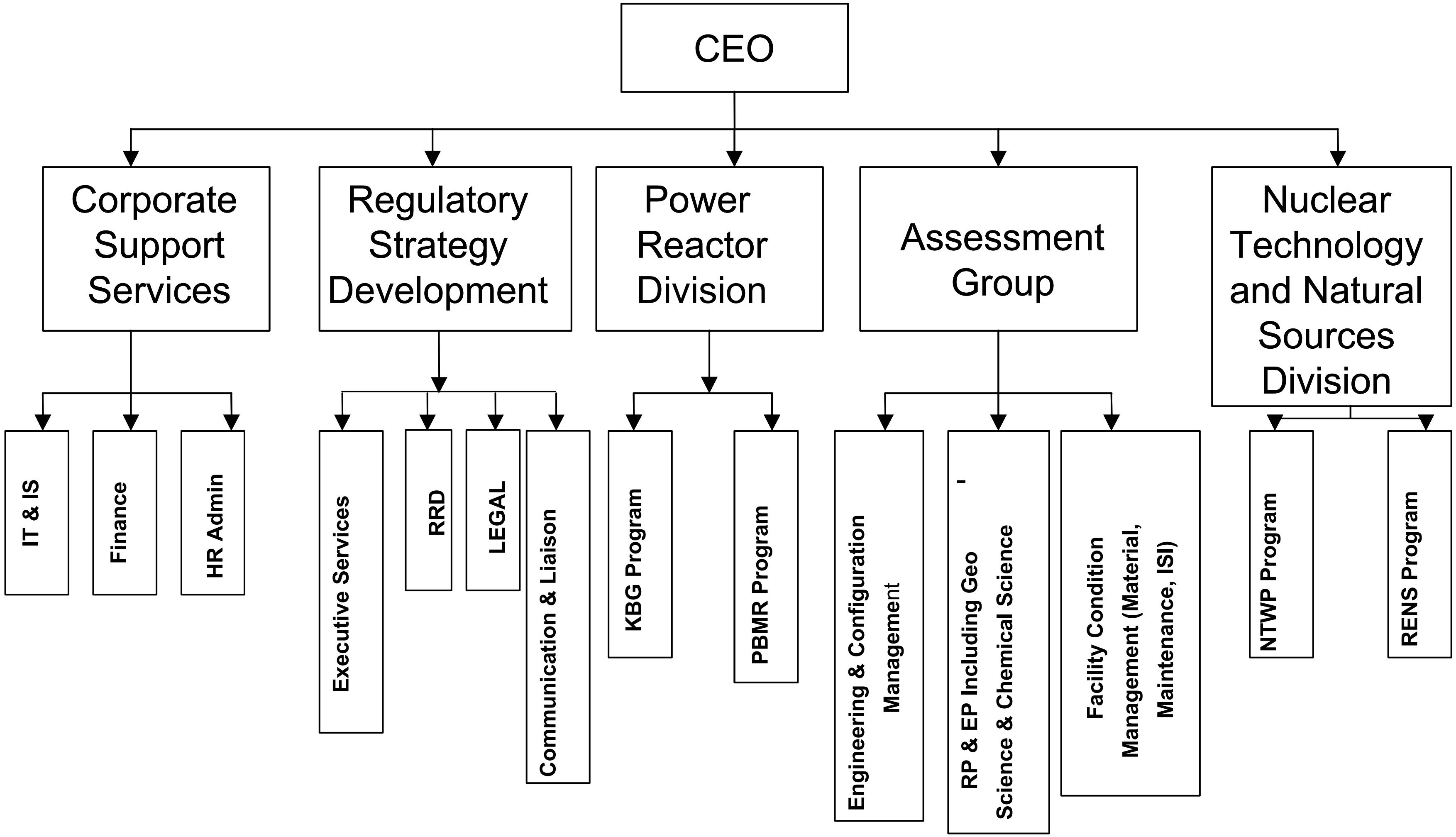
In addition the NNR has also access to technical support from other regulatory authorities with whom the NNR has entered into bi-lateral agreements (refer 8.9 below).

8.6 QUALITY MANAGEMENT SYSTEM

The Regulator 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. It is estimated that this Project would be completed within two to three years.

Figure 8.2-1

ORGANOGRAM OF THE EXECUTIVE STAFF OF THE COUNCIL FOR NUCLEAR SAFETY



8.7 INTERFACES WITH GOVERNMENT

According to section 6 of the National Nuclear Regulator Act, the regulator must give effect to the principles of co-operative governance as contemplated in the Constitution of South Africa i.e. all organs of state with functions in respect of the monitoring and control of radioactive material or exposure to ionising radiation must co-operate with one another in order to –

i) ensure the effective monitoring and control of the nuclear hazard
ii) co-ordinate and promote consistency regarding the exercise of such functions whilst ensuring that duplication of effort is minimised.

8.7.1 Summary of Present status

The function of the NNR is to safeguard the public, workers, property and environment of South Africa against radioactive nuclear hazards. In view of this function, co-operative governance agreements between the NNR and the relevant government departments are essential for the orderly administration of measures designed to ensure the safety of the nation against radioactive hazards.

The NNR is bound by the National Nuclear Regulator Act (Act 47 of 1999) to exercise co-operative governance with other departments of state on issues in nuclear and radiation safety where it is relevant.

Current Status

Three draft agreements have been gazetted for public comment by 18 September 2003. These agreements are as follows:

- Department of Minerals and Energy- Mine Health and Safety Inspectorate
- Department of Minerals and Energy- Electricity & Nuclear
- Department of Health- Directorate Radiation Control

Addressing the comments have been pursued and the agreements await finalization

Future Developments

Two further agreements, being Department of Labor and Department of Water Affairs & Forestry can be issued for public comment shortly.

The NNR has pursued agreement with the Department of Transport and have been informed that agreements have to be concluded with each of the agencies with the department. The NNR is currently engaged in discussions with the Civil Aviation Authority, South African Marine Safety Authority, The National Department of Transport and the Railway Safety Regulator.

The NNR is also working in drafting an agreement with the Department of Environmental Affairs and Tourism.

8.8 INTERFACES WITH OTHER BODIES

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 vests 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 National Nuclear Regulator is organisationally and functionally independent of these various bodies. Eskom Holdings Limited, Necsa and NUFCOR are all holders of authorisations issued by the regulatory body.

The relationship of the regulatory body to bodies responsible for the promotion and utilisation of nuclear energy and related aspects is shown in Figure 8.8-1. It can be seen that independence exists between the respective lines of authority of the regulatory body and the holder of the nuclear authorisation.

The work and functions of the regulatory body are documented on an annual basis in its annual report .

8.9 INTERNATIONAL C0-OPERATIONS

- The regulator is a member of NERS (Network of Regulators of Countries with Small Nuclear Programmes) and as such, shares experiences, etc. associated with having a small nuclear programme. The regulator has successfully initiated bursaries, university courses, schools projects, bilateral training, cooperation agreements, etc. in an effort to attract and maintain competence within its ranks.

- The regulator has entered into several bi-lateral agreements of which some are active and some have expired and can be renewed by exchange of letters. The 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 bilateral agreements with the following regulators are active:

  - The US Nuclear Regulatory Commission (USNRC)
  - The French DGSNR
  - The Australian Radiation Protection and Nuclear Safety Authority (ARPANSA)
  - Slovenian Nuclear Safety Administration (NSA)
  - Atomic Energy Control Board of Canada (AECB)

Whereas the following bilateral agreements will need to be re-instated:

  - Argentina (NBNR)
  - Sweden (SKI)
  - The UK Health Safety Executive Nuclear Safety Directorate

- The Regulator is also part of a group of regulators from countries in which nuclear power station 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 Regulator is also represented in the IAEA Safety Committee NUSSC, WASSC, TRANSSC and RASSC (main SA representation being from the Department of Health Directorate: Radiation Control)

8.10 COMMUNICATIONS AND OUTREACH INITIATIVES OF THE NATIONAL NUCLEAR REGULATOR

The National Nuclear Regulatory Act, 1999 (Act No.47 of 1999) requires public participation in 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 have been established to ensure clear, open and proactive provision on information on regulatory requirements and decisions to stakeholders. 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.

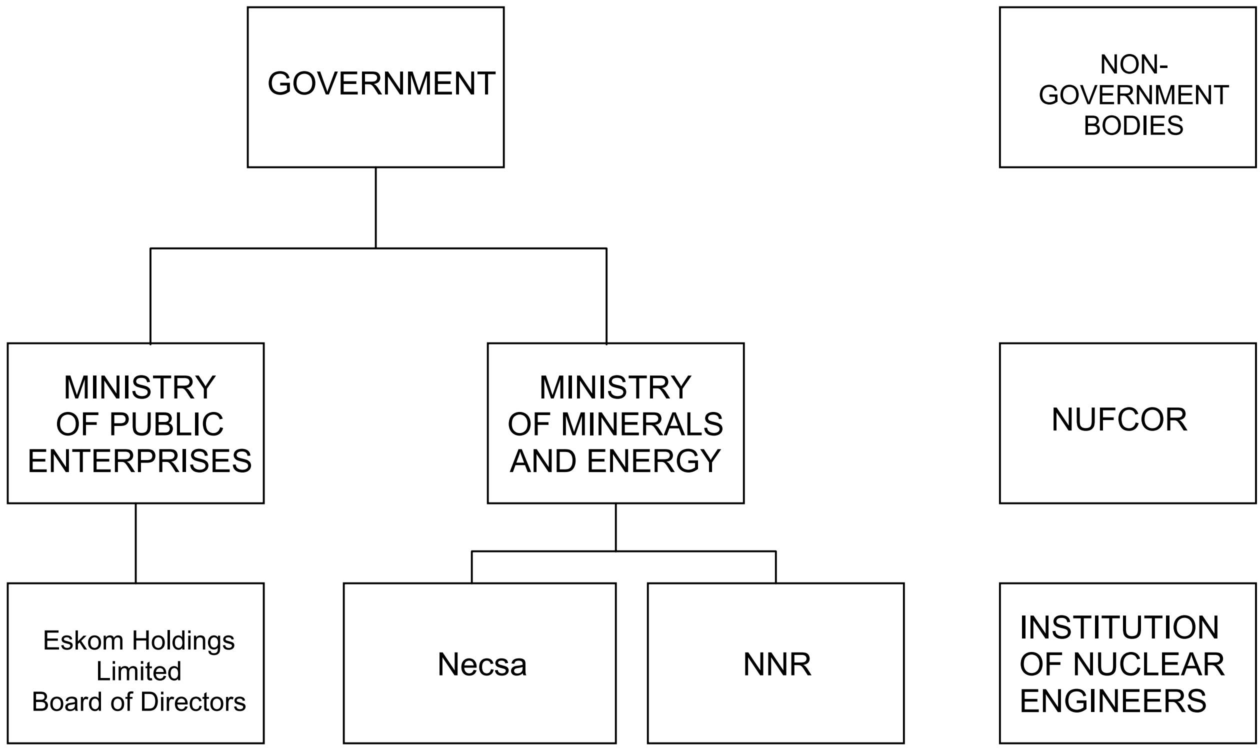
A number of communication forums have been established independently by the Regulator such as labour representative working in authorised facilities, communities living around licensed operations as well as Civil Society forums to ensure regular interactions. Communication with the general public is 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.

The NNR publishes its regulatory outcome activities in the following various publications including annual report, 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.

Figure 8.8-1

RELATIONSHIP OF THE REGULATORY BODY TO BODIES RESPONSIBLE FOR PROMOTION AND THE UTILISATION OF NUCLEAR ENERGY



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:

1. Section 9.1 has been updated to describe process base licensing
2. Section 9.1.2 has been updated to include the changes as a result if the issuance of Variation 14 of the Koeberg Nuclear Licence (NL-1)
3. Section 9.2.4 has been updated to reflect the changes in the organizational structure of both the NNR and Eskom

9.1 DESCRIPTION OF THE MAIN RESPONSIBILITIES OF THE LICENCE HOLDER

9.1.1 The prevailing legislation covering nuclear activities in South Africa takes the form of two Acts of Parliament. These are the Nuclear Energy Act, No. 46 of 1999 and the National Nuclear Regulator Act, No. 47 of 1999 which stipulates that the licence holder is responsible for:

9.1.1.1 Strict liability for any nuclear damage caused by his facility or activities.

9.1.1.2 Compliance with all conditions of a nuclear authorization issued by the regulatory body and implementation of an inspection programme to ensure such compliance.

9.1.1.3 Compliance with Regulations on safety standards and practices as determined by the Minister of Minerals and Energy on the recommendation of the National Nuclear Regulator Board and after taking public comment into consideration. These are currently in draft form.

9.1.1.4 Establishment of a public safety information forum.

9.1.2 In terms of the nuclear licence issued by the regulatory body, the licence holder's responsibilities are:

(i) To operate the nuclear installation within the design and configuration descriptions set out in the licence.

(ii) To conform to the approved fuel designs and performance criteria.

(iii) To comply with provisions and processes regarding the control of plant design and configuration

(iv) 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.

(iv) To regularly assess safety, including carrying out a probabilistic risk analysis.

(v) To demonstrate compliance with the safety criteria of the regulatory body by risk assessment.

(vi) 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.

(vii) To control fabricated isotopes for use on-site.

(viii) To control and limit operation in accordance with an approved Operating Technical Specifications (OTS) document and procedures approved by the regulatory body.

(ix) To adhere to controls on the training, qualification, re-qualification and conduct of licensed operators and candidates.

(x) To provide and control medical and psychological surveillance of licensed operators and candidates.

(xi) To conduct in-service inspection of components in accordance with the approved standards and programmes.

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

(xiv) 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 regulatory body.

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

Radiation dose limitation to persons on site and the public;

A radiation protection organisation structured and staffed to fulfill all the requirements of the regulatory body;

Production of adequate radiation protection standards, procedures and documentation to cover all aspects to the satisfaction of the regulatory body;

Maintenance of health and radiation dose registers to the standards of the regulatory body.

(xvi) To provide an environmental monitoring programme including a meteorological component to the standards of the regulatory body.

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

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

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

(xviii) 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 regulatory body.

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

(xx) To establish, maintain and operate physical security measures to meet the requirements of the regulatory body.

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

(xxii) To obtain written prior approval from the regulatory body for:

Movement of fuel in or out of the reactor cores;

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

Specific reload core designs for each reload; and

Changes to licence conditions or to any document listed as part of the licence.

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

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

Civil monitoring test reports; occurrence notifications for incidents, events, non-conformances and quality deficiencies.

(xxiv) To ensure that, notwithstanding the provisions of the 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 regulatory body.

In terms of the above a distinction can be made between two fundamental types of licensing approaches: a prescriptive licensing approach and a 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 licensees processes thereby placing the responsibility for technical details in the hands of 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 Koeberg is somewhere between these two approaches. The NNR put forward a proposal of general licence conditions with this aim in mind. From that point onwards it was up to Eskom to produce the necessary documentation to meet this proposed approach.

The strategy followed was for Eskom 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 standards.

- Monitoring of compliance with requirements, including reports to NNR.

The NNR and Eskom conducted a number of workshops and meetings. The objectives of the Koeberg licence optimization project have been achieved and the new licence was issued in June 2002.

The NNR has stipulated a number of documents important to nuclear safety which will still require NNR approval prior to the implementation of any change. The NNR maintains controlled copies of selected safety related documentation, and has access to Koeberg's documentation database.

The "trivial" workload has been reduced, allowing more time for NNR staff to maintain a clearer perspective on international issues and developments. The KLBM includes Eskom's processes in respect of experience feedback, which the NNR will monitor.

The KLBM 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 regulatory body 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 licence are documented and incorporated into an approved process with independent assurance that the licence requirements are complied with.

9.2 DESCRIPTION OF THE MECHANISM BY WHICH THE REGULATORY BODY WILL ENSURE THAT THE LICENCE HOLDER WILL MEET ITS PRIMARY RESPONSIBILITY FOR SAFETY

The NNR ensures that the licence holder meets its primary responsibility with regard to safety essentially by the establishment of nuclear safety standards, the issuance of a nuclear installation licence and regulatory letters and by a compliance assurance programme, 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 9.2.1 – 9.2.4, 10.4, 10.5, 14.4 and 14.5.

9.2.1 Fundamental Safety Standards

The NNR has established fundamental safety standards (initially developed during the licensing phases of the Koebeg Nuclear Power 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, must be assessed for licensing purposes. These standards include:

- Risk criteria addressing mortality risk to the public (present and future generations) and workforce,
- Radiation dose limits to members of the public and workforce arising from normal operations,
- Fundamental safety principles (including defence-in-depth and ALARA),
- General safety principles relating to the requirement to comply with international norms and practices,
- Requirements for emergency planning,
- Criteria for exemption from the nuclear licensing process.

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

These safety standards, are currently detailed in regulatory documentation e.g regulatory requirements or/and regulatory guides and are included as applicable in the authorization granted to the licensee e.g for Koeberg Nuclear power Station Nuclear Licence NL-1. Section 36 of the NNR Act (which came into effect in 2000) requires that the Minister of Minerals and Energy must, on the recommendation of the NNR board, make regulations regarding the safety standards and regulatory practices. These would be National Standards. A process to produce these standards is currently on going. Draft standards were published for public comments and the Ministry is currently reviewing those comments

9.2.2 Nuclear Licence

In terms of the National Nuclear Regulator Act (Act no 47 of 1999), the licence holder is required to provide the NNR with any information the NNR considers necessary to demonstrate that the licensed site is acceptably safe.

The nuclear licence is a set of conditions drawn up by the NNR expanding on the requirements of the act with conditions specific to the site in question, relating to the plant, the site and environs, licensee organization and processes, and safety related documentation. These conditions essentially amount to three types, namely, for the documented safety case (including supporting documentation and operational programmes), implementation of compliance assurance related processes, and reporting requirements.

9.2.2.1 Safety Case

The licence requires the licence holder to develop and maintain a documented safety case which demonstrates compliance with the safety standards of the NNR, 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
- Nuclear safety rules, criteria, standards and requirements relevant to the safety assessment
- Safety analysis documentation addressing rules, computer codes, models, methodology, input data, analyses, results and conclusions demonstrating compliance with nuclear safety rules, criteria, standards and requirements
- Operational safety-related programmes and limitations of operation
- Plant management documentation (ie 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.

It is required that the safety case include a risk assessment carried out in accordance with the NNR licence document.

The Koeberg Licence Basis Manual includes a requirement that the safety case itself shall be subject to review and periodic safety reassessment using an internationally accepted reference as a benchmark.

9.2.2.2 Processes

9.2.2.2.1 Safety Assessment

The 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 of the NNR. Proposed modifications to the plant or changes to documentation referenced in the licence must be submitted to the NNR for approval prior to implementation along with a safety justification including a risk assessment where applicable.

9.2.2.2.2 General operating rules

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. These cover the following:

- Controls and limitations on operation
- Maintenance and inspection programme
- Staffing and qualification
- Radiation protection
- Waste management
- Environmental monitoring and surveillance
- Accident management and emergency planning
- Transport of radioactive material
- Physical security
- Quality management programme
- Decommissioning programme

The licensee is required to ensure that all operational safety-related programmes covered by the general operating rules are procedurised and implemented accordingly.

9.2.2.2.3 Compliance Reporting

In addition to the technical assessment reports referred to above, the licence holder is required, by a condition of the licence and the Act, to make available reports and other information to the NNR. These include the following:

- Problem notification, occurrence, quality assurance and audit reports, including close-out reports

- Environmental monitoring reports
- Reports on gaseous and liquid effluents from the plant
- Radiation protection dosimetry reports
- Medical and psychometric testing reports
- Operating experience feedback reports
- Fuel performance reports
- Specific Reload Safety Evaluation Reports
- In-service inspection reports

9.2.3 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 responsibility of this department is to provide assurance that the licensee complies with the licence. The NNR compliance assurance programme is described 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).

