7th NATIONAL REPORT BY

SOUTH AFRICA

ON

THE CONVENTION ON NUCLEAR SAFETY

August 2016

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

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ABBREVIATIONS

AADQ	Annual Authorised Discharge Quantities
AAM	KNPP Accident Analysis Manual
AEB	Atomic Energy Board
AEC	Atomic Energy Corporation
AFRA	African Regional Cooperative Agreement
ALARA	As Low As Reasonably Achievable
ANS	American Nuclear Standard
ANSI	American Nuclear Standards Institute
ASCOT	Assessment of Safety Culture in Organisations Team
ASN	French Nuclear Safety Authority
BDBA	Beyond Design Basis Accident
CA	Corrective Action
CAE	Compliance Assurance and Enforcement Division
CAP	Compliance Assurance Plan
CAR	Corrective Action Review
CEO	Chief Executive Officer
CNS	Convention on Nuclear Safety
CNSC	Canadian Nuclear Safety Commission
CNSS	Centre for Nuclear Safety and Security
CoCT	City of Cape Town
CP	Contracting Party
CSS	IAEA Commission on Safety Standards
DBA	Design Basis Accident
DCT	Disaster Coordination Team
DMR	Department of Mineral Resources
DOC	Disaster Operations Centre
DoE	Department of Energy
DoH	Department of Health
ECC	Emergency Control Centre
EDF	Électricité de France
EERT	External Events Review Team
ENAC	Convention on Early Notification and Assistance in Case of a Nuclear Accident
Enatom	Emergency Notification and Assistance Technical Operations Manual
EOP	Emergency Operating Procedure
EP	Emergency Planning

EPC	Emergency Planning Committee
EPD	Electronic Personal Dosimeter
EPMS	Electronic Problem Management System
EPREV	Emergency Planning Review
EPSOC	Emergency Planning Steering and Oversight Committee
ESCS	Energy Security Cabinet Subcommittee
FNRBA	Forum of Nuclear Regulatory Bodies of Africa
FRAREG	Framatome Reactor Regulators Group
GNS&A	Generation Nuclear Safety and Assurance (Eskom)
GOR	General Operating Rules
GWe	Giga Watt electrical power
HP	Human Performance
HRA	Human Reliability Analysis
IAEA	International Atomic Energy Agency
ILRT	Integrated Leak Rate Test
IMS	Integrated Management System
INES	International Nuclear Event Scale
INIR	Integrated Nuclear Infrastructure Review
INPO	Institute for Nuclear Power Operators
INSAG	International Nuclear Safety Advisory Group
IRAs	Strengths and Issues Requiring Attention
IRRS	Independent Regulatory Review Service
IRS	Incident Reporting System (IAEA)
ISI	In-Service Inspection
ISIP	In-service Inspection Programme
ISIPRM	In-service Inspection Requirements Manual
ISTP	In-Service Testing Programme
JMC	Joint Media Centre
KEG	Koeberg Events Group
KINS	Korea Institute of Nuclear Safety
KLBM	Koeberg Licensing Basis Manual
KNPP	Koeberg Nuclear Power Plant
KORC	Koeberg Operating Review Committee
KOSC	Koeberg Operational Safety Committee
KSR	Koeberg Safety Reassessment
LG	Licence Guide

MCC	Mass Care Centre
MDEP	Multinational Design Evaluation Programme
MOA	Memorandum of Agreement
MWe	Megawatt (Electrical)
NEA	Nuclear Energy Agency
Necsa	South African Nuclear Energy Corporation
NERS	Network of Regulators of Countries with Small Nuclear Programmes
NIL	nuclear installation licence
NISL	nuclear installation site licence
NNR	National Nuclear Regulator (South Africa)
NORM	Naturally Occurring Radioactive Material
NPP	Nuclear Power Plant
NRC	United States Nuclear Regulatory Commission
NRWDI	National Radioactive Waste Disposal Institute
NSA	Eskom Nuclear Safety Assurance Group
NSSS	Nuclear Steam Supply System
NTWP	Nuclear Technology and Waste Programmes
NUSSC	IAEA Nuclear Safety Standards Committee
OE	Operating Experience
OECD	Organisation for Economic Cooperation and Development
ONR	United Kingdom Office for Nuclear Regulation
ORT	Operation at Reduced Temperature
OSART	Operational Safety Review Team
OTS	Operating Technical Specifications
PAIA	Promotion of Access to Information Act
PBMR	Pebble Bed Modular Reactor
PEE	Portable Emergency Equipment
PTR	refueling water storage
PRA	Probabilistic Risk Analysis
PRIS	Power Reactor Information System
PSA	Probabilistic Safety Assessment
PSIF	Public Safety Information Forum
PTR	Reactor Cavity and Spent Fuel Pit Cooling System
PWR	Pressurised Water Reactor
QA	Quality Assurance
QMS	Quality Management System
RADCON	Directorate of Radiation Control

RASSC	IAEA Radiation Protection Safety Standards Committee
RCM	Reliability Centered Maintenance
RERC	Regulatory Emergency Response Centre
RG	Regulatory Guide
RO	Reactor Operator
RP	Radiation Protection
RPV	Reactor Pressure Vessel
RSA	Republic of South Africa
RVSP	Reactor Vessel Surveillance Programme
SALTO	Safety Assessment of Long Term Operations
SAMG	Severe Accident Management Guidelines
SAQA	South African Qualifications Authority
SAR	Safety Analysis Report
SARA	Standards, Authorisation, Review and Assessment
SARIS	Self-Assessment of Regulatory Infrastructure for Safety
SAT	Self-Assessment Tool
SCWG	Safety Culture Working Group
SG	Steam Generator
SOER	Significant Operating Event Report
SFP	Spent Fuel Pool
SRO	Senior Reactor Operator
SRSM	Safety-Related Surveillance Manual
SSC	Structures, Systems and Components
SSHAC	Senior Seismic Hazard Analysis Committee
SSR	Site Safety Report
SSRP	Regulations on Safety Standards and Regulatory Practices
STUK	Finnish Radiation and Nuclear Safety Authority
TEDE	Total Effective Dose Equivalent
TLD	Thermoluminescence Dosimeter
TEM	Traffic Evacuation Model
TRANSSC	IAEA Transport Safety Standards Committee
TSO	Technical Support Organisations
TWG	Thematic Working Group
UPZ	Urgent Protective Zone
WANO	World Association of Nuclear Operators
WASSC	IAEA Waste Safety Standards