9.2.4 Regulator/licensee meetings

The findings of the compliance assurance activities (inspections, surveillances, audits) are taken up with the licensee at different levels.

The following meetings are conducted between the Koeberg project department of the NNR and the corporate safety assurance department of the utility:

9.2.4.1 Koeberg licensing and liaison committee meetings (KLLC) (monthly)

These meetings are attended by the Manager and two Process Coordinators of the Koeberg Programme of the NNR, and on behalf of Eskom by the Manager: Generation Safety and Assurance and five deputies ("Process Custodians") responsible for Safety Assessment, Operations, Engineering, Maintenance & In-Service Inspection, and Radiation Protection. At this meeting the status of actions arising from submissions and other correspondence, projects (including modifications, assessments, etc.) are discussed, and follow-up actions identified. Where necessary Single Point Contact Meetings (see below) are arranged to resolve in-depth technical issues.

9.2.4.2 Koeberg Safety Assurance Group (KSAG) (Quarterly)

These meetings are attended by the Manager and two Process Coordinators of the Koeberg Programme of the NNR, and from Eskom, the Manager: Generation Safety and Assurance and three deputies responsible for Quality Assurance, Inspections and the Koeberg Events Group. Koeberg Nuclear Power Station is represented by the manager of the Independent Safety Evaluation Group (ISEG).

The purpose of the meeting is to deal with matters concerning safety assurance processes, including the Integrated Monitoring Programme, Quality Assurance audits, experience feedback and safety indicators.

9.2.4.3 Single Point Contact Meetings

These are specialist meetings held between Koeberg and NNR specialists and attended by the relevant Eskom "Process Custodian" and NNR counterparts on an ad hoc basis to address in-depth technical issues typically relating to a single discipline area (e.g. Radiation Protection, Maintenance, In-service Inspection, Operator Training)

9.2.4.4 Programme Meetings

These are held on a regular basis during a major project such as changes to fuel design, spent fuel reracking, optimized licence basis project, emergency planning basis, etc. They are typically attended by the relevant Process Coordinator of the Koeberg Programme along with NNR specialists and or regulatory officers, and from Eskom by the relevant specialists and project manager.

9.2.4.5 Nuclear Strategic and Safety Liaison Committee (Quarterly)

This is attended and chaired by NNR and Eskom senior management, i.e.; NNR: CEO, Senior Manager Power Reactor Division, Manager Koeberg Programme; Eskom: General Manager (Nuclear Cluster), Generation Safety and Assurance Manager, Koeberg Power Station Manager and the PBMR Client Office Manager. The subject of these meetings concerns national, international, organizational, legal and specific issues not adequately resolved at lower level meetings.

9.2.4.6 NNR/Eskom Executive meeting (Ad hoc)

Specific issues not resolved at above NSSLC meetings are dealt with at this forum.

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 section on safety principles 10.1 has been updated
2. The section on Safety Culture 10.2 has been updated
3. The section on operator training 10.3 has been considerably updated

10.1 ESTABLISHMENT AND IMPLEMENTATION OF SAFETY PRINCIPLES

10.1.1 Safety Policies

Nuclear safety policy is addressed at three levels viz. the national government, the national nuclear regulatory body and the operating utility as licence holder.

10.1.1.1 National Policy

At the national level, legislation has been promulgated which establishes a national nuclear regulatory body and which prohibits operation of any nuclear installation that has not been licensed by that body. The regulatory body is independent, free of any potential conflicts of interest and funded primarily from licence fees and also by a government grant. It is comprised of a Board whose prime responsibilities are to ensure that the objects of the regulator are carried out and to exercise general control over the performance of the regulator's functions. The legislation requires applicants and licensees to submit whatever information is requested in respect of licence applications and for changes thereto, and empowers the regulatory body to impose whatever conditions are deemed necessary in the interests of nuclear safety. Powers of access, inspection and instruction to rectify unsafe situations are afforded to nominated inspectors of the regulatory body.

Strict liability for nuclear damage is covered in the NNR Act and is ascribed to the licensee who must provide financial security to the satisfaction of the Minister of Minerals and Energy. This liability is limited to an amount determined by the Minister but the Minister is further empowered to require the holder of the nuclear installation licence to give additional financial security or approach the national parliament for additional funding to provide for nuclear damage, should this be deemed necessary.

10.1.1.2 Policy of the Regulatory Body

At the level of the regulatory body, the licensing policy adopted is one that requires applicants or licensees to demonstrate compliance with three prime requirements. Firstly, that internationally recognised standards of good engineering design and operational practice are respected. Secondly, that the risks presented by the facility to the workforce and the public, from both normal operation and from accidents, meet specified quantitative criteria and thirdly that a viable emergency plan be established and maintained in a state of preparedness.

The risk standards are based on the principles that the risks arising from licensed facilities should be comparable with those from other industries and they should not dominate the risk to the sectors of society involved. Facilities must also be designed in such a way as to accommodate observed trends of society becoming less tolerant of risk with time such that no significant backfitting of safety features is required over the lifetime of the facility.

The licensee is required to maintain the validity of the safety case in respect of modifications to the plant or in the light of new findings or knowledge. The latter requirement is manifested in processes of both ongoing review and periodic safety re-assessment. Conditions of licence address all aspects of operation including those related to personnel qualification. In this respect reactor operator candidates are subject to examination by the regulatory body prior to qualification as control room operators.

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 cluster 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. The directive commits to compliance with regulatory requirements and openness to inspection by the regulatory body 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 licence, together with plant technical specifications and operational programmes it is obliged to implement. The licence also details the reports that must be made by the utility to the regulatory body viz. both routine and occurrence reports.

10.1.2 Regulatory Safety Standards

The Regulatory Safety Standards have been explained in Article 9.2.1 above

10.2 SAFETY CULTURE

10.2.1 Safety Culture Programmes

The regulatory body was involved at an early stage in the development of safety culture programmes as part of the teams formed by the IAEA to progress INSAG-4 and the ASCOT guidelines. Since 1991, this involvement has continued and regulatory body 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 regulatory body was actively involved in its follow-up. As a result of the overall success of this evaluation, the licence holder was encouraged by the regulatory body to pursue the close-out of the survey findings and to continue safety culture climate surveys at the nuclear installation.

10.2.2 Safety Culture Monitoring and Feedback

To aid in identifying underlying trends of safety culture, the regulatory body 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 regulatory body to the nuclear installation staff on safety culture topics and the licence holder convenes periodic nuclear safety awareness seminars, which are attended by all site 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 regulatory body and the licence holder to enhance safety culture have included the following:

(i) Establishing dialogue with worker representatives and Trade Unions on 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) Reward system for recognition of safety issues.
(ix) Nuclear Safety Concern process.
(x) Human Performance drive.
(xi) Outage safety focusand 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. The regulatory body has moved to a more process-oriented licensing approach, which demand increased discipline and safety culture from staff of the nuclear installation and increased vigilance from the regulatory body to detect incipient weaknesses or any deterioration of safety commitment.

10.3 OPERATOR TRAINING AND EXAMINATION

The competence of operating staff and the regulatory measures that are in place are key elements that contribute to ensuring the safe and conservative operation of the Koeberg units.

10.3.1 Historical perspective

During the early 1990's, Koeberg experienced a shortage of licensed operators due to a high attrition rate from the operating department, an inadequate 'feedstock' of licence candidates, and a continuing poor initial licensing exam pass rate.

The changes in South African political framework and the re-admittance of South Africa into the world's nuclear forum created a flow of information and a realization that improvements in operator training were needed to meet the increased expectations of operator performance. This mismatch between the quality of re-qualification training and expectations of operator performance led to the implementation of an Operator Enhancement Programme (OEP) which was implemented during 1996 and 1997. The OEP was successful in raising the standard of operator competence at Koeberg and upgrading the standard of operator re-qualification training. Process and regulatory measures were introduced to ensure that operator competence and the quality of operator re-qualification training remained at a high level. New regulatory measures included new standards and requirements, periodic assessments of licensed operators and training programmes, and close monitoring of the implementation of the training process by the NNR.

The OEP did however raise operator stress to an unacceptable level, which was one of the main reasons for organizing an international peer review of operator training at Koeberg during 1998.

Four of the main recommendations from this international peer review were:

- Revise the governance of training to support a performance-based regulatory model.
- Organise the training department to consolidate resources, integrate training management accountability, and facilitate achievement of INPO accreditation.
- Develop a selection and bridging programme that will enable KNPS to meet its staffing requirements to address the unique demographic and entry-level characteristics of new recruits.
- Continue to apply the systematic approach as the KNPS primary training management tool. Complete lesson plans and formal on-the-job training guides for the Koeberg Nuclear Power Station operator training programmes.

Important initiatives emanating from this review were:

- A Koeberg Training Manager position was introduced, reporting directly to the PSM. An 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 Developments since 2001

Although the standard of licence re-qualification training had been improved, various actions from the international peer review still needed to be completed, and the licensee continued to experience poor initial licensing exam pass rates. There were continuing concerns regarding the quality of licence candidate preparation and what constituted an appropriate difficulty level for initial licensing exams, prompting the need for a review of the situation.

10.3.2.1 Initial licensing workshop and improvements

A workshop was arranged in September 2001 to allow Eskom and NNR staff involved with the training and licensing of operators at Koeberg nuclear power station to discuss all aspects of the operator licensing process. Two ex-NRC staff with extensive experience in the licensing of operators in the USA participated in the workshop and provided expert guidance and recommendations on the application and interpretation of the NUREG-1021 operator evaluation methodology.

The workshop was thus focused on reviewing the NUREG-1021 licensing standard and criteria, and consequently on making recommendations for future licensing of operators at Koeberg.

The following were the main recommendations from the workshop:

- Move to the application of the NUREG-1021 examination methodology, to eliminate previous deficiencies in preparation, validation and administration.
- Eskom to prepare license exams, NNR to review and approve.
  - The NNR to conduct next license exams, with Eskom participation.
  - The longer-term goal was for Eskom to conduct exams with NNR oversight and final licensing.
- External expertise should, if possible, be used to validate guidance on the application of NUREG grading criteria using hypothetical examination results.

- Further USNRC assistance should be sought to develop evaluators, and ensure appropriate application and benchmarking of the NUREG criteria and standards as applied at Koeberg.

- Independent technical review of future examination grading by Eskom and NNR was warranted to ensure consistent application of grading criteria. The NNR management were to consider measures to accomplish this recommendation.

- Eskom were to continue efforts to address the following issues:
  - ♦ SAT
  - ♦ Accreditation
  - ♦ Operating procedure weaknesses
  - ♦ OTS improvements

A new operator initial licensing examination process based on NUREG-1021 was developed jointly between Koeberg and the NNR. Under the new process, Koeberg 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 has also positively impacted on the re-qualification training of licensed operators.

10.3.2.2 Implementation of System Approach to Training (SAT)

Although delayed, the process of converting the operator training process to an SAT-based system has now been completed, although further improvements continue. All operator 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.

10.3.2.3 Operating simulator upgrade

A multimillion-dollar project that includes new hardware, operating system and selected software models (core, reactor coolant system and steam generator models) has been 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.

10.3.2.4 Accreditation of operator training

At the end of 2003, Koeberg was successful in achieving accreditation for all of its operator training programmes with the USA-based National Academy of Training (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 regulatory body 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 regulatory body 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 regulatory body has further reinforced its commitment to safety at the installation by enhancing its dedicated team of site inspectors and examiners with further specialists to upgrade its monitoring and permanent presence. This has enabled the regulatory body 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 regulatory body is, therefore, better informed to assure the public that the installation's staff are committed to the pursuit of safety and that the regulatory body is equally committed to effective vigilance and appropriate action.

10.4.2 Establishment of corporate safety assurance group

Eskom have established a corporate safety assurance organisation “Generation Safety and Assurance” (GS&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

GS & A also runs the Nuclear Safety Inspectorate and Quality Assurance functions. The establishment of GS&A has resulted in an organisation 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 GS&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 GS&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 International review of operator training

International review of operator training and follow up actions and INPO accreditation for operator training achieved in 2003 is reported on in Article 10.3.

10.4.4 Safety Engineer Function

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

10.4.4.1 Safety Function Confirmation

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

- Trend critical plant parameters during normal operation to detect early warnings of potential safety problems.
- Provide an independent level of monitoring of safety system performance and make recommendations accordingly.
- Confirm the availability of safety related systems.
- Confirm the availability of post accident mitigation equipment.
- Approve the plant work plan after a risk evaluation.
- Confirm 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.

10.4.4.2 Outage Safety

- Assist and advise during the planning phase to ensure compliance to the OTS.
- Participate in deterministic risk analyses and propose mitigation methods.
- Confirmation that the equipment is correctly requalified.
- Confirm that the 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.

10.4.4.3 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 Ops 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 (SAMG's).

10.4.4.4 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 SAMG's.
- Review changes to the Operating Technical Specifications (OTS) and surveillance requirements.
- Participate in the safety review of plant modifications and safety cases.
- Participate in KORC and KOSC. (Koeberg review and safety committees)
- Participate in appropriate audits and evaluations.
- Provide training related to nuclear accidents and incidents, prevention and mitigation.

10.4.5 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 17 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.

10.4.6 Operating Experience Feedback

During the review period, significant changes in terms of processes and organization were put in place affecting all groups involved with Operating Experience. The most significant changes were the formation of the Operating Experience OE Group, responsible for external experience feedback and the total direction and management of the OE system. (Refer to secion 12.2.5)

10.5 REGULATORY CONTROL

10.5.1 Design, Construction and Commissioning Phase

The system of regulatory control for nuclear installations within South Africa was structured around several factors. At the time that the existing power station was under consideration in the mid 1970's, it was clear that the technology would be imported and as such would most likely have been licensed in the source country. The approach adopted therefore was to require that the design should be compliant with internationally recognised principles and requirements, that it should have been demonstrated in the source country and that it should be demonstrated to comply with laid down quantitative risk criteria. These criteria considered both normal conditions of operation and potential accidents, including those within and beyond design basis accidents. They also considered the workforce and members of the public. In addition to having to demonstrate compliance with the risk criteria, it was also required that a viable emergency plan be established and maintained in a state of preparedness.

The responsibility was placed on the licence holder to structure and present a documented safety case for the nuclear installation that would be reviewed by the regulatory body. The approach adopted did not entail prescription by the regulatory body of any specific design or operational requirements, rather allowing the licence holder or its contractors to propose and justify their chosen internationally recognized standards, which were then subject to review by the regulatory body and referred back for assessment if deemed necessary. Similarly, no format was prescribed for presentation of the safety case. This aspect was also subject to proposals by the licence holder or its contractors and followed by regulatory review. The agreed format entailed compilation of a site safety report and a preliminary and intermediate safety analysis report. The latter was complemented by a series of licensee submissions leading to start-up and commissioning through to full power operation. The site safety report presented all the technical information relating to the site covering all pertinent aspects including geology, seismicity, hydrology, meteorology, demography and geography. The safety reports presented a description of the installation, an assessment of compliance with the design bases and a probabilistic risk assessment of potential accidents.

The reports were subjected to extensive review by the regulatory body both before and during the construction phase of the project and various design changes were made on account of shortcomings and issues identified. The review also identified areas for more focused regulatory inspection during the fabrication and construction phases and identified aspects of the commissioning programme, which were to be subjected to regulatory scrutiny. Hold points were identified during the construction phase which covered, inter alia, civil, mechanical and control and instrumentation aspects, physical security and emergency planning.

10.5.2 Operational Phase

At the stage of bringing nuclear fuel onto site, a licence was issued which was subsequently varied to allow for nuclear commissioning up to full power and commercial operation. This is reported on in section 9.2. The licence covers various key elements namely:

- The plant description and its configuration and modifications thereto
- The maintenance of a valid safety assessment
- Scope of activities that may be undertaken
- Controls and limitations on operation
- Plant technical specifications
- Control room requirements
- Maintenance and in-service inspection programmes
- Operational radiation protection
- Effluent and solid waste management
- Emergency planning
- Physical security
- Quality Management
- Reporting requirements to the regulatory body

The conditions of licence embodied in the different sections of the licence refer to documented specifications, programmes, processes and procedures. These may be installation or regulatory body documents.

The licence forms the basis for all regulatory control activities. Any modifications to the plant or its operation are subject to a process that requires progressively greater levels of review and approval with increased potential for nuclear/radiation safety impact. This process varies from in-house installation review and approval up to review and approval by the regulatory body. The safety assessment requirements are set out in a regulatory body document and address the necessity for maintaining the assessment current.

10.5.2.1 Change Control Process

In terms of the requirements of the nuclear licence (Article 9.2) the licensee is required to submit safety assessments to the NNR for review of the following:

1. New licence application.

2. Modification on a licensed site impacting on safety.

3. Change to the current licensing basis.
   Change to licence-binding documentation
   Change to any aspect of the safety envelope.

4. Experience feedback concern (international or plant-specific)
   Any safety concern raised as a result of a proactive assessment on an International topical issue.

5. Any assessment required by the NNR.

Guidance is given to the licensee on such safety submissions in terms of:

- Background on licensing process
  - Legislation
  - Fundamental Safety Standards
  - Safety Case
- Licensing schedule and submissions
  - Notification
  - Submission of safety case
  - Contents of safety case
  - Safety case for different licensing stages
  - Preliminary assessment
- Construction/modification/installation
  - Fuel on site/fuel/loading/testing/commissioning
  - Plant operation
  - Decommissioning
- Project management
  - Safety analysis report
  - Licensing requirements and fundamental standards
  - Safety philosophy and approach

Rules applicable to the safety case

Design criteria

Codes and standards

Testing

Description of the plant, site and environs

Safety/risk analysis

Safety analysis methodology and validation

General operating rules

Interim safety related programmes

Supporting documentation for safety case

Plant management documentation

10.5.2.2 Compliance Assurance

A baseline inspection and audit programme was developed and implemented on an electronic task management system linked to a system of safety indicators. The scope of the inspection and audit programme is described in section 14.4.

The NNR compliance inspection programme is laid out in NNR document STI-18 "Compliance Inspections at Koeberg Nuclear Power Station". This, along with the audit programme, serves as a useful basis for the findings which serve as input to the safety indicators. Each safety indicator may be traced back electronically to specific findings with reference to the reports on the task management system.

Input to the safety indicators is provided by the various monitoring processes implemented by the NNR which 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).

(Compliance assurance programme is further described 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:

1. Chapter 11.3 on Financial and human resources for decommissioning/ radwaste has been updated

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 privatization, escalating resource costs, national demands for cheaper power and social integration will challenge the ability of Eskom to remain competitive. This in turn impacts on the regulatory body’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 regulatory body 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 licence that the efficacy of these training programmes is audited on a regular basis. Participation in these audits is actively undertaken by the regulatory body. 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 licence. It is also a requirement of the nuclear licence that the efficacy of these training programmes is audited on a regular basis. Participation in these audits is actively pursued by the regulatory body.

It is a condition of the nuclear licence that only individuals licensed by the regulatory body 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: to pass written examinations set by the regulatory body in the areas of nuclear power plant fundamental theory, and in normal, abnormal and incident plant operation; to pass simulator examinations in normal, abnormal and incident conditions; to pass in-plant walk-through examinations; and, for SRO candidates, also to pass in-plant examinations in the performance of emergency controller duties. The licensing standards of the regulatory body are considered to be the equivalent of NUREGs 1021 and 1122. The content and scope of examinable subjects, for licensed operator training, is prescribed by the nuclear licence.

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 regulatory body. Full re-qualification examinations are given regularly. Provided that operators meet all the regulatory body 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 regulatory body.

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 licence to a standard considered to be the equivalent of ANSI: ANS-3.5. Failure to meet the regulatory body criteria for simulator fitness-for-purpose results in non-compliance with the regulatory body training standards and has a direct impact on operator re-licensing qualification.

The nuclear licence requires minimum shift staffing levels and the notification of organisational changes to the regulatory body. 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.

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. Subsection 12.2.5 ‘Operating Experience Feedback’ is completely rewritten. Outdated information with reference to WANO has been omitted.

2. Subsection 12.4 ‘Role of the Regulatory Body’ has information added concerning the development and use of Safety Culture Indicators.

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 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 qualification is achieved through stringent examinations that include written, simulator and plant walkthrough testing by the regulatory body.

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 feedback of operational experience, results of performance monitoring and human error analyses to the management, the training department and incident investigation committees of the nuclear installation leads to the identification and implementation of appropriate corrective actions. Re-qualification training for licensed operators provides on-going correction and enhancement of operating skills. The human factors specialist of the regulatory body 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. (See Section 18.5 for a further discussion of Man-Machine Inter face considerations in plant design changes)

12.2.5 Operating Experience 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.

The areas for improvement highlighted during the self assessment at the end of 1998 and confirmed by the WANO peer review also led to some fundamental changes in the processes used to handle internal event investigations and corrective actions. (CAs)

Examples:

- 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 CA's at a Corrective Action Review (CAR) Meeting.
- Prioritization of all CA's.
- Effectiveness review of closeouts identified at time of issuing the CA.

All significant operating event reports (SOER's) received from WANO and INPO are formally tracked and generic studies by EDF processed via the 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 independent corporate safety group, referred to as Generation Safety and Assurance (GS&A), has been operational for approximately four 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

The regulatory body 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 licence documents (References 1 & 2). The operators are to comply with these requirements at all times.

The regulatory body maintains the services of consultant medical and psychological experts to provide independent advice, monitoring and evaluation of nuclear installation staff. Six monthly psychological interviews are conducted with operating staff by the regulatory body consultants in a climate of openness and confidence with the operators. It enables the regulatory body 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 regulatory body 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.

The safety culture indicators are based on the IAEA INSAG safety culture principles and attributes as described in the ASCOT Guidelines. Data gathering utilizes a perception survey instrument to elicit responses from two sample groups of licensed nuclear reactor operators. Given their extensive nuclear license training and ultimate responsibility for operational safety on plant the perceptions of control room operators provide vital information on safety culture issues. Salient findings of the survey are the following:

- The survey investigation provided some insight into the intangible nature and formation of safety culture, as well as contributing to an understanding of the way safety culture affects operational safety.

- The use of safety culture indicators and subsequent management of safety concerns effectively extends the role of the regulator in safety culture beyond that of merely passive monitor.

- The perceptions of the operators serve as a critical critique of the effectiveness of safety culture oversight groups such as plant management and organizations external to the plant, notably the regulator and government.

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 :

1. Section 13.1.1 has been removed as it provided the QA policy of the erstwhile Council for Nuclear Safety which is no longer applicable.

2. The new section 13.1.1 (previously section 13.1.2) has been updated to reflect changes to Eskom's organizational and management structure in terms of the Nuclear Cluster organisation.

3. Section 13.4 has been updated to describe the PBMR Safety Assurance Group (PSAG).

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 Cluster and the Generation Safety and Assurance Department. These are based on the IAEA Safety Code 50-C/SG-Q, Licence Document LD-1023 and the Eskom Directives.

The responsibility for the implementation of QA policies is that of the General Manager Production (Nuclear Cluster), and the Generation safety and Assurance Manager who are responsible to the Managing Director (Generation Division) for operating the installation safely within the terms of the nuclear 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 regulatory body.

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 regulators 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. If an Indicator should deteriorate 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

Requirements of the regulatory body for the licence holder's quality assurance activities are specified in a licence document (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 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 licence holder.

The monitoring programme for Koeberg Nuclear Power station and the PBMR Demonstration Power Plant is developed in accordance with the requirements of LD 1023 in consultation with the regulator. 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 regulatory body
- Corporate Safety Assurance oversight processes

Corporate Safety Assurance Activities

In addition to the above, further monitoring activities are conducted by the regulatory body as required.

During refueling outages, the licence holder generates a dedicated surveillance programme, which is designed, implemented and controlled by its QA Department. Site-based inspectors of the NNR identify those surveillance activities that they are required to observe. Results of these surveillances are reviewed by the installation's operations review committee whose duty it is to identify and initiate appropriate corrective actions.

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

- Corrective action close-out
- Occurrences
- Audit findings
- Non-conformance reports
- Work orders

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

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

The regulatory body and the licence holder conduct their own independent auditor training programmes whilst the licence holder, represented by the 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.

Site based inspection personnel are required to be trained and become certificated according to a modular Inspector Training programme. The modules cover the Nuclear Energy Act, basic inspection techniques and reporting and a Site-specific training module which is based on the functional area and discipline in which the Inspector is a technical expert.

Audit findings and concerns are used as input to NNR safety indicators (and separately the utility's safety indicators) described in sections 9.2.2 and 10.3. The indicators are used to prioritise future monitoring activities.

Koeberg Safety Assurance Group (KSAG)

Regular meetings are held to deal with matters concerning safety assurance processes related to the Koeberg Nuclear Power Station.

NNR access to the Eskom's Electronic Problem Management System (EPMS)

The NNR monitors Koeberg's process of closing out deficiencies through direct access to the plant Electronic Problem Management System (EPMS).

13.4. OTHER QUALITY MANAGEMENT ACTIVITIES

Eskom is currently exploring the possibility of acquiring a High Temperature Gas Reactor (HTGR). With the possible advent of having to licence such a type of reactor the Regulator and Eskom have embarked on a series of initiatives.

From the quality management, assurance and control aspects the Regulator has developed a Licence Document, LD-1094. Eskom used this as the basis for a User Requirement Specification, to be upheld during the design, which in turn will be specified in the Contract Works Information during the construction and, commissioning of the reactor.

The quality management programme requirements applicable to the HTGR have been established on various international quality 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 Regulator has embarked on a programme in order to keep pace with the design development.

13.4.1 PBMR Safety Assurance Group

Regular meetings are held to deal with matters concerning design and safety assurance processes related to the PBMR.

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 nuclear authorization process adopted in South Africa in the early 1970's, when the Koeberg Nuclear Power Station project was in the planning stage, was originally based on the assumption that the national electricity utility would purchase reactors of a design that had been demonstrated in the country of origin and licensed in that country, according to national requirements and compatible with internationally accepted standards. The particular design was then demonstrated to comply with national safety criteria, which were laid down by the nuclear regulator. These criteria are of a quantitative nature in terms of radiation doses and risks to the public and the workforce and address both normal and operation and accident conditions. The licensing approach adopted was to require that:

- the design basis of the plant should respect prevailing international norms and practices in terms of engineering codes and standards, implementation of defence in depth, operational practices etc…and ,

- that a quantitative risk assessment should demonstrate compliance with the safety criteria.

The risks to the operators and members of the public, related to identified accidents scenarios, were required to be assessed by way of probabilistic risk assessment and to respect safety criteria. The criteria were expressed in terms of individual risk and population risk with a bias against more severe accidents. The assessment was also required to demonstrate deterministically that public and occupational exposures arising from normal operations would be compliant with a dose limitation system and a requirement to maintain doses as low as reasonably achievable (ALARA principle).

It is also required that an appropriate emergency plan be demonstrated to be in place and that preparedness to implement the plan be maintained.

The above broad approach was followed in the 1970's-1980's for reviewing the licence application and issuing the nuclear licence for the commercial operation of the Koeberg nuclear power station.

In terms of new licensing projects the South African National Nuclear Regulator (NNR) has received an application for a nuclear installation licence for the prospective siting, construction, operation, decontamination, and decommissioning of a demonstration unit for a Pebble Bed Modular Reactor (PBMR) electricity generating power station.

The overall licensing philosophy applied to the licensing of the Koeberg Nuclear Power Station (as briefly outlined above) has been adopted for the licensing of the PBMR. However, one of the major components of the licensing process, which needs to be thoroughly considered is the credibility of the PBMR design basis. Unlike Light Water Reactors (LWRs) such as the Koeberg Nuclear power Station design, for which well-researched and documented design criteria and rules are readily available, broad international consensus has not been developed in terms of general design criteria and design rules for the PBMR. Although similar designs of High Temperature Gas Cooled Reactors have been licensed and operated elsewhere in the world, no international "off the shelf" package is available for defining the design basis of the PBMR. The establishment and documentation of the PBMR design basis, codes and standards is thus an important step in the licensing process and is currently receiving major attention by the designers, applicant and the nuclear regulator (reported in Article 18).

14.1.1 Safety Analysis Report

Documentation relating to compliance with the safety criteria is provided in the safety analysis report. The safety analysis report is carried out in three stages.

Firstly, a preliminary safety analysis report together with a preliminary site safety report is compiled by the licensee and submitted for review and approval by the regulatory body prior to construction activities.

Secondly, an intermediate safety analysis report is compiled during the construction phase together with an updated intermediate site safety report.

Thirdly, towards the end of the construction phase, a series of submissions are compiled and submitted to the regulatory body. The submissions are in support of the major phases of non-nuclear commissioning, fuel loading and nuclear commissioning. Review and acceptance of these reports by the regulatory body allows progression through the commissioning stages into commercial operation.

The nuclear licence is varied for each phase of the commissioning programme, allowing progression subject to satisfactory compliance with the requirements of each stage. In addition, conditions of licence are introduced specifying additional requirements for subsequent stages.

The safety assessment process demonstrates that the installation is in compliance with both the design requirements and the safety criteria. It also identifies and justifies the operating technical specifications, to which the plant should be operated, as well as the maintenance and testing programme and all the operational programmes. These include the operational radiation protection programme, the waste management programme and the emergency planning and preparedness arrangements.

In addition to the operational programmes identified above, the operating licence requires the licensee to maintain an installation description, a modifications procedure, an occurrence reporting procedure and to maintain a current safety assessment. The manifestation of the latter is the result of two mechanisms. The first is the requirement that all modifications to the installation or any of the operating, maintenance and testing procedures be assessed in terms of their impact 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.

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. Further information on this is given below.

14.2 PERIODIC SAFETY RE-ASSESSMENT

14.2.1 Introduction

The nuclear licence currently in place for the Koeberg Nuclear Power Station (KNPS) requires that a valid and updated safety assessment be maintained.

Koeberg has been operational since 1984 and throughout its operating lifetime, the safety assessment, initially produced before operation commenced, has been regularly updated taking into account modifications to the installation and its operating procedures. Such modifications were made to enhance both the safety and efficiency of the installation.

Despite the safety assessment having been regularly updated, in line with international practice, it was concluded that a major re-assessment of the safety of the nuclear installation should be undertaken. In December 1994 the NNR made such a request to the licence holder Eskom. Such safety re-assessments compare the "original" design bases of the plant with those that would be adopted in plants built today. They employ the latest techniques of safety assessment and take into consideration the cumulative effects of plant ageing and modifications. The NNR requirements for the Safety Re-assessment were presented to Eskom in April 1995.

The safety re-assessment is a major undertaking and the NNR and Eskom expended extensive efforts in formulating the nature and extent of the work to be undertaken. The process was seen to be complementary to the licensing activities conducted to date

In formulating the process, discussions also took place between the NNR and the French nuclear safety authority, DGSNR (formerly known as DSIN). The DGSNR is responsible for licensing nuclear power stations similar to Koeberg within the French nuclear power programme and had embarked upon a similar re-assessment process.

The objectives of the Koeberg Safety Re-assessment Project (named the KSR Project) were:

- To update the current Koeberg Safety Analysis Report and associated safety documentation to accurately reflect the status of the existing plant.

- To compare the safety case for Koeberg against an up-to-date internationally recognised standard. This entailing a comparison of the design basis of the systems and components at Koeberg and the operating practice with current internationally recognised standards and re-validation of the Koeberg risk assessment methodology. The latter being used to ensure that the plant would still meet the risk criteria laid down in the fundamental standards of the NNR, taking into account the cumulative effects of modifications and plant ageing.

Eskom has completed the re-assessment and the results, as well as recommended actions have been documented in a Safety Re-assessment Report (SRA). The NNR review and conclusions of the KSR Project are documented in the NNR KSR assessment report.

The project started in April 1995 with the formulation of the NNR requirements for the Koeberg Safety Re-assessment. Eskom submitted its SRA report for NNR review in December 1998 and the NNR completed its review in July 1999. The project involved approximately one hundred man-years of effort from Eskom and six man-years from the NNR. As a general conclusion it can be said that the broad objectives set for the KSR Project have been achieved

14.2.2 KSR Project Methodology

At the onset of the project it was clear that for a comparison of KNPS with current norms of design and operational practice to be made, a reference case would have to be identified.

The French Construction Programme-Series 1 (CP-1) Safety Referential, was used as a benchmark for this comparison as it was representative of current international norms and practice. The reference plant for KNPS is Tricastin, a French 900 MW pressurised water reactor of the CP-1 type.

Following extensive discussions between Eskom and the NNR, the process for execution of the KSR Project was agreed. The project was broken down into several sub-projects to ensure efficient project management.

14.2.3 Output of the KSR

(i) Updating and consolidation of all the licensing related safety documentation into a standard Safety Analysis Report (SAR), reflecting the as built plant status at April 1997, was finalised by Eskom. Following NNR review and approval, the updated SAR Rev1 was updated to Rev 1a and approved for reference into the nuclear licence NL-1 in May 1998.

(ii) Updating and consolidation of the documented operational programmes (GORs) was completed. This task proved to be relatively straightforward, as this documentation had been maintained up to date on an on-going basis. The Koeberg Site Safety Report (KSSR) required the major updating.

(iii) The comparison between the updated Koeberg safety documentation and the selected French referential identified approximately five hundred differences. Following application of an approved screening process, approximately one hundred and forty of these differences of potential safety significance were retained for further assessment. The balance was determined by Eskom, in concurrence with the NNR, as having no nuclear safety significance. During this process, no differences were identified as requiring immediate corrective action. All differences were recorded in a "Difference File" which will be retained and maintained (as required for the future) as an integral part of the safety documentation. The NNR was satisfied with the comparison process and its output in terms of identifying all the differences between Koeberg and the CP1 safety analysis reports and prioritising the potential safety significant differences for further consideration.

(iv) The scope and themes of the safety re-assessment were finalised between Eskom and the NNR. The re-assessment was undertaken by Eskom and documented in the Safety Re-assessment (SRA) Report, which is the main output from the project.

14.2.4 The Safety Re-assessment

The safety re-assessment was broken down into a number of components, which are presented individually:

(i) Benchmarking/differences analysis

The differences screened with potential nuclear safety significance were grouped in related topics and analysed in terms of nuclear or radiation safety practice and in terms of potential risk significance.

(ii) Safety systems "vertical slice" analysis - integration between SAR requirements and General Operating Rules.

The more important Koeberg safety systems were re-analysed to ensure coherence between the identified safety requirements of the SAR and their implementation in the plant general operating rules documents i.e. Operating technical specifications, operating procedures etc. This also included analysis of plant operational feedback.

(iii) Transverse studies

These studies were mainly undertaken on topics that had an impact across all the safety systems re-analysed, thus the appropriate name "Transverse studies." The relevant topics covered internal and external hazards such as flooding, fire, seismic fall-down hazards and issues specific to Koeberg, e.g. equipment classification, civil and radiation protection issues. Where appropriate the French referential practices were used for comparison to the Koeberg plant.

(iv) Accident Analyses

The objectives of this particular aspect of the Safety Re-assessment were to ensure consistency between the SAR accident analyses section and the accident and incident procedures which are available on the plant.

(v) Benchmarking of the Koeberg probabilistic risk assessment

The probabilistic risk assessment was benchmarked against:

- The French Probabilistic Risk Assessment EPS900 study for the plant analysis and
- The US – North Anna Individual Plant Examination - IPE study for the containment analysis

(vi) Topical engineering issues

Known topical engineering issues at Koeberg (international and local) were studied and analysed. These included, inter alia, the issues and actions from the Three Mile Island accident.

Within the scope of each of these six topics, Eskom undertook the necessary studies and analyses following the development of documented processes. The processes were evaluated and audited by the NNR and found to be acceptable.

The safety re-assessment (SRA) report has six appendices; each appendix addressing the findings and recommendations relating to each topic indicated above. The SRA report was finalised by Eskom at the end of 1998.

As part of the project processes, the differences and issues identified were analysed and evaluated for safety significance. A qualitative risk assessment (QRA) methodology, based on IAEA guidance, developed by Eskom and agreed to by the NNR was applied to assist in assessing the safety significance and for recommending actions for closing out of the issue or topic.

14.2.5 Findings and results of the safety re-assessment

The SRA report produced by Eskom includes a comprehensive listing of findings and recommendations in each of the areas discussed above.

The report concludes that no deficiencies have been identified that require immediate corrective action. However, some short and medium term measures are required to either justify differences or to resolve some of the issues identified. These measures, including modification proposals are listed in attachments to this report, and have been classified according to their safety significance (medium or low categories).

Of the 9 issues identified as "medium" only two have been formally closed to date by the engineering evaluations – to close other issues implementation of major modifications will be required. Modification proposals have been already evaluated are in the final design stage.

The comments and conclusions arising from the NNR review of the SRA report are recorded in the NNR Assessment Report. Most of the initial NNR comments were resolved through technical meetings with Eskom.

The NNR generally agrees with Eskom's conclusions and recommendations made in the safety re-assessment report. there are however, a number of topics on which the NNR differs from the Eskom assessment. These require further work by Eskom, e.g. analyses, assessments etc. in order to justify or close out the issues.

14.2.6 Overall NNR conclusions of the KSR project

The principal objectives of the Koeberg Safety Re-assessment Project (KSR Project) are contained in Section 14.2.1.

In terms of these objectives the following KSR results have been achieved:

- An updated SAR and documented operational programmes (General Operating Rules) accurately reflecting the current plant status were produced and approved by the NNR.

- A comprehensive comparison of the safety case of Koeberg including the design basis of the systems and components at Koeberg and the operating practices with a credible international reference was carried out.

This process has resulted in identification of a number of differences or issues, which have been screened and assessed for safety significance. No differences or issues have been identified as requiring immediate corrective action in term of challenges to the NNR risk criteria. Some actions, which will either justify the differences or resolve the issues, have been identified to align Koeberg plant design basis and operating practice with current international standards i.e. the French CP-1 referential.

- A comprehensive comparison of the Koeberg Probabilistic Risk Assessment methodology against internationally recognised standards was completed. These processes also 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 PSA model has been significantly upgraded – all the previous deficiencies, apart from internal and external hazards have been addressed. It can be concluded that new Koeberg PSA approach/ methodology provides a conservative overall estimate of risk and demonstrates compliance with the NNR risk criteria.

The NNR, therefore, concludes that, provided the identified and agreed actions are addressed within acceptable timescales, the main objectives of the KSR Project have been achieved and that continued operation was justified.

A list of the agreed actions has been formulated and progress in their implementation is monitored at the Koeberg licensing interface meetings between Eskom and NNR.

14.3 CONTINUED HEALTH OF THE NUCLEAR INSTALLATION TO ENSURE LICENCE COMPLIANCE

Based on the outcome of the safety assessment, which was carried out during the initial licensing phase of the installation, conditions of licence were set down requiring the following major elements:

- A valid installation description and configuration to be maintained together with a modification control procedure
- The maintenance of a valid and updated risk assessment
- Establishment and compliance with Operating Technical Specifications including operating surveillance requirements.
- An in-service inspection programme
- A Reactor vessel surveillance programme
- A maintenance programme
    - A civil monitoring programme
    - A physical security programme
    - A fire safety programme
- A routine occurrence reporting programme
- A quality management programme

14.3.1 Routine On-Going Safety Review at the Nuclear Installation

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 briefly discussed below.

14.3.1.1 Plant Operational Feedback

- In-Service Inspection Programme (ISIP)

  A comprehensive ISIP is in place at the nuclear installation covering all the safety related components and including mandatory examinations of welds, piping, vessels, valves etc. It is based on the ASME XI requirements and for the second interval, which came into effect after twelve years of operation, has been upgraded incorporating international and local operational feedback and a probabilistic approach in the selection of non-mandatory welds.

- Maintenance and Testing Programme

  A fixed time-based preventive maintenance programme was originally developed for the nuclear installation. This is being upgraded by the introduction of the graded approach and the use of probabilistic techniques to optimise the programme with respect to:

  - Importance ranking of components
  - Importance ranking of activities
  - Reliability monitoring
  - Condition based maintenance (CBM)
  - Reliability-centred maintenance (RCM)

  Operational feedback from the maintenance and testing activities is an important component in respect of the reliability of structures, systems and components (SSC's) classified as important to nuclear safety. Feedback is necessary to ensure that maintenance results in acceptable levels of reliability, as required by the plant design and NNR safety criteria and also to integrate the specific plant data into the plant specific probabilistic risk assessment.

- Occurrence / Incident Reporting and Analysis

  A system of occurrence identification, recording and reporting is required by a condition of the nuclear licence. This system encompasses 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 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.

14.3.1.2 Hardware and Procedural Modifications

Changes to the installations and/or procedures impacting any nuclear licence condition have to be go through safety screening evaluation process and subsequently submitted for review and approval by the regulatory body. These changes must be supported by a safety case including a quantitative risk assessment. Some of the numerous modifications which have resulted in safety improvements are indicated under Article 6.

14.3.1.3 Emergency Planning Exercises

The preparedness of emergency plans is demonstrated by an ongoing programme of training and exercising with a comprehensive full scale exercise conducted at intervals between twelve and eighteen months. See under Article 16 for more details.

14.3.1.4 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 fundamental safety standards and installation safety. The outcome of the audits results in a corrective action programme by the licence holder and also feedback into the risk assessment process. See under Article 13 for more details.

14.3.1.5 Surveillance and Compliance Inspection Programme

A comprehensive surveillance and compliance inspection programme has been developed by the regulatory body to ensure compliance with the nuclear licence requirements and to identify any potential safety concerns. Most licence conditions are subjected to the inspection programme, which is independently implemented by the inspection staff of the regulatory body. See under Article 14 for more details.

14.3.1.6 Licensing of Control Room Reactor Operators

Reactor operators are subject to independent examination by the regulatory body prior to commencement of duties. The examination process entails theoretical, simulator and plant walk-through examinations. The operators are also subject to psychometric screening and monitoring during operational activities. In addition to initial examinations, the operators also undergo a process of in-service re-training. See under Article 10 for more details.

14.3.1.7 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 regulatory body.

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. See under
Article 19 for more details.

14.3.2 Verification programmes

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 rules, codes and standards and also local licensing requirements 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 manage effectively the ageing of the installation hardware. This process includes repairs, replacements, refurbishments, modifications and changes to operational conditions.

14.3.2.1 Maintenance process

This 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.

The initial maintenance process for the first 14 calendar years at the nuclear installation focused on a fixed time-based preventive maintenance programme in support of controlling corrective maintenance practices. The selection of components for the preventive maintenance programme has been very comprehensive and the maintenance activities and periodicities for these activities were based on a combination of manufacturers' recommendations, industry experience, operating technical specifications and other applicable statutory and mandatory requirements.

14.3.2.2 Updating/improvements of the maintenance process

(i) The introduction of component and activity importance categories for determining the levels of maintenance controls:

- Critical Safety Related (CSR)
- Safety Related (SR)
- Availability Related (AR)
- Not Safety or Availability Related (NSA)

(ii) Condition-based maintenance

This was introduced approximately five years ago in parallel with the fixed time-based maintenance. The programme covers a wide spectrum of systems and component types and has to-date proven to be successful in that no CSR component failures have been experienced under this programme.

(iii) Maintenance Optimisation

The maintenance process has been divided into 12 functional control areas:

- Determination, documentation and changes to the maintenance basis
- Planning and scheduling of work
- Development, authorisation and assembly of working documentation
- Failures and the evaluation of experience
- Execution of work
- Post-maintenance re-qualification
- Equipment history and plant asset configuration
- Programme violations
- Monitoring of maintenance effectiveness and component reliability
- Corrective action plans
- Quality

- Training and authorisation of staff

These functional control areas are managed through a higher tier maintenance policy document. 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.

The major emphasis of this optimisation process is to determine and to document the basis for maintenance (i.e. the maintenance requirements) for all SSCs important to nuclear safety and to ensure a dynamic maintenance programme, with changes being controlled. This new process, which is focusing on maintaining the safety related functional capabilities of SSC's important to nuclear safety, is based on the RCM philosophy and principles. 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.

The licence holder's Problem Notification Reporting (PNR) system is utilised for reporting deficiencies, non-conformances and statutory violations to the regulatory body. The regulatory body is notified on a monthly basis of all authorized mandatory waivers on SSCs important to safety that are in force.

Current maintenance optimization developments include:

The establishment of a fully staffed maintenance engineering discipline, which has prime responsibility for: facilitating and controlling the RCM process, conducting failure investigations and analyses of risk significant maintenance preventable functional failures, evaluating intrusive maintenance tasks on an *ad hoc* basis and feedback of analysis and evaluation results into the maintenance programme.

The development of a process for measuring the effectiveness of the maintenance programme as a integral part of a plant condition management process with systems engineering as the major responsible discipline.

The licence holder is currently embarking on a more integrated approach towards plant condition management to ensure and to provide assurance to the effect, that the condition and performance of SSCs important to safety and operations are such that they remain capable of performing their design intended functions as required. This entails the integration of the related results/inputs of all safety related processes and disciplines e.g., design base engineering and configuration, safety analysis and assessment, operations, radiation protection, experience feedback, in-service inspection & testing and maintenance. Major emphasis is placed on the development and implementation of life management strategies for SSCs important to safety and operations.

14.3.2.3 In-Service Inspection

This covers both nuclear risk-related passive and functional components including bolting, pipework, integral attachments, vessels (including the RPVs), steam generators and their tubes, pumps, including the primary pumps, valves, containment penetrations, supports and dynamic restraints, and special inspections for microbiologically induced corrosion.

The ISI Programme (ISIP) is presently based on the 1992 edition of the ASME Section XI Rules for ISI but is augmented by the inclusion of plant specific issues derived from local and international experience, especially from that of Electricité de France (EdF). The ISIP at the nuclear installation is administratively managed through a mandatory standard and technically managed through a locally derived ISIP Requirements Manual, which is revised on an annual basis and approved by the regulatory body.

Preparations are being made for the move to the third interval commencing in 2007. These preparations include discussions between the utility and the regulatory body as to how to incorporate inspection qualification and risk-informed ISI into this third inspection interval.

The selection of the component scope for ISI/IST is based on deterministic principles inherent in the ASME XI code, with the additional use of risk-importance considerations in selecting the balance of components for fulfilling pre-determined quotas.

From a temporal perspective, the inspection and test periodicities are based on programme B of the ASME XI code in that successive ten year intervals of three periods in each interval are used as the basis. Most ISI/IST activities are performed during refueling outages which presently occur as part of an approximately 16 month fuel cycle. However, tests and inspections are also conducted outside of the outage wherever possible. Both units at the nuclear installation are now well into the second inspection interval of programme B.

Plant-specific inspections and tests are included in the programme where special items of concern are raised through local or international experience. Examples of these items are dead-end piping integrity, steam generator tube integrity and auxiliary feedwater branch welds.

Recent items of integrity concern include atmospheric stress corrosion cracking of stainless steel systems exposed, either directly or indirectly, to the marine environment. Also, repercussions from the Davis Besse incident in the US have prompted a systematic programme of visual inspection of the outside of the RPV top heads. Safety cases addressing the long term concerns of primary cast elbow integrity and RPV pressurised shock are being revised in line with mandatory milestones set during the life of the plant. Unexpected deterioration of PSI and ISI records including radiographs, has been detected and appropriate corrective actions are being put in place before the loss of information significantly impacts on the effectiveness of the ISI programme.

The logistics of employing inspection contractors from overseas to perform specialised inspections presents extra challenges to the licence holder. Such inspections within the scope of the ISIP are those of the RPVs and of the SG tubes. Presently contractors from Europe are employed for these projects.

14.3.2.4 Reactor vessel surveillance programme (RVSP)

This is based on French experience and implemented as part of the French surveillance programme through a contractual agreement between the licence holder and EdF.

Each vessel had four irradiation surveillance capsules installed prior to operation and these are being progressively removed at intervals according to the predetermined mandatory programme. The positioning of the capsules within the vessel is such as to give a substantial lead time in order to be able to anticipate any necessary corrective actions as a result of excessive irradiation embrittlement of the vessel material being detected in the irradiation samples. Results to-date indicate a higher than expected shift in the toughness parameters, possibly related to the effect of neutron irradiation on chemistry variables in the vessel materials. However, present predictions are that acceptance criteria will not be violated within the design life of the installation.

As a result of SG tube integrity concerns arising from the early detection of primary water stress corrosion cracking (PWSCC) a number of mitigating actions were taken by the licence holder. These included the reduction of the operating temperature (ORT) of the primary circuit. This has proved to be very effective in slowing down the rate of PWSCC, but has a potentially negative effect on the rate of vessel embrittlement since it reduces the degree of self annealing of the vessel material during service. In order to monitor this effect of ORT on the progress of irradiation embrittlement it has been found necessary to modify the RVSP. This change has included introducing new unirradiated capsules in order to be able to assess the rate of embrittlement solely at the new reduced temperature.

The RVSP has been modified in an attempt to quantify the possible effects on RPV embrittlement of a new mode of operation at reduced temperature (ORT), to this end, use has been made of spare irradiation surveillance capsules. ORT was introduced by the utility in an attempt to mitigate stress corrosion cracking of the steam generator tubes.

14.4 REGULATORY CONTROL 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 licence requires the licensee to report unusual 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 licence, and compliance assurance programmes outlined below.

14.4.1 NNR Approval Process

The 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 of the NNR. Proposed modifications to the plant or changes to documentation referenced in the licence must be submitted to the NNR for approval prior to implementation along with a safety justification including a risk assessment where applicable. Guidance is provided in LG-1041 "Licensing Guide On Safety Assessments Of Nuclear Power Reactor Sites". Refer to 9.2.2.2 for more details.

The licence also dictates that NNR approval is required for fuel unloading, fuel loading and return to criticality.

14.4.2 NNR Compliance Assurance Programme

The NNR'S compliance assurance 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.

14.4.2.1 Basis

The safety goals refer to the fundamental safety standards of the NNR covering risk to the public arising from normal operations and potential accidents, ALARA, 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 license in terms of the licensee's safety assurance processes, the design, operating rules, 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 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. This is based on assessments in terms of the safety fundamentals with the aim of minimising subjectivity.

The compliance assurance 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.

14.4.2.2 Application

A baseline inspection and audit programme was developed and implemented on an electronic task management system and linked to the safety indicators. The scope of the inspection and audit programme is illustrated in Tables 14.5.1 and 14.5.2.

The compliance inspection programme is laid out in STI-18 "Compliance Inspections at Koeberg Nuclear Power Station". This, along with the audit programme comprises the compliance assurance programme.

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).

The NNR technical specialist or inspector responsible for a finding arising from any of the above processes, performs a provisional classification of the finding.

Guidelines are given to technical and inspection staff in a project document STI-20 "Categorisation of Findings on Koeberg Nuclear Power Station and Input to Safety Indicators" on the classification of findings in terms of level of safety concern. A qualitative process is used as a first level of screening in all cases. This may be followed up by a quantitative analysis.

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 established.

If it is believed that a finding challenges the validity of assumptions or data used in the safety case, then a quantitative analysis may be performed.

A specific individual in the project department of the NNR is allocated the task of entering the data into the NNR Safety Indicators Database, for maintaining records generated associated with the classification of the findings and for generation of reports.

Depending on the level of concern, the follow-up actions are generally as follows:

LEVEL OF SAFETY CONCERN ARISING FROM INSPECTION OR INCIDENT	NNR RESPONSE	
	NNR RESPONSE IN THE EVENT THAT ESKOM RESPONSE ACCEPTABLE IN TERMS OF NUCLEAR SAFETY	**NNR RESPONSE IN THE EVENT THAT ESKOM RESPONSE NOT ACCEPTABLE IN TERMS OF NUCLEAR SAFETY**
INTOLERABLE	Notify Programme Manager (or if unavailable, Senior Manager: Power Reactors, or if unavailable, CEO immediately. Implement response as agreed with manager. Subsequent inquiry by NNR may be called for by NNR line management. Discuss with management for report to IRS	Notify Programme Manager (or if unavailable, Senior Manager: Power Reactors, or if unavailable CEO, immediately. Identify immediate NNR response and implement accordingly. Subsequent inquiry by NNR may be called for by NNR line management. Discuss with management for report to IRS
HIGH	Report back at weekly department feedback meeting. Complete Inspection Task Report Input to indicators Discuss with management for report to IRS	Report back to Programme Manager during office hours. Complete Inspection Task Report Call special NSAG meeting Input to indicators Discuss with management for report to IRS
MEDIUM	Report back at weekly department feedback meeting. Complete Inspection Task Report Input to indicators Discuss with management for report to IRS	Report back at weekly department feedback meeting. Complete Inspection Task Report Input to indicators Take up with Eskom at scheduled KLLC meeting. Discuss with management for report to IRS
LOW	Report back at weekly department feedback meeting. Complete Inspection Task Report Input to indicators Discuss with management for report to IRS	Report back at weekly department feedback meeting. Complete Inspection Task Report Input to indicators Take up with Eskom at scheduled KLLC meeting. Discuss with management for report to IRS
DROP	Complete Inspection Task Report	Complete Inspection Task Report

The appropriate level of interaction with the licensee is decided upon. This may be any of the following:

- Nuclear Safety Assurance Group
- Licensing and Liaison Committee Meetings
- Ad hoc communication between NNR inspector/assessor/manager and licensee counterpart.

Single Point Contact meetings between NNR and licensee specialists may be called for arising from any of the above initial interactions.

If a satisfactory response is not obtained from the above interactions, the issue may be raised to a higher level of interaction with the licensee accordingly, ie Executive or Board level.

TABLE 14.4.1 BASELINE COMPLIANCE INSPECTIONS

	Reference	Description	Freq (days)	Inspection Title	Licence Condition	Regulatory Officer
1	S-CORE-NUCL	Core Parameters	180	Core Parameters	1.2, 3.2, 14.4	Engineering
2	S-CR-002-OPS	Verify status of documents in control rooms	60	Control Room informal letters check	13.1	Operations
3	S-CR-OPS	Determine compliance to limits as dictated by SAR, OTS and the relevant operating procedures	7	Control Room Inspection	1.1, 1.4, 3.3, 4.1, 4.2, 4.3, 14.1	Operations
4	S-EFF-ORP	Verify compliance with effluent management procedures and processes.	180	Effluent Management Inspections	7.0	RP/EP
5	S-EFF-TRP	Assess quarterly radioactive effluent and radwaste reports	90	Effluent Management	7.0	RP/EP
6	S-EPGoldenArrow-OPS	Availability of buses	440	Emergency Plan	10.1	RP/EP
7	S-EPIodine-OPS	Determine Iodine provision	440	Emergency Plan	10.1	RP/EP
8	S-EPREF-TRP	Verify bases of emergency plan in terms of the reference accident	360	EP reference accidents	2.0, 10.1	RP/EP
9	S-ESL-ORP	Verify compliance with ESL processes and procedures	180	Environmental Monitoring	9.0	RP/EP

	Reference	Description	Freq (days)	Inspection Title	<u>Licence Condition</u>	<u>Regulatory Officer</u>
10	S-ESL-TRP	Assessment of ESL Quarterly Report	90	ESL Quaterly Reports	9.0	RP/EP
11	S-EXP-GEN	EPMS, Occurrences and Human Performance	90	EPMS, Indicators, Audit findings	2.0	Human Factors
12	S-EXP-KPD	EPMS, Occurrences, Indicators	90	EPMS, Occurrences, Indicators	4.6	NDE/ISI, Maintenance Engineering
13	S-EXP-NUCL	EPMS, Occurrences, Indicators, Risk Management	90	EPMS, Occurrences, Indicators, Risk Management	14.1, 14.2, 14.4	Engineering
14	S-EXP-ORP	LD-1091, EPMS, Safety Indicators	90	LD-1091, EPMS, Safety Indicators	6.1, 6.2	RP/EP
15	S-EXPOSE-TRP	Evaluate annual report on occupational and public exposure	360	Report on occupational and public exposure	6.1, 6.2, 6.4	RP/EP
16	S-FILTER-ORP	Annual filter testing inspection	360	Filter Testing	6.0	RP/EP
17	S-ILT-OPS	Perform inspections on the classroom training conducted for initial licence training	7	ILT Observations		Operations
18	S-Implementation of Processes-OPS	Screening, Evaluation and Justification process & Operability Determination	180	Screening, Evaluation and Justification process	1.2, 2.0, 16.1	Operations/ Engineering
19	S-KSR-KPD	Periodic Review	180	Periodic Review	2.0	Engineering
20	S-LOG-OPS	Concerns arising from daily CR log entries – Record and track concerns arising from control room log entries.	30	Daily Control Room Log entries	4.1, 4.2, 4.3, 14.1, 14.2, 15.4	Operations
21	S-MANAGEMENT-ORP	Verify Management inspection records	360	Management Inspection records	6.0	RP/EP
22	S-MET-TRP	Availability of off-site and on-site	180	METEOROLOGICAL	10.0	RP/EP

	Reference	Description	Freq (days)	Inspection Title	Licence Condition	Regulatory Officer
		meteorological data		PROGRAMME		
23	S-MM-001	Attend and Feedback on Morning Production Meeting, highlight any issues that require further NNR involvement.	7	Morning Production Meeting	4.1	Operations
24	S-NDE-OPS	ISI/NDE/Maintenance Inspection Report	30	NDE Monthly Report	5.1	NDE/ISI, Maintenance
25	S-OE-ALL	Experience Feedback Reports	360	Experience Feedback Reports	2.0, 15.4	ALL
26	S-Procedure Changes-OPS	Procedure Changes	60	Procedure Changes	13.1, 16.1	Operations
27	S-PROC-TCH	Annual Process Inspections	360	Annual Process Inspections	2.0, 16.1	ALL
28	S-RADIUS-TRP	Developments within 5 km radius	180	Developments within 5 Km radius	2.0,10.1	RP/EP
29	S-RADSOURCE-ORP	Inspection of Radioactive Sources	360	Radioactive Sources	3.6	RP/EP
30	S-RADWASTE-ORP	ANNUAL RADWASTE INSPECTION	360	RADWASTE	3.4, 8.1	RP/EP
31	S-RQ-OPS	Observation of "As Left" requal module evaluations	7	Requal Observations	4.4, 4.4.2	Operations
32	S-SECURITY-001	Physical and plant related security related inspections	30	Security Surveillance check	12.1	Operations
33	S-SUR-ORP	Radiological surveillance inspections	180	Radiological surveillance	6.2	RP/EP
34	S-TOI-OPS	Evaluation of implementation and adequacy of TOI process	360	Review of TOI Process	13.1, 16.1	Operations

	Reference	Description	Freq (days)	Inspection Title	Licence Condition	Regulatory Officer
35	S-TRANS-ORP	Transport Requirements inspection	360	Transport Requirements	3.5, 11.1	RP/EP

APPENDIX 1(b): OUTAGES COMPLIANCE INSPECTION PROGRAMME

	Reference	Description	Licence Condition	Inspection Title
1	M-OUTAGE-Maintenance	Provide confirmation that maintenance, particularly on CSR equipment, is planned and carried out according to the prevailing standards.	5.1	Outage Maintenance
2	M-OUTAGE-Mods	Provide confirmation that hardware were installed and tested as per the specifications and processes	1.3, 1.4	Outage Modifications
3	M-OUTAGE-OPS	Monitor shutdown, heat-up and start-up activities. Observe criticality.	3.2, 4.1, 14.2, 14.4	Outage Operating Activities
4	M-OUTAGE-ORP	Perform inspections on RPC compliance, dose tracking, containment cleanliness, bioassy and whole body count requirements.	6.1, 6.2, 6.4	Radiation Protection
5	M-OUTAGE-Config	Provide confirmation that that work is controlled and managed as per the outage safety plan and OTS requirements	1.4, 14.2, 14.4	Configuration Management
6	M-OUTAGE-NDE	Perform inspections to confirm that ISI outage activities were performed by qualified staff, with approved procedures, assessed against specified criteria, NCRs raised and dispossitioned.	5.1	Outage NDE

	Reference	Description	**Licence Condition**	Inspection Title
7	M-UN Planned OUTAGE-OPS	Inspection cover all disciplines that could be impacted by a short duration or unplanned outage.	All above	Un Planned Short Duration Outages

TABLE 14.4.2. TYPICAL SCOPE OF AUDITS

1. Conformance to technical specifications
2. Training and qualification
3. Problem reporting, follow-up and close-out
4. Radiological protection programme
5. Effluent discharge programme
6. Physical security
7. Radiological environmental surveillance programme
8. Meteorological programme
9. Fuel integrity evaluation programme
10. Fuel storage, handling and transportation
11. Radioactive waste management programme
12. Quality assurance programme
13. Emergency plan
14. Fire protection
15. Maintenance programme
16. Civil works monitoring
17. In-service inspection programme
18. Safety screening and safety evaluation processes
19. Design, specification and equivalency processes

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

Achievements and changes in safety-related activities since preparation of the previous National Report

- The licensee has updated the Radiation Protection Organisation Standard, to reflect that the regulatory authority must be informed of the changes in the RP Organisation in accordance with the licensee process.
- Lower level procedures are now reflecting the requirements that were deemed not appropriate for the corporate licensee radiation protection standards . 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.
- The so-called Activity migration model was used to derive the Annual Authorised Discharge Quantities (AADQs) that feature the migration of activity from the fuel via the clean-up systems and effluent treatment systems and various drain systems up to the point of discharge.
- The licensee has adopted scaling factors (the difficult to measure nuclides) for solid radioactive waste comprising filters, evaporator distillates and demineralizer waste. The results allow the determination of correlation factors/ratios relative to Co-60 and Cs-137 (easy to measure isotopes).
- The licensee has completed a clearance assessment pertaining to volumetric contaminated equipment and materials in order to release these from regulatory control.

- The licensee has completed the development of radiation protection standards for the licensing basis document, and associated assessment and compliance reporting processes to comply with the proposed licence were finalised.

15.1 SUMMARY OF LEGAL REQUIREMENTS

Legislative Framework

The NNR was established by the National Nuclear Regulator Act (Act No 47 of 1999) and its mandate and authority are conferred through sections 5 and 7 of this Act, setting out the NNR's objectives and functions. The NNR is mandated to provide the safety standards and regulatory practices for the protection of persons, property and the environment against nuclear damage and thus safeguard persons and the environment against damage from the activities within the nuclear fuel cycle by regulating and exercising control through the issue of nuclear licences. The Act makes provision for the NNR to impose any condition in a nuclear installation licence, which is deemed necessary to ensure the protection of persons, property and the environment against the risk of nuclear damage. The regulations would ensure that criteria are in place for all radiation protection oversight for authorisation activities. In the absence of the published regulations the IAEA Radiation Protection (RP) standards are generally followed.

15.1.1 Dose Limits

In achieving the objectives for the control of occupational exposure, the regulatory body 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 regulatory body are applicable to both members of the public and the occupationally exposed population. These limits are referenced in the nuclear license and are detailed as follows:

REGULTORY DOSE LIMITS	Annual Individual Dose Limit
Occupationally Exposed Group	50 mSv per annum
	Annual Dose Limit To Member Of The Public (Critical Group)
Members Of The Public	0,25 mSv

OPERATOR DOSE LIMIT	Annual Individual Dose Limit
Occupationally Exposed Group	20 mSv per annum averaged over 5 years and 50 mSv per annun maximum in a single year

In achieving these 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 nuclear licence makes reference to the principles upon which these verification programmes and to the principles upon which the facets of the operational radiation protection programme are established. All of these principles are embodied in both the nuclear licence and in licence holder corporate standards on Radiological Protection which cover the following areas:

Establishment of the radiation protection organisation

Qualification of radiation protection personnel

The system of operational radiological protection

The radiological surveillance programme

The optimization of radiation protection (ALARA programme)

The control of portable radiation monitoring instrumentation,

The appointment of medical practitioners

Qualification of radiation workers

- The establishment and maintenance of a Health Register for radiation workers
- The establishment and maintenance of a Dose Register for radiation workers
- The external and internal dosimetry programme
- The respiratory protection programme
- The control of fabricated radio-isotopes
- The radiation shielding verification programme
- The radiological effluent management programme
- The radwaste management programme
- The environmental surveillance programme
- The technical audit programme

15.2 FULFILLMENT OF CONDITIONS FOR RADIOACTIVE MATERIALS RELEASE

15.2.1 Radiological Effluents

15.2.1.1 Establishment of annual authorized discharge quantities

The safety assessment process is the vehicle for the establishment of Annual Authorized Discharge Quantities (AADQ's), which relate to quantities of specific radionuclides in liquid and gaseous effluents which may be discharged from the nuclear installation under planned conditions such as to comply with the annual dose limit established for members of the public. These quantities are stipulated in the Operating Technical Specifications (Reference 4). The AADQs are derived quantities constraint by the annual source related dose limit and feature constraint optimization below the dose limit. This is governed by design considerations and it provides justified discharge limits based on conservative design and operational conditions such as fuel/activity migration, primary clean-up etc. In view of the above-mentioned, the AADQ of Koeberg is based on a so-called activity migration model that features the migration of activity from the fuel (Origen, fuel clad failure, Primary migration) via the clean-up systems (TEP, RCV) and effluent treatment systems and various drain systems considering various volumes of effluent (TEU,TEG) up to the point of discharging. In the assessment of the model, Framatome design features and assumptions have been used in order to derive the quantities discharged. The ultimate result of the activity migration exercise is the annual amount of effluent release in Bq. This is done on a nuclide specific basis. These discharge quantities are called the AADQs. The main factor influencing the AADQs is the fuel clad failure rate and therefore the reason why the licensee AADQs is significantly higher than the actual releases during normal operation.

A Dose Conversion Factor (DCF) has been established for each nuclide. The DCF calculates the maximum annual effective dose to a member of the critical group within the exposed population resulting from unit release of that nuclide.

The product of the DCF and the AADQ is constraint by the source related dose limit of 250 μSv/a for all radionuclides discharged to the environment. The AADQ, as modeled above, is a derived quantity based on conservative design assumptions and design ALARA.

15.2.1.2 Operational control over discharges

In the operational phase of the radiological effluent management programme, the principles of which are documented (Reference 5), 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.

15.2.1.2.1 Batch release pathways

The design of the plant ensures that those discharge pathways with a potential for discharge of substantial amount of effluents to the environment are designated as batch release pathways. Batches of effluent are sampled and analysed, the analysis is reviewed, and specific authorization by a qualified person is then given prior to allowing discharge to commence. All batch discharges are then subject to continuous on-line monitoring with termination of discharge should the setpoint for the monitor be activated. Radionuclide accountancy is performed utilising the data from the analysis of batches prior to release.

15.2.1.2.2 Continuous release pathways

Discharges via continuous discharge pathways are subject to continuous on-line monitoring with termination of discharge should the setpoint for the monitor be activated. Radionuclide accountancy is performed by compositing samples, taken over some period, which are then analysed. These samples are taken to be representative of the activity discharged during the period. Because the safety assessment studies have indicated that the activity concentrations in effluent discharged via the continuous pathways are low, the compositing of samples does not lead to significant error.

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 References 4 and 5 respectively.

15.2.1.2.3 Control over installation and environmental parameters of influence to the Annual Authorised Discharge Quantities's

The AADQ's have been derived at the safety assessment stage 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 will be 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 safety assessment.

In this regard, the 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.

15.2.1.3 Radioactive Wastes

15.2.1.3.1 Establishment of annual waste produced

Radioactive wastes are defined as solid wastes which are either volumetrically contaminated or their surfaces are contaminated with radioactivity. The safety assessment regarding the production of radioactive wastes is complementary to that of radioactive effluents. However, the discharge of radiological effluents is regulated by authorization as described above. Radioactive wastes are regulated in a different way, where the consequence modeling becomes part of the safety assessment for the repository to which the waste is committed and not the installation itself. The quantities of radioactive waste produced annually by the nuclear installation have been estimated but these do not constitute limits. The nuclear licence requirements stipulated by the regulatory body 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 lonising Radiation and for the Safety of Radiation Sources".

15.2.1.3.2 Operational control over radioactive wastes

Operational control over radioactive wastes is exercised through the radioactive waste management programme which is documented in Reference 5. 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.

15.2.1.3.3 Control over installation parameters of influence to the annual quantity of wastes produced

The control over installation parameters of influence to the annual authorized discharge quantities effectively constrains the annual production of solid wastes as well. An exception to this is the decontamination policy, established at the nuclear installation, which has become more rigorous with time. This has resulted in larger volumes of waste produced but the associated increase in activity is small compared to that produced in solid wastes from operational processes i.e. spent resins, filters etc.

15.2.1.3.4 Quantification of radioactivity in produced wastes

The methods of quantification of the radioactive inventory associated with wastes varies according to the waste type. For process wastes comprising spent filters, spent resins and evaporator concentrates, the beta/gamma emitting radionuclide inventory is determined in the drum by measurement of doserate 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. The assignment of non-beta/gamma emitting activity is performed using generic scaling factors. The licensee has adopted EdF accredited scaling factors i.e, the difficult to measure nuclides for solid radioactive waste comprising filters, evaporator distillates and demineralizer waste. EdF has embarked on research some years ago in various (8) PWR nuclear plants in France in order to quantify the difficult to measure nuclides such as Tritium, Tc-99 Sr-90, C-14 etc in process waste streams. The process involved the measurement of almost 500 samples in waste streams for long-lived Beta and gamma nuclides whereby a static population was created which can be considered to be representative of the

French PWR system. The results allow the determination of correlation factors/ratios relative to Co-60 and Cs-137 (easy to measure isotopes). As the measurement results are seen as a good average of the scaling factors of the French family of PWR plants as well as the fact that the licensee plant relates to a PWR plant, it has been deemed appropriate to adopt the EdF scaling factors for the plant. EdF has confirmed that the EdF derived scaling factors compares favorably with those applied by the American utilities. All relevant licensee documentation had been revised to incorporate the process and methods to quantify those nuclides that are difficult to measure in sold radioactive waste.

With regard to compactable wastes produced from decontamination activities at the nuclear installation, the activity is determined by measurement of the doserate on the drum and assigning a ^{60}Co activity equivalent.

15.2.1.4 Clearance From Regulatory Control

The concept of clearance of materials from regulatory control has been developed. The radioactive waste management programme at present ensures that all solid wastes produced at the nuclear installation within the controlled zone are processed as radioactive wastes. Segregation for purposes of treatment/ conditioning is performed as a function of point-of-origin rather than on the basis of measurement, with the exception of compatible wastes from decontamination activities which have high associated dose rates. All solid wastes produced from work inside the controlled zone are subject to radiological survey and labeling at point-of-origin, and material egress from the controlled zone is controlled according to the requirements given in Reference 5.

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 the slightly contaminated material, the operator decided to clear the material from regulatory control unconditionally. The license holder had therefore embarked upon a clearance assessment which must demonstrate that the resulting doses to the critical group is trivial ie, within the clearance criterion of less than 10 μSv/a.

A suitable landfill site was identified off-site. The clearance assessment considered the properties of the contaminated material and of the landfill site. All currently available information on the characteristics of the landfill site was collated and screened. Current and future natural and human induced conditions have been identified. Doses to the different age groups of members of the public (critical group) were calculated using appropriate source terms and appropriate atmospheric and ground water pathways together with the increase of activity in soil due to deposition and irrigation.

The clearance assessment had resulted in doses complying with the clearance criterion, the highest dose being less than 10 μ Sv/a for the age group 12-17 years. The endpoint of the clearance assessment was a list of derived nuclide related specific activities and where relevant also total activities as derived unconditional clearance levels associated with a specific release pathway for each of the waste streams.

Once the clearance assessment was completed and approved by the regulatory authority, the actual disposal of the contaminated material at the designated landfill site was not allowed by the waste operator. This was due to the public in the surroundings of the landfill site objecting to the disposal of the material irrespective of the clearance levels of the nuclides. The licensee is still seeking for an appropriate disposal solution.

15.2.2 As Low As Reasonably Achievable (ALARA) Steps Taken

15.2.2.1 Occupational Exposure

In terms of ALARA, the regulatory body 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 principles under which the ALARA programme has been established are documented in Reference 5. 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 to reduce occupational exposure ALARA are as follows:

15.2.2.1.1 Primary circuit chemistry

Operation at high pH reduces corrosion and therefore the formation of activated corrosion product radionuclides in the primary circuit. With the implementation of operation at reduced temperature for purposes of sustaining the integrity of the steam generators, the target pH is currently 7.25.

15.2.2.1.2 Primary circuit oxygenation

Primary circuit oxygenation 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. The nuclides which are mobilized as a result of oxygenation can be removed because the operating state allows operation of one primary circuit pump with the availability of the chemical and volume control system filters and demineralisers. One of the major benefits of this is dose-saving during defueling/refueling operations.

Oxygenation can be performed in one of two ways. The first involves the aeration of the primary circuit by sweeping air through the volume control tank and out via the auxiliary building ventilation system with the charcoal filters in line. The second involves the addition of hydrogen peroxide via the chemical and volume control system and then routing the gaseous effluent to the gaseous radioactive waste treatment system decay tanks.

Overview of occurrence pertaining to the previous Outage Oxygenation resulting in increase dose rate (source term optimisation)

The implementation of the Oxygenation Programme during outages is aimed at reducing the radiation source term in the primary circuit. Is it seen as an ALARA initiative to reduce the radiation exposure to individuals and ultimately reducing the station collective dose. This programme addresses the actions required by the various station departments before the unit is shut down and during oxygenation process, which is performed during the unit cooling process. The Chemistry and Radiation Protection departments take the lead in this programme. The licensee experienced problems with incomplete oxygenations during the previous outage where the levels of Ag-110m elevated in the primary system and caused dose management problems.

A new documented process prolonged the oxygenation and this led to dose rates in the fuel building and PTR tank room increasing dramatically over two days by a factor of 10. The results of the samples analysed during this event showed that the activity was not following the expected trend for the cleanup condition set. A decision to flood the reactor cavity without waiting for the activity limit be met resulted in high dose rates on the reactor pool water surface. The primary system was not cleaned appropriately as the volume of oxygen injected in the system was not sufficient. The RP and Chemistry revised their procedures to reflect the new process whereby elevated levels of oxygen is maintained in the primary system during the clean-up.

15.2.2.1.3 Reactor cavity decontamination

Following the process of defueling, the water level in the reactor cavity is lowered which results in the deposition of radioactive particulates on the walls of the reactor cavity. Once dry, these become available for re-suspension by ventilation air currents causing an internal contamination hazard. The implementation of reactor cavity decontamination at the installation reduces the potential for such exposure to occur.

15.2.2.1.4 Reactor building contamination control during outage

In general, the policy for contamination control adopted at outages involves the dezoning of the reactor building prior to allowing outage work to continue. The emphasis on contamination control is then placed on confining the contamination to point-of-origin rather than allowing the reactor building to be classified as one contamination zone.

Surface contamination is confined using the “step-off pad principle" at the task site. The dress-out policy regarding entry to the reactor building is currently to use yellow coveralls which indicate the potential for contamination. Where entry to the reactor building is required for purposes of contamination work, two pairs of yellow coveralls may be required – one to be removed at the step-off pad at the task site, and the other for removal upon egress from the reactor building. White coveralls are prescribed clothing in the nuclear auxiliary building where the objective is to keep this as an essentially non-contaminated area.

In terms of the control of airborne radionuclides, experience has shown that the use of tents can be discontinued for most tasks, such as primary pump work, that involve the breaching of active systems. Reliance is placed on the use of portable ventilation units, linked to the breached system, which provide a net air flow into the opening of the system. In addition, on-line airborne contamination monitoring is also provided with the alarm set-point based predominantly on the airborne activity concentration equivalent to one tenth of the DAC value for ^{60}Co. The reduction in the number of tents will also have a positive benefit in terms of reduction in the volume of radioactive waste.

15.2.2.1.5 Nuclear auxiliary building/fuel building contamination control

The objective for the control of contamination in the nuclear auxiliary building is to reduce the building to a non-contaminated area. The key features in achieving this are 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 effectiveness of these efforts is measured at the installation through routine radiological surveillances and post-decontamination surveillances.

15.2.2.2 Public Exposure

In 1992, 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 from which the annual radiological effluent discharges were computed. Changes in both the consequence modeling and the migration model were made owing to better information on elemental bio-accumulation factors and plant operational parameters to derive updated dose conversion factors (Sv per 1 Bq inhaled/ingested). At this time, a change to the configuration of the discharge pathway to the sea was also instituted. This allowed for a larger dilution factor to be taken into account in respect of the calculation of dose conversion factors (Sv to a member of the critical group per 1 Bq discharged to water). At the conclusion of the work, a further optimisation study was performed to examine the possibility of not using the evaporators in the decontamination of floor drains effluent. The evaporators were being used continuously for drains effluent decontamination and were subject to frequent breakdown. The study showed that the installation could be operated without evaporation of floor drains effluent and still respect the dose limit to members of the public. The above mentioned activity migration model was revised due to the intended application of the higher enriched fuel modification which could affect the discharge quantities of both solid waste and effluent. It was proved that the impact of this modification would respect the public dose limit.

As mentioned above, the AADQ system is a system of effluent discharge limitation adopted by the NNR and the derivation of the AADQs take cognizance of design ALARA. The dose equivalent of the current AADQs of Koeberg equate to about 230 μSv/a that is below the source related dose limit. Hence, from a plant design point of view, the AADQs comply with the design ALARA requirement. However, the AADQs are largely based on limiting conditions in the safety assessment that raises the question as to how operational ALARA is ensured during those operational conditions that are less limiting than the design assumptions (normal operation). The regulating authority has formally initiated discussions with the licensee to establish an annual ALARA dose target for effluent discharges that commensurate with operational limiting conditions as far as fuel clad failure and effluent processing are concerned. Operations at the licensee must comply with the ALARA dose target during normal operation and if not, the licensee would be required to provide justification that effluent discharges are optimized.

15.2.3 Environmental Radiological Surveillance

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 principles for the establishment of the environmental monitoring programme are documented in Reference 5.

The pre-operational environmental surveillance programme was implemented to establish a baseline of prevailing levels of radioactivity in the environment against which future comparisons could be made. A survey was conducted over a period of two years from July 1979 to June 1981 to account for any possible seasonal variation in certain measurements. The survey covered all sources of radiation, both from nuclear bomb fallout and from naturally occurring radioisotopes encompassing a radius of 50 km around the site. Together with the land use census, the pre-operational survey programme provided the necessary data for the establishment of the characteristics of the critical group.

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.

15.3 REGULATORY CONTROL ACTIVITIES

Regulatory control is achieved at the most basic level by the conditions of the nuclear licence which constrain the licencee to operate according to defined protocols. 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. Additionally, SPC meetings with the licencee are scheduled frequently at which operational problems and the effectiveness of the operational programmes are discussed.

An occurrence reporting system is in place through which the licencee is required to report events, including the transgression of agreed procedures, to the regulatory body.

The licensee is required to implement a schedule of quality assurance audits each year. The regulatory body is invited to participate in these audits as an audit member and the results of the audits are formally transmitted to the regulatory body. 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.

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.

Current issues under discussion at SPC level include; tracking of the change-over to SI Units of all radiological quantities, operational AADQ targets for public exposure, minimisation of solid radioactive waste, methodology of design basis accident consequence calculations, and the review and finalisation of the revised documentation framework.

With regards to SI units, the regulatory authority has required the licensee to implement SI units following a national move towards using SI units in the nuclear industry.

The licensee had subsequently started the SI units project, which includes modification of the installed radiation monitors, procurement of additional instrumentation, training of personnel and updating all relevant station documentation. During the latter stages of the project, the licensee requested the regulator to consider their concern relating to implementation of the project based on experience feedback and contact with international nuclear power stations. Although the switch to SI units is on track to be implemented within about 6 months, the regulatory authority had proposed that the project be phased in to allow the licensee to consider lessons learned from other countries, where operational difficulties were encountered, as well as those countries where the project has been successfully implemented.

The licensee will now commit to investigate concerns relating to on-going operational experience from the plant, other conventional facilities that belong to the licensee, as well as international feedback to be incorporated into the project plan.

15.3.1 Process based licensing for Radiation Protection

The regulatory authority and the licensee undertook to perform a review of the conditions of licence and both the NNR and Eskom agreed with the objective to move towards a more "process based" licensing process. In terms of this approach, the nuclear licence would focus on the necessary "processes" to ensure radiation safety. This 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.

In terms of this system, the regulator had produced a new licence which provides a basis on which the licensee developed their safety case. A document was produced which encapsulates the Licensing Basis and the licensee finalised its processes for compliance monitoring and reporting to the regulator.

Workshops have been held involving Radiation Protection staff from both organisations on a monthly basis finalising the development of radiation protection aspects for the licensing basis document, and associated assessment and compliance reporting processes to comply with the proposed licence. The Radiation Protection Standard (RPS) was replaced by a new licensee standard that lists all the chapters in the RPS, which are now in the form of individual licensee standards. The approval followed an assessment by the regulatory authority of additional requirements, and verification whether all existing requirements have been included in the standards. The licensee had embarked on the next step in the project, and both licensee and regulator would verify if appropriate lower tier requirements have been included in the station procedures. All radiation protection changes are addressed by means of a screening and safety evaluation process.

15.3.2 Design Basis Accident consequence calculations

Following the review of the licensee updated safety analysis report pertaining to new fuel for design basis accidents, the regulatory authority was prompted to revisit the deterministic methodology for off-site radiological consequence assessment. It was decided that a sophisticated code should be more appropriate for aspects identified as not adequate namely the addition of a number of pathways, and the timescales for uptake.

It was decided that PC COSYMA or an alternative code be used to perform the deterministic studies, as the dose models in the SAR do not employ all the pathways and that experience feedback from other utilities is used.

The evaluation of the radiological consequences of design basis accidents would be performed using an off-site consequence code to assess the maximum dose to an individual located downwind of the unit at the site boundary. Calculations will be performed to demonstrate that the releases of radioactive material into the atmosphere from Koeberg Nuclear Power Plant as a result of design basis accidents have radiological consequences to the public, which are less than the set criteria for design basis accidents.

Events would be assessed that are not expected to occur, but are postulated because their consequences would include the potential of the release of significant amounts of radioactive material. Events are the most drastic which must be designed against, and thus represent the limiting design case. The external pathway dose and thyroid dose for an individual located downwind of the unit at the site boundary would be determined.

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. Experience at the nuclear installation indicates that this can only be achieved by the application of good radiological safety assessment at the design stage, upon which a comprehensive and systematic radiation protection programme is superimposed.

The issue of the implementation of ICRP 60 principles at the nuclear installation has been finalized by the licensee. Although this requires consideration of much broader issues than simply the application of a different strategy with respect to the dose limits. Table 15.4-1 provides a snapshot of the variation in the number of individuals exceeding 20 mSv y^{-1} and 50 mSv y^{-1} from 1999 to 2003.

Table 15.4-1

SUMMARY OF KOEBERG OCCUPATIONAL EXPOSURE DATA FROM 1999 TO 2003

Year	No of Individual exceeding 20 mSv per year	No of individuals exceeding 50mSv per year	Average annual dose to the occupationally exposed workers mSv	Annual Collective Dose man-mSv
1999	1	0	0.983	1726.4
2000	0	0	0.448	848.54
2001	0	0	1.02	2308.38
2002	0	0	0.75	1585.39
2003	0	0	0.9977	2044.3

15.4.1.3 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 2003.

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, by world standards, in keeping collective dose for outages reasonably low.

15.4.2 Public Exposure

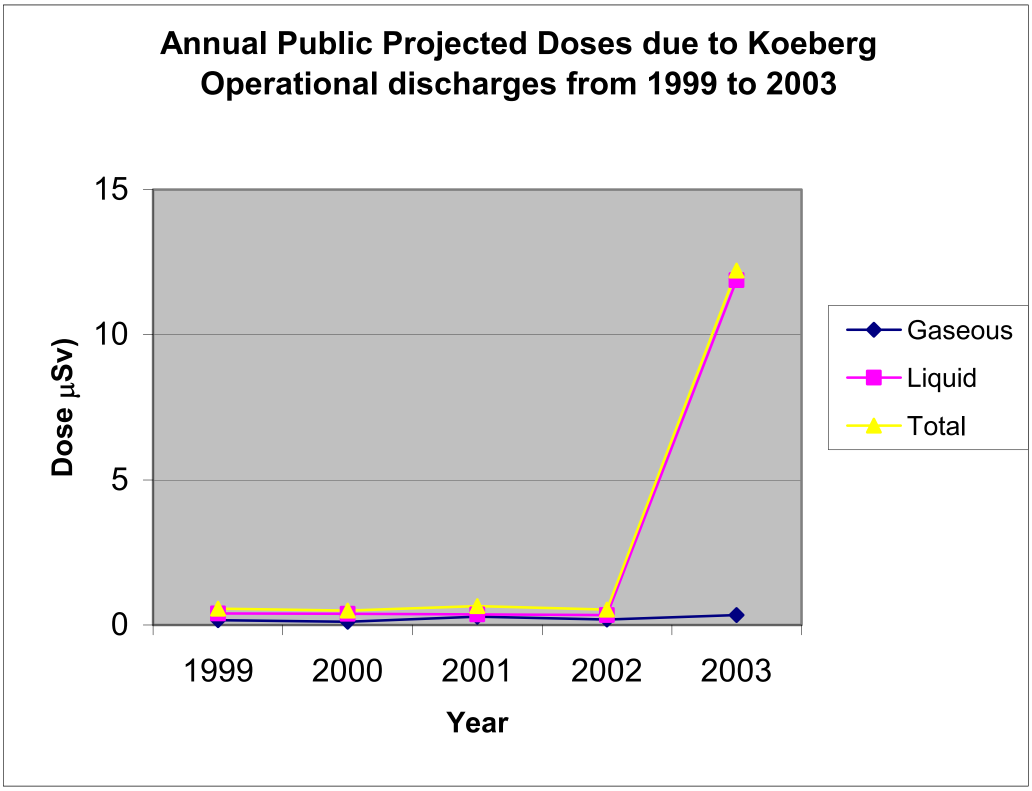
15.4.2.1 Control Of Public Exposure

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. In addition to this, a complementary environmental surveillance programme provides feedback from measurement of activity levels and doses in the environment as verification to ensure that the predicted doses by each exposure pathway continue to be conservative. A study was undertaken in 1992, for the purposes of recalculation of the dose conversion factors. These new factors were approved for use by the regulatory body in 1993 followed by a re-evaluation and subsequent approval of a new set of factors in 2002.The variation in the public dose by year is provided in Table 15.4-2.

Table 15.4-2

Annual Public Projected Doses Due to Koeberg Operational Discharges From 1999 To 2003

YEAR	GAS	LQUID	TOTAL(μSv)
1999	0.17	0.394	0.564
2000	0.111	0.384	0.495
2001	0.288	0.36	0.648
2002	0.19	0.34	0.53
2003	0.339	11.874	12.213



The AADQ system of the plant is based on a so-called activity migration model that features the migration of activity from the fuel via the clean-up systems and effluent treatment systems and various drain systems up to the point of discharge. The ultimate result of the activity migration exercise is the annual amount of effluent release in Bq on a nuclide specific basis.

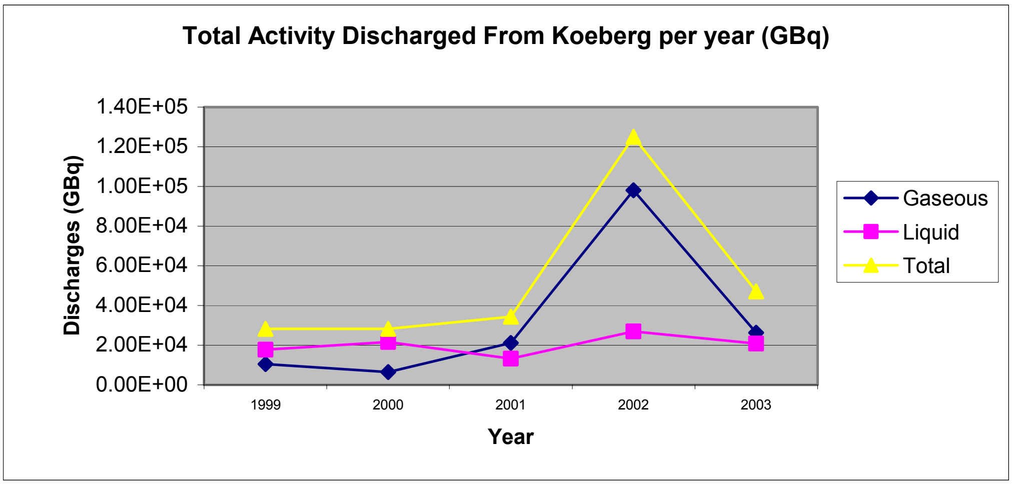
It is evident that the annual projected dose arising from effluent discharges from the plant during 2003 was 4.8% of the NNR limit compared to less than 1% for previous years. The reason for the increase in projected dose compared to the previous year(s) can be attributed to a more accurate and realistic method of modelling doses to the public during normal operations. The revised system is based on the latest international guidelines in modelling releases, as well as software codes. The regulating authority is currently in discussion with the licensee to establish an annual ALARA dose target for effluent discharges commensurate with operational limiting conditions as far as fuel clad failure and effluent processing are concerned.

The variation in the total activity discharged by pathway in each year from 1999 to 2003 is detailed in Table 15.4-3.

Table 15.4-3

Total Activity Discharged From Koeberg By Year [GBq]

Year	**1999**	**2000**	**2001**	**2002**	**2003**
Activity in Gaseous discharges	1.05E+04	6.51E+03	2.11E+04	9.81E+04	2.63E+04
Activity in Liquid discharges	1.78E+04	2.16E+04	1.33E+04	2.69E+04	2.08E+04
Total activity Discharged	2.83E+04	2.82E+04	3.44E+04	1.25E+05	4.71E+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, and the highest value reported for this radionuclide occurred in white mussels at a level of approximately 16 Bq kg^{-1}. Taking the annual consumption value of white mussels to be equivalent to that of black mussels, the resulting annual public dose is calculated as 7 x 10^{-4} mSv. However, white mussels are not widely consumed by local residents and the calculated dose is therefore not realistic. This explains why this calculation is inconsistent with the dose predicted as a result of total discharges over all pathways for all years as presented in Table 15.4-3. The measurement of radioactivity in white mussels is however a good indicator of environmental trends.

Table 15.4-4

Average Monthly TLD Exposure Measurements at Site Boundary

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Exposure (**Sv**	47.7E-06	51.1E-0	48.6E-06	42.6E-0	41.6E-0	40.8E-06
Year	**1998**	**1999**	**2000***	**2001**	**2002**	**2003**
Exposure (**Sv**)	39.8E-06	43.4E-0	25.8E-06	24.1E-6	22E-6	26.9E-6

* From 2000 onward, the measured monthly TLD values are corrected for internal contributions, including self-irradiation.

Table 15.4-4 has been revised to show representative average measurements of monthly external exposure at the site boundary by year from 1992 to 2003. 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.

It should be noted that the dramatic 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.

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 regulatory body.

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 made in section 16.4, overall national emergency preparedness, following the promulgation of the Disaster Management Act in 2002, becoming operational in July 2004.
2. Section 16.5, on-site and off-site plans including support bodies was updated with regard to the development of the late phase emergency plan for Koeberg Nuclear Power Station.
3. The section 16.7.2.4, Koeberg emergency exercises for the year 2002 and 2004 has also been updated.

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

The National Nuclear Regulator Act makes provision for the regulatory body to impose any conditions in a nuclear installation licence which is deemed necessary to ensure the protection of persons, property and the environment against the risk of nuclear damage. In addition the legislation enables the regulatory body to call for whatever information is necessary to determine that adequate safety provisions are in place and that a nuclear installation licence may be granted.

The legislation, *inter alia,* specifically specifies the requirements on emergency planning to ensure the preparedness to deal with nuclear accidents.

The legislation requires that, where the possibility exists that a nuclear accident affecting the public may occur, the regulator must direct the relevant holder of a nuclear installation licence 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 regulator.

The regulator 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, liaison with off- site authorities as well as relevant international organizations and emergency preparedness provisions.

Furthermore, the relevant Minister may, on recommendation of the regulator'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 regulator. In terms of the arrangements for the reporting period in place, authority has been ceded to the nuclear installation emergency controller to require implementation of off-site protective actions in the event of a nuclear accident according to the procedures laid down in the emergency plan. These arrangements will however change in the near future through the establishment of a new national disaster management organization and policy by new legislation by the Ministry of Local and Provincial Government. The affected local authorities have nuclear emergency response plans in place that are exercised on a regular basis as part of the Koeberg exercises.

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 regulatory body. The role of the nuclear installation is that of accident recognition and quantification, reporting to the regulator 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 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.

When a nuclear accident is reported to the regulator, the regulator is statutorily required by the legislation 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 and regulatory practices as contemplated in the National Nuclear Regulator Act; 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.

The regulator 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 regulatory body 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 regulatory body 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.

In accordance with the relevant conditions of licence, the licence holder has provided the necessary facilities, equipment, response teams, training and exercising. Similarly, the relevant local 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.

16.2.1 Review of Koeberg Emergency Planning

As part of the periodic safety re-assessment process for Koeberg, the emergency plan was revisited. During 1997 Eskom, after consultation with the NNR, contracted the services on international consultants to undertake this review.

The extensive scientific technical work undertaken to develop and review the Koeberg Emergency Planning Technical Basis was brought to a conclusion.

Taking into consideration all implications associated with the Koeberg Emergency plan e.g public safety considerations, socio-economic considerations e.g developments around Koeberg, etc.. The regulator felt that, in order to make a well informed decision towards the finalisation of a plan, which will be favourable to all interested and affected parties, it was necessary to canvass the views, opinions and perspectives of a wider forum of public representation in the environs of the power station.

In general, the existing emergency planning zones were found to remain justified. Despite the extensive work undertaken, no compelling information emerged which strongly suggested a reduction in the emergency planning zones. In this light, the NNR requested that status quo with the following planning zones be retained, although current initiatives undertaken by the Licensee may be considered and assessed by the Regulator for reviewing these planning zones:

Ep zone	**Current zones**
PAZ	**0-5 km**
UPZ	**5-16km**
LPZ	**0-80 km**

For effective implementation of the plan action times need to be specified. Using a radius of 16 km and a 4-hour initial implementation time for public notification and actions in the PAZ the following table has been developed.

PUBLIC NOTIFICATION AND ACTION TABLE

ZONE	SIZE (km)	ACTION	TIME hours	JUSTIFICATION
PAZ	0-5	**Evacuation** (all sectors) based on in-plant conditions	4[a]	Reduces the risk of deterministic effects by pre-emptively evacuating out to a radius where deterministic mortality effects may not occur. LG-1036 and IAEA TECDOC 953 and 955
UPZ	5-16	**Shelter** (downwind sectors)	4[a]	Reduces the risk of stochastic effects by pre-emptively sheltering downwind and then evacuating based on prevailing conditions (e.g. plant degradation and environmental monitoring). LG-1036 and IAEA TECDOC 953 and 955
		Evacuation based on in-plant conditions leading to 12-16 hour advance warning.	16	
		Thyroid blocking (downwind sectors)	10[a]	In line with international practice

16.3 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 national government. Emergency situations, for which the classification system caters, are defined according to the following categories.

- Unusual Event
- Alert
- Site Emergency
- General Emergency

16.3.1 Unusual Events

Unusual Events are those which indicate a potential for degradation of the level of safety of the installation. Releases of radioactive material requiring off-site response or monitoring would not result unless further degradation of safety systems occurred. Only notification to the regulatory body 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.

16.3.2 Site Alert

A Site 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 regulatory body 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

Examples of events, which would lead to the declaration of a Site Alert, include the following:

- Excessive primary leakage
- Fire, which affects a safety system
- Fuel handling accident
- Unexpectedly high radiation levels in the installation
- Inability to reach cold shutdown
- Inability to shutdown the reactor
- Loss of AC or DC electrical power
- Security threat (penetration of protected area)
- Severe damage to fuel cladding
- Steam generator tube rupture
- Steam line break

16.3.3 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.

Events which would lead to declaration of a Site Emergency would include:

- Aircraft crash that has a direct impact on vital structures
- Core damage with potential loss of coolable geometry
- Earthquake greater than safe shutdown level (SSE)
- Fire (compromises functions of vital safety systems)
- Loss of coolant greater than makeup capability
- Loss of AC and DC electrical power for more than 15 minutes
- Security threat with imminent loss of plant control
- Toxic gas preventing access to vital areas
- Wind (extremely high wind speeds)

16.3.4 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.

16.4 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 emergency, 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 state of disaster as provided for in the Disaster Management act of 2002.

The Disaster Management Act was promulgated in 2002 and has become operational in July 2004 This will give rise to the formation of a national disaster management, policy and organisation. The disaster management organisation will be operated under the auspices of the National Department of Provincial and Local Government. The regulatory body has played a key role in developing national guidelines for radiological and nuclear emergencies.

16.5 ON- AND OFF-SITE PLANS INCLUDING SUPPORT BODIES

Emergency preparedness and response plans are documented for interventions relating to the early, intermediate and late phases of a nuclear emergency. During the early phase the on-site emergency plan of the installation is initiated by the installation once it has been recognised that an emergency condition exists. Emergency notification, communication and pre-determined urgent protective actions are recommended to the Local, Provincial and National Disaster Management organisations in accordance with authorised procedures to mitigate possible radiological risks to the workers, public and the environment. The Local, Provincial and National Disaster Management organisations are responsible for implementation of urgent protective actions as recommended by the on-site organisation. The installation is responsible for radiological monitoring. During the late phase of a nuclear emergency, the response to mitigate potential consequences are directed by the Local, Provincial and National Disaster Management Organisations in accordance with the Late Phase Nuclear Emergency Plan. The late phase emergency plan addresses aspects such as environmental monitoring, relocation, decontamination of structures and infra-structure and access control to contaminated land. International support is activated via the ENATOM agreement as required.

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 approval process of the improved Late Phase Emergency Plan is underway. The document submitted to the Regulator for approval details the requirements, processes and responsibilities applicable to late phase nuclear emergency response. The document has been compiled in conjunction with the relevant municipalities and provincial authorities in accordance with international standards and guidelines. The Late Phase Emergency Plan is supported by a suite of operational procedures which are sufficiently detailed to identify resources, infrastructure, and actions that may be required during the late phase response.

16.5.1 On-Site Emergency Organisation

The various facets of the on-site organisation are described briefly below:

16.5.1.1 Identification of an emergency situation

The identification of emergency situations which pose a potential or actual threat to the installation is performed from the control room where the supervisor in charge of the 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 organisation 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 at the emergency control centre should happen within 30 minutes of notification. In addition, the notification to off-site authorities is also given at this time and mustering of their respective emergency organisations will take place concurrently.

16.5.1.2 The emergency control centre (ECC) and survey teams

Management of the emergency in the early phase is performed by the on-site emergency organisation at the 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. With regard to the latter, a joint media centre is established at another location in order to deal with media communication. 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.

Upon mustering at the ECC, the on-site emergency team organisation recommends protective actions for implementation. The implementation of protective actions is performed jointly by the ECC and the off-site organisations. In addition, the ECC directs the off-site survey teams to provide data to be taken into consideration in these recommendations.

Redundant communications systems are provided at the ECC for communication with the off-site organisations, the regulatory body, the licence holder's head office, and the joint media centre.

A further requirement is that an alternate ECC must be available for use if the ECC becomes untenable owing to the accident consequences.

In addition, a Technical Support Centre, manned by plant specialists, exists to provide assistance to the ECC and operations staff.

16.5.2 Off-Site Emergency Organisations

The off-site emergency organisations involved are emergency organisations of the district and metropolitan councils. Initial notification of an Alert or Site/General Emergency is communicated to the Unicity of Cape Town Administration and Blaauwberg Administration from the ECC. Notification to other authorities, of which there are five, is performed by the Unicity of Cape Town Administration.

16.6 MEASURES FOR INFORMING THE PUBLIC AND AUTHORITIES

Following the declaration of an Alert, Site Emergency or General Emergency, media releases concerning the incident will be provided by the Joint Media Centre. This centre will be activated upon declaration of an Alert by the Standby Communications Officer and supported by the Regional Emergency Manager. In the case of a rapidly evolving situation, media information can be provided by the ECC. In the case of an Unusual Event, public notification shall be at the discretion of the Emergency Controller.

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 lead responsibility for nuclear emergency preparedness and the implementation of protective actions for the public has been delegated to the City of Cape Town (CCT) by the Provincial Administration of the Western Cape (PAWC). CCT plays a coordinating role in the implementation of Disaster Management activities between the former six municipalities (Blaauwberg, City of Cape Town, City of Tygerberg, Helderberg, Oostenberg, and South Peninsula). Once the Emergency Control Center (ECC) is activated communications is established with the Cape Town Metropolitan Council (CMC) Civil Disaster Management Organization.

Prior to the activation of the Emergency Control Center (ECC) 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 and communication from the ECC takes place by means of a telephone call, which will be followed by a fax, to the CCT Joint Operation Center (JOC). The fax will also be copied to the Regional Nuclear Emergency Manager at the Joint Media Center (JMC). Details of the fax include details of the emergency situation, the classification of the emergency, the time, and the recommended protective action(s). The CCT JOC will then disseminate information to other sub-zones at regular intervals to update them on the implementation of protective actions.

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 ECC at Koeberg. Briefings will be provided by the Regional Emergency Manager assisted by the Regional

Communications Officer and technical staff from the Alternate ECC. 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 Regulator 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 Necsa the responsible South African institution in this regard.

16.7 TRAINING/EXERCISES

16.7.1 Training In Emergency Planning

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. These groups are typically:

- Licence holder’s emergency response team
- Government Technical Advisors
- Local authorities' professionals
- Civil protection officers
- Water and agricultural product suppliers
- Trading standards officers

Those who develop and provide specialist support services in respect of the licence holder’s emergency response are nuclear professionals. These include Government Technical Advisors from the regulatory body. For the other personnel, training courses are developed at a level appropriate to the function required of the individual.

16.7.2 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 measurement of the performance 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 are therefore not frequent, currently being held at one year to eighteen month intervals, and therefore reliance has to be placed on more frequent but less extensive 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 regulatory body, however, relies on the full scale exercise in order to test total acceptability.

16.7.2.1 The full-scale emergency exercise

This type of exercise provides the opportunity to put into practice a major part of the on and off-site emergency plan. It also provides a more realistic setting for the evaluation of the communication flow between organisations, the decision-making and control from the emergency control centre and the implementation of protective actions. The exercises are developed by the regulatory body, against defined objectives, and provide a means by which the regulatory body can be assured that all components of the emergency plan will function coherently in an emergency situation.

16.7.2.1.1 Specification of objectives

In designing the scenario for the exercise, the regulatory body decides on specific objectives for the exercise e.g. the testing of public notification, adequacy of decision-making or the implementation of specific protective actions. These objectives then form the framework around which the detail of the exercise is developed. The objectives also take account of areas of suspected weakness identified from previous exercises.

16.7.2.1.2 Development of the exercise scenario

From the exercise objective, the detail of the exercise scenario is then formulated. Consideration is given to the distance over which a protective action is required to be implemented, the release type and associated meteorological conditions, development of the in-plant scenario to give the release, and in-plant indicators which provide operating staff with the necessary data and inputs to identify and classify the accident. In the development of the scenario, it is necessary to establish a set of ground rules with the licence holder in order that no misunderstandings arise regarding what is expected of the emergency response organisation. However, the detail of the actual exercise scenario is kept confidential to the regulatory body.

16.7.2.1.3 Preparation and briefing of umpires and observers

Prior to conducting the exercise, it is necessary to identify all locations where exercise information is required to be provided to the licence holder and assign regulatory body personnel (umpires) to these locations. These umpires are then trained in the use of cue cards, which are developed for each exercise, and provide all necessary information, which should be cued, to the exercise participant. In those locations where umpires are not required, regulatory body observers may be allocated to provide feedback on the effectiveness of response. Umpires and observers are trained in the particular facet of emergency response that they are required to monitor during the exercise.

16.7.2.1.4 Preparation of the post-exercise report

Upon completion of the exercise, all observers and umpires are de-briefed in order to obtain an holistic picture of the licence holder's performance. This information is consolidated into an exercise report, which is then discussed with the licence holder to ensure that criticism is valid and constructive. Upon agreement, this report then contains the points of criticism in the various areas of emergency response requiring future attention. The tracking of the close-out of each point is performed by liaison between the licence holder and the regulatory body at periodic emergency planning meetings which are scheduled throughout the year.

16.7.2.2 Installation exercise

Installation exercises primarily involve the on-site emergency organisation. However, depending upon the exercise objectives, off-site organisations may also be involved. These exercises involve the full scope testing of the on-site organisation, the objectives of which are based upon existing deficiencies identified in the full-scale exercise.

16.7.2.3 Table top exercises

Table top exercises may be conducted by either the on-site or the off-site emergency organisations in order to test emergency response in defined areas. Essentially, the objective of such exercises is to test decision-making and communications.

16.7.2.4 Sample of Exercise Report Summary

Since 2001 the NNR conducted two full-scale emergency exercise on the Koeberg Nuclear Power Station. These two exercises are summarized below:

16.7.2.4.1 2002 Koeberg Emergency Exercise

The National Nuclear Regulator (NNR) conducted an emergency exercise at the Koeberg Nuclear Power Station (KNPS) on the 26 February 2002 from 8:30 to 14:00. Late Phase response was not tested. The off-site public warning sirens were not activated as they had been tested separately.

The scenario provided to Eskom entailed the loss of power supply and the failure of the stand-by generators, causing the reactor to trip and ultimately to the failure of the safety injection system. Subsequently the primary circuit overheated, the core was damaged and uncovered, and containment failure ensued. The wind directions and release were such that Protective Actions were required in the 5km and 16km emergency planning zones. The main emphasis of the exercise was the physical evacuation of 500 military personel, used as evacuees. Previous exercises have only simulated evacuation, however on this occasion the intervening organizations had an opportunity to demonstrate their effectiveness in dealing with a more realistic situation.

The overall response from Eskom was acceptable and was executed according to procedures.

All the intervening organizations participated and responded well to the emergency although some deficiencies have been noted.

The NNR identified some weaknesses during the exercise, which were subsequently addressed through appropriate actions.

16.7.2.4.2 2004 Emergency Exercise

The overall objective of the emergency exercise that was conducted on the 18th February 2004, by the National Nuclear Regulator (NNR) on the Koeberg Nuclear Power Station (KNPS), was to test the response of both the on-site and off-site organizations towards a simulated nuclear emergency.

The exercise scenario developed by the NNR simulated an accident with a large release of radioactive material, resulting in consequences equivalent to a Level 7 on the INES scale. The wind directions and release magnitudes were such that appropriate protective actions would have been required in the Precautionary Action Zone (PAZ) and the Urgent Protective Zone (UPZ. Implementation of the appropriate protective actions depended on the ability of Koeberg staff to classify the accident and gather sufficient data to enable intervening organizations to respond effectively. The scenario also provided for the testing of the response for the evacuation of 200 staff members from the power station as well as the treatment and evacuation of "contaminated" injured workers from the power station to an hospital in Cape Town

The NNR concluded that the overall response of Eskom and the intervening organizations had shown that the Koeberg nuclear emergency plan is viable, however areas have been identified by the NNR for improvement including key aspects such as protective action decision making, communication to off-site authorities and use of potassium iodate tablets.

Eskom has identified corrective actions, to address the findings raised by the NNR, to be implemented in accordance with the timescales identified. The NNR is tracking the close-out of the findings and implementation of these corrective actions through liaison meetings and by means of formal communication with Eskom.

16.8 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

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. Instances requiring such notification would be handled on an *ad hoc* basis.

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 newly published regulation
2. Chapter 17.4 was update to taking cognizance of the review of internal hazards carried out during the periodic safety re-assessment of the nuclear installation.

17.1 LEGISLATION AND LICENSING PROCESS

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

In terms of reviewing the suitability of a specific site, the applicant must submit to the regulator a site safety report which will sufficiently characterize the site such as to demonstrate that the safety standards laid down by the regulatory body could be met in respect of the plant design. Typically the site safety report should 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 regulatory body 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 current 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 regulatory body.

17.3 IMPACT OF THE NUCLEAR INSTALLATION ON THE SURROUNDING ENVIRONMENT

The regulatory body requires the licence holder to provide adequate source term data to demonstrate that the projected dose to the critical group owing to normal operations and accident conditions of moderate frequency (1-10 $^{-2}$ pa) comply with an annual average dose limit of 0.25 mSv y^{-1} to the critical group. For accidents of frequency lower than 10 $^{-2}$ pa, the licence holder is required to calculate accident source terms to demonstrate compliance with the risk criteria laid down by the regulatory body in terms of maximum individual risk, average population risk and societal risk. The dose and risk calculations are performed by the licensee.

The regulatory body 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 Regulator (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 regulatory body to determine risk to the public and compliance with the above-mentioned risk criteria. 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

In the light of an increased rate of development in the vicinity of Koeberg, the NNR initiated a programme of work to revisit the technical basis of the emergency plan with a view to establishing criteria against which developments could be assessed, and if necessary to propose new regulations which would limit such developments.

This work was initiated in 1997 and involved the NNR, Eskom, and the local authorities in the area of Koeberg. The three main aspects of the work were as follows:

- Technical basis of the Koeberg emergency plan with the objective of re-evaluating the radii of the various emergency planning zones and evacuation time criteria.
- Population projections for the Cape metropolitan area up to 2030.
- Evacuation modelling from the above defined zones with the objective of establishing criteria on population limits and infrastructure to meet the evacuation time criteria.

The above work was completed in 2001 which culminated in the results presented in Article 16.2.1.

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 Regulator 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 terms of the Regulations the relevant provincial and/or municipal authorities must—

(a) develop and implement processes, based on the requirements (as indicated above), including associated acceptance criteria, for the conduct of periodic assessment of —
    (i) current and planned population distribution;
    (ii) disaster management infrastructure; and
    (iii) new development,

to ensure that the emergency plan, as contemplated in section 38 of the Act, can be implemented effectively at all times;

(b) document the processes contemplated in subsection 4*(a)* in procedures acceptable to the regulator; and

(c) report to the Regulator on the implementation and the results of the monitoring processes at intervals acceptable to the Regulator.

The Regulator's work to develop the requirements, as required by the Regulation, that will have to be applied in the assessments performed by the authorities in respect of Koeberg, is near finalisation. As per the Regulation once the NNR has completed its work, consultations with the provincial and local authorities will take place in order to finalise the requirements

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.

(ii) Shortcomings in the fire safety case were identified in the Koeberg periodic review. In response to these findings Eskom plans to reassess the fire hazard safety case by the end of December 2004. This will involve both a deterministic and probabilistic analysis.

(iii) Some of the electrical equipment was qualified for earthquake resistance by shaking table tests. 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 completion is scheduled for 2008.

(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 identified for future action.

Furthermore as indicated above in 17.3.2 a major review was undertaken related to development around the nuclear installation, to ensure the viability of the nuclear emergency plan, which has culminated in regulations which are currently being implemented by the regulator.

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. Section 18.3 was updated to include new modifications made to the plant
2. Section 18.3 was updated to include upgrade of the simulator
3. New section 18.1.4 was added for reference to the Pebble Bed Modular Reactor (PBMR)
4. Section 18.2 "Defence In Depth" (DiD) was updated to take cognizance of safety improvements to enhance DiD.
5. Sections 18.2, 18.3, 18.4 and 18.5 were updated to include the following opening statement:

"The information provided in this Section 18.# is in the context of the Koeberg Nuclear Power Station. The corresponding information for the PBMR mentioned in Section 18.1.4 is being developed as part of the PBMR licensing process."

18.1 LEGISLATION AND LICENSING PROCESS ON DESIGN AND CONSTRUCTION

18.1.1 Statutory Requirements

The legislation in place is broad, enabling legislation that empowers the regulatory body to apply whatever conditions are necessary to provide for the protection of persons, property and the environment against nuclear damage. In addition, the legislation enables the regulatory body to call for whatever information is necessary in order to evaluate the licensee's application.

The licensing process adopted on the basis of these statutory requirements 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 was required, in the safety assessment process, to be demonstrated to be compliant with the design codes and criteria specified, the equipment to be fit-for-purpose and the risk criteria met. This was achieved through a process of the licence holder providing safety submissions with supporting evidence and these submissions were subject to a technical review and approval process by the regulatory body.

The construction process was required by the regulatory body to be carried out in terms of assessed specifications and processes including testing and examination requirements. The overall process was subject to a quality assurance regime assessed and approved by the regulatory body. During the construction process, ongoing review and inspection of compliance with these requirements was maintained and staged approvals were provided throughout the construction phase.

18.1.2 International Norms and Standards

In terms of meeting international norms and standards, the design and general operating rules of the nuclear installation conform to the applicable laws, regulations, codes and standards that were used in the design and construction of the nuclear installation as used in the reference station, Tricastin. The French laws, regulations, codes and standards, including Electricité de France (EdF) rules used for design, procurement, manufacturing, construction, and testing, were those used in the reference station on June 18, 1976.

18.1.3 Other Regulations

In 1984, EdF and Framatome formulated design and construction rules (RCC) for the design and construction of pressurised water reactor power plant systems, which evolved over subsequent years with revisions to these documents. In particular the RCC-P provides the design and construction rules for the system design of the 900 MWe PWR nuclear power plant, and which clarify the criteria applied to the 900 MW series units constructed prior to the issuance of the RCC. The RCCs are therefore not applicable to the design and construction of the nuclear installation, but are applicable in certain cases where Framatome, as the original equipment manufacturer, has provided plant modifications (including fuel) designed, and sometimes manufactured, to RCC rules. One of the outputs of the Koeberg Safety Re-assessment (KSR project) (discussed in Article 14) was a recommendation to align the nuclear installation e.g Koeberg, to the French CP-1 safety referential. This may entail adopting some of the French RCC rules, however, the optimal level of alignment is currently under investigation.

Whenever, French safety rules did not cover the scope of South African or US rules, according to how they were interpreted for the reference station, the South African rules were applied.

Tricastin 1 is the reference plant for the Nuclear Steam Supply System (NSSS) for the nuclear installation. For certain specific features, Gravelines and Cruas were used as reference plants.

18.1.3 New nuclear installation licence applications

The Pebble Bed Modular Reactor (PBMR) project, is being investigated by Eskom as an alternative energy source.

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.

The South African safety standards and regulatory practices as contemplated in the legislation are applicable to this application.

The "Basic Licensing Requirements for the PBMR" which have been developed by the NNR and issued to the applicant, describe the fundamental safety standards adopted by the National Nuclear Regulator and provides some insight into their basis and establishment.

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

In order to demonstrate that the PBMR design will meet the above 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 regulator, 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

The information provided in this Section 18.2 is in the context of the Koeberg Nuclear Power Station. The corresponding information for the PBMR mentioned in Section 18.1.4 is being developed as part of the PBMR licensing process.

18.2.1 Requirements

The principle of defence-in-depth, as applied in the design , construction and subsequent operation of the nuclear installation is taken from the IAEA INSAG-10 and in its broadest context is upheld by the following requirements of the regulatory body such that the licence holder is required to demonstrate compliance with fundamental safety standards which include:

- Risk criteria addressing mortality risk to the public (present and future generations) and workforce
- Public and operational exposures arising from normal operations
- Fundamental safety principles such as defence-in-depth and ALARA
- General safety principles relating to the requirement to comply with international norms and practices
- Requirements for emergency planning

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. Requirements on risk assessments for nuclear installations are given in a nuclear licence document. Guidance on the contents of a safety case are provided by the regulatory body.

18.2.2 Defence-in-depth in plant design and operations

The principle of defence-in-depth is upheld in the design basis of the nuclear installation and its general operating rules.

The implementation of defence-in-depth has been significantly enhanced as a result of the risk approach required by the regulatory body. It has been shown to support the design basis and to identify important improvements in safety, 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 regulatory body), 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 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 (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.

Complementary to the licence holder's monitoring programme, a comprehensive independent surveillance and compliance inspection programme is developed by the regulatory body to verify compliance with the nuclear licence requirements and to identify any potential safety concerns. Most nuclear licence conditions are subjected to the inspection programme, which is implemented by the regulatory body staff. Some of the major topics covered by this programme relating to defence-in-depth are:

- Occurrences/incident assessment and trend analysis
- Monitoring of selected safety related systems e.g. ventilation, fuel handling equipment, electrical power supplies, effluent discharge control etc.
- Compliance with the installation's Operating Technical Specifications
- Maintenance and ISI activities
- Physical security
- Quality assurance programme implementation

In terms of its implementation in the design, the defence-in-depth principle is based on the concept first developed by the USNRC in its document WASH 1250. Consideration is given to three levels of defence as follows:

(a) The first level is provided by the maximum inherent ability of the nuclear installation to function safely during normal operation, through conservative design and quality of fabrication.

(b) The second level is provided by postulating, despite the care taken with regard to the first level, a certain number of abnormal transients and incidents, and designing each unit with protection systems which are able to stop the development of an accident and to place each unit in a safe shutdown condition.

(c) The third level is provided by postulating hypothetical accidents which may affect the integrity of any or all fission product barriers. To counter these, safeguard systems are designed to mitigate or limit the consequence of such accidents, taking into account one possible additional failure during safeguard actions. As an example, the loads resulting from a hypothetical accident such as a reactor coolant pipe break in conjunction with total failure of the external power supply together with the loads resulting from an earthquake, are considered in the design of the safeguard systems.

In practice fourth and fifth levels of defence (as indicated in IAEA INSAG 10) have been implemented at the Koeberg Nuclear Power Station 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.

18.3 PREVENTION/MITIGATION OF ACCIDENTS

The information provided in this Section 18.3 is in the context of the Koeberg Nuclear Power Station. The corresponding information for the PBMR mentioned in Section 18.1.4 is being developed as part of the PBMR licensing process.

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. 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 – As indicated in Article 6 the following modifications were implemented at the Koeberg Nuclear Power Station:

- Improved accumulator level measurement
- Upgrade Reactor coolant level measurement
- Increased spent fuel pool cooling
- Upgrade of Spent Fuel Pool crane
- Upgrade of Control Room alarms
- Automatic venting system for high head safety injection pumps
- Pressure Operated Relief Valve nitrogen back-up
- Code repair of stress corrosion cracking on the refueling water storage tank and pipe work of the spent fuel pool, containment spray and low head safety injection systems.
- Upgrade to reverse power protection of the generator.
- CP1 - Protection of high head safety injection regenerative heat **exchanger.**

Additionally, a suite of modifications identified as safety re-alignment projects (CP1) has been identified (88 modifications in total). The first modification has been implemented this year – all projects will be completed by 2010.

(b) Improvements to general operating rules/operator training

- Development of shutdown Operating Technical Specifications
- Improved accident procedures (Westinghouse symptom-based emergency response guidelines)
- Installation of an Emergency Response Facility (ERF) in support of the above procedures
- Installation of a full-scope simulator and simulated ERF – simulator hardware and software have been upgraded in 2004.

(c) Severe Accident Management Guidelines were implemented in 2000**.**

(d) Rules for accident analysis

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 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.

18.4 MEASURES REGARDING APPLICATION OF PROVEN TECHNOLOGIES

The information provided in this Section 18.4 is in the context of the Koeberg Nuclear Power Station. The corresponding information for the PBMR mentioned in Section 18.1.4 is being developed as part of the PBMR licensing process.

18.4.1 During initial design, construction and commissioning

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 general safety principles for the nuclear installation were established to address the radiological consequences of normal operation and also those intended to prevent accidents and to limit their consequences.

The design basis of the plant was established following the design rules and regulations prevailing at the time and applicable to the French reference station, Tricastin. These regulations, codes and standards had been derived from the US General Design Criterion as referenced in US 10CFR50 and other more specific codes, standards and procedures issued by the IEEE, ASME and ANSI.

The plant, as designed and built, was therefore 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, have been validated by extensive 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. Some of the major steps of the commissioning programme were the following:

- Preliminary systems functional tests
- NSSS functional tests
- Cold functional tests
- Hot functional tests
- Preparation for fuel loading
- Fuel loading and start-up operations
- Pre-criticality tests
- Criticality and low power tests
- Power escalation

At each step of the commissioning programme the results of each test were compared to acceptance criteria derived from the safety analyses.

18.4.2 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 current international norms and standards including an acceptable nuclear quality assurance programme. 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.

18.4.3 Koeberg Reassessment Project

The NNR review and conclusions of the KSR project are reported in section 14.

18.4.4 Follow-up of Periodic review

The licensee has established a comprehensive programme to close-out the findings of the periodic review by 2005.

As part of this process Koeberg have embarked on a project to study the feasibility of aligning Koeberg to equivalent French plants (CP-1 plants). This is referred to as the CP1 Alignment Project (2001-2008) which would aim to bring Koeberg into closer alignment with French CP1 plants in terms of modifications, operating procedures and maintenance practices.

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

The information provided in this Section 18.5 is in the context of the Koeberg Nuclear Power Station. The corresponding information for the PBMR mentioned in Section 18.1.4 is being developed as part of the PBMR licensing process.

The licensing process requires that any design changes affecting safety related systems, components and activities are approved by the regulatory body prior to their implementation. Procedures, approved by the regulatory body, are in place to provide standard instructions for modification control compliance, as documented in Reference 7. 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 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 PWR experiences over the years in this respect. (Refer also to Section 12.2.4).

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. Section 19.3 has been updated to provide feedback on the status of the Upgraded Technical Specification (UTS) project.
2. Section 19.4 has been updated to provide feedback on the status of the Safety Related Surveillance Manual (SRSM) project
3. Section 19.5 on Incident and Accident procedures has been updated
4. Section 19.9.2 on Spent Fuel has been updated

19.1 LEGISLATION

The National Nuclear Regulator is charged, by virtue of the provisions of National Nuclear Regulator Act (Act No 47 of 1999), to consider all relevant aspects of an application for a nuclear licence which it may receive and may direct the applicant to furnish it with such information as may assist it in reaching a decision on the granting of a nuclear licence or not and the conditions subject to which such licence ought to be granted.

Specifically, the Nuclear Licence for the nuclear installation contains conditions relating to the operation of the plant. There are also restrictions embedded in the licensing process which prohibit operations under unsafe or undiagnosed conditions.

19.2 HOW INITIAL AUTHORISATION TO OPERATE WAS ACHIEVED

As well as the standard safety submissions made to the regulatory body, based on the normal deterministic approach to licensing of nuclear power plants, adopted by regulatory bodies in Western Countries (e.g. PSAR, ISAR, FSAR, etc.), the regulatory body further required numerous additional supporting submissions, together with a specific "safety case" submission, which strongly linked the deterministic licensing requirements with the very specific probabilistic safety analysis required by the regulatory body, to show compliance with the laid down risk-based fundamental safety standards of the regulatory body.

Following the acceptance of the safety design of the installation, the regulatory body is required to be satisfied that the "as built" installation matched that of the approved analysed installation. This was accomplished by extensive inspection and auditing programmes adopted throughout the construction, commissioning and operation stages of the installation, based on approved documentation provided throughout each of these stages. Regulatory control was accomplished throughout the licensing process through the issue of a nuclear licence divided into a number of defined stages (variations) e.g. fuel on site, fuel loading, start up and initial criticality, synchronisation and power raising from 6 % to 100 % power. Each variation of the licence contained specific conditions applicable to that particular stage and approval was required from the regulatory body before permission was given to advance to the next licensing stage. After initial full power operation was achieved, a final "safety case" was required by the regulatory body to demonstrate that the nuclear installation could be operated safely in accordance with the criteria of the regulatory body throughout the installation's design lifetime.

19.3 OPERATIONAL LIMITS/CONDITIONS BASED UPON ANALYSIS

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 presently 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 was 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 station's PSA models to verify that the deterministically derived requirements are appropriate in terms of risk criteria.

The UTS project commenced in the first quarter of 2002 and was scheduled for completion by the end of 2004. A shortage of staff and some technical production and review problems has delayed progress. Completion of the project is now unlikely before the end of 2005.

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

Inspection and testing is performed 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 OTS. The project commenced in 2001 and was scheduled for completion at the end of 2002. The project was placed on hold at the end of 2002 after non-completion and concerns regarding the quality of the material produced. Procurement of suitable contractor staff is presently underway to allow completion of this project.

19.5 PROCEDURES FOR INCIDENTS AND ACCIDENTS

Although not members 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 to align 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 is presently in progress and completion is expected during 2004.

A comprehensive set of severe accident management guidelines (SAMGs) have been written by Westinghouse for the licence holder. These were authorized by the regulatory body for implementation in December 2000. A further project to upgrade the SAMGs and to include guidance for severe accidents initiating during shutdown conditions, is presently in progress. Completion of this upgrade is expected before the end of 2004.

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 (CP1 modifications).

19.6 ENGINEERING AND TECHNICAL SUPPORT AVAILABLE

To comply with the conditions of the nuclear licence the licence holder needs to have sufficient resources in order to address the full scope of requirements imposed by the regulatory body. Through its continual monitoring of activities associated with the operation of the nuclear installation, the regulatory body 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 discovered by the regulatory body, 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 (EdF) 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

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 licence is that the licence holder must establish and maintain a problem management and reporting system to the satisfaction of the regulatory body. 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 9 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 INES rating of the event, which is performed by a committee.
- Preparation of a report on the event for nuclear installation management and the regulatory body
- 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 regulatory body
- 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 regulatory body 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 regulatory body 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 regulatory body and the information is screened for statistical evaluation and analysis. This information is used as one of the tools to gauge compliance with the Mission, Strategy and Policy (MSP) of the regulatory body and the Statement on Quality as contained in the licensees Quality Management Manual and to assess the level of safety of the installation.

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

Areas most likely to indicate a deficiency would be plant related e.g. breakdowns, trips, faults or, in the human reliability fields, non-adherence to procedures/rules, human error, lack of knowledge, lack of supervision or poor safety culture, etc. Whatever the reasons, it is essential that the root causes are found for all events, individual or collective. For event analysis the licence holder has an established group whose members are trained in root cause analysis techniques and corrective action reporting. This group is complemented by the independent root cause analysis carried out by trained regulatory body staff who follow up significant events until a satisfactory close-out has been achieved.

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 regulatory body 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 regulatory body 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 regulatory body's event reporting requirements for the nuclear installation are such that events are categorised, graded and reported to the regulatory body 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 regulatory body accordingly. At all times, the regulatory body 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 regulatory body anonymously if preferred.

Events are an important source of regulatory data and can yield extensive information for aiding further investigation by the regulatory body 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 regulatory body according to a condition of the nuclear licence. The relevant licence document also 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 regulatory body. 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 regulatory body. Close-out reports of the events are produced by the licence holder and these reports are subsequently reviewed by the regulatory body 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.

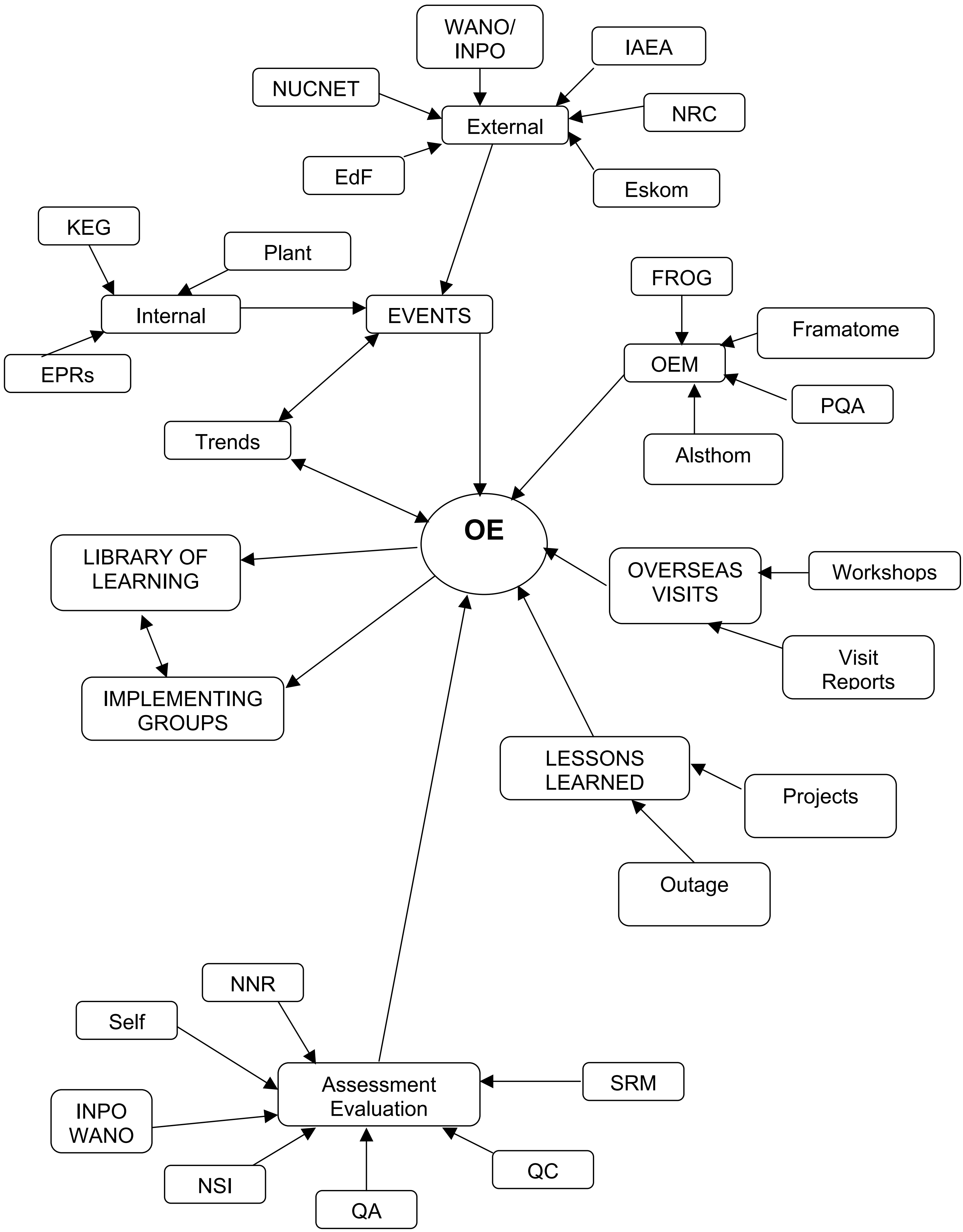
The licence holder reports nuclear safety significant events to WANO, and the regulatory body also reports events to the IAEA-IRS (Incident Reporting System) for international OEF. The IRS database is made available to all staff within the regulatory body and has proved to be an extremely useful tool. 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 regulatory body 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.

Various international technical exchange agreements have been entered into by the regulatory body and these include agreements with the USA, France, Sweden, UK , Canada, Argentina and Slovenia.

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 regulatory body, 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. See 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
EPRs
FROG
Framatome
OEM
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 MANAGEMENT

19.9.1 Low and Intermediate Level Waste

Radioactive waste arising from the operation of the nuclear installation is categorised into low, intermediate and high level waste categories. These are all collected, treated, stored and disposed of in accordance with conditions of licence. The treatment of wastes gives rise to both airborne and waterborne effluents which are subject to a monitoring regime and subsequently released to the environment.

Low level wastes are comprised mainly of contaminated consumable equipment such as clothing, plastic sheeting, etc. used during operation and maintenance of the installation to control the spread of contamination or to prevent the contamination of personnel. Apart from a policy of introducing the minimum amount of potentially contaminable material to contamination controlled areas of the installation, such consumables are collected at various designated points within the installation. Such materials are collected periodically and transported to a central drumming station were they are compressed into metal drums. All materials removed from controlled areas of the installation are subject to monitoring to verify compliance with clearance levels.

Low level waste is minimized in accordance with the ALARA principle via material control, waste collection segregation, contamination monitoring and the application of unrestricted release criteria. All packaging and consumables are minimized inside the radiological controlled zones. The use of disposable protective clothing is minimized. Employee training programmes address measures for waste reduction. Waste is segregated by the workers inside the radiological controlled zone. Separate 'clean' and 'contaminated' receptacles are provided for trash with different colors. A trained and dedicated workforce is used for waste collection and monitoring. Consumable waste with activity below the unrestricted release criteria is released unconditionally from radiological controlled zones. Supercompaction is being considered to reduce the low level waste volumes significantly. The drummed low and intermediate level wastes are stored in a dedicated waste storage facility prior to dispatch to the national radioactive waste repository.

Intermediate level wastes consist of ion exchange resins, evaporator concentrates and various filters. These wastes are treated in a dedicated waste processing facility where they are immobilised in concrete and placed within concrete containers. The choice of containers, which have varying wall thickness providing differing shielding values, is dictated by the radionuclide content of the waste to ensure compliance with surface radiation dose limits compatible with transport requirements. Intermediate level waste is minimized via demineralization and filtration. Ion exchange resins and filters are applied to remove activity from the primary system. The resins and filters are changed based on two criteria namely high differential pressure across the component and elevated radiation levels.

Water-based liquid effluents arising from the operation of the installation are differentiated into two categories according to the potential for contamination. The stream with little propensity for significant contamination is continually discharged through a monitored pathway. The other stream with more propensity for contamination is discharged by way of a batch system which is sampled and analyzed prior to release. Water-based liquid effluents are minimized via evaporation. However evaporation of liquid waste results in increased volumes intermediate waste. A modification to by-pass the evaporators and route liquid effluent to ion exchange demineralisers are on the cards. This will reduce intermediate level waste significantly.

Airborne effluents are treated in a similar manner with plant off-gases being treated by way of filters, absorbers and hold-up beds and tanks. Ventilation is through a monitored pathway. Airborne effluents are minimized via high efficiency filters, absorbers and tanks which reduce activity via decay.

The release of effluents into the environment is subject to compliance with annual authorized discharge quantities set down as a condition of licence by the regulatory body. The compliance with dose limits laid down for members of the public is addressed under Article 15.

19.9.2 Spent Fuel

Units 1 and 2 at Koeberg Nuclear Power Station were put into commercial service in 1984 and 1985 respectively.

Initially it was intended that spent fuel assemblies would be stored in the spent fuel pools at the power station for a maximum period of 4 years, where after, they would be transferred to an interim dry storage facility which would be created at a safe site, unidentified at the time.

By 1986 an appropriate dry storage facility system had not yet been identified, and as the exhaustion of the installed capacity of the pools (285 cells per pool) was approaching, the initial racks were replaced in 1988 with high density racking with a capacity of 728 cells per pool.

In 1990 an order for 4 Castor type X/28F licensed dual transport/storage casks was placed, in anticipation that transportation from the Koeberg spent fuel pools, to the remote interim dry storage site would take place. The casks could also function as a contingency storage capacity for 112 spent fuel assemblies. The four casks were acquired and spent fuel has been loaded into these casks since the spent fuel pool reracking project in 2000. The NNR has approved the storage of a maximum of four Castor X/28F casks in the Cask storage Building until 31 March 2008.

In 1995 Eskom began a feasibility study to establish an optimum interim storage facility. Eskom finally concluded that wet storage was the most viable option. The four dry storage casks would, however, be needed as a contingency in view of time constraints during the implementation of the spent fuel re-racking project.

For the wet storage option, the decision was taken to install super high density racks to accommodate the storage requirements at Koeberg for 40 years. Borated stainless steel would be used as a neutron absorber to ensure sub criticality. The added advantage of this option is that borated stainless steel does not shrink or swell (a problem encountered with the present racks) and exhibits better corrosion resistance than the existing racks.

The Spent Fuel Re-racking Project replaced the previous racks with higher density racks to approximately double the storage space. Re-racking on both units has been completed, ensuring 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 cooling to the pool. A first stage of upgrading has been completed, a second phase which includes improved instrumentation commences during 2004, and a third phase which increases the cooling capability is presently in the design phase.

REFERENCES

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

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

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

4. OPS-7030
   Eskom – Operating Technical Specifications.

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

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

7 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."

12. KAA - 688

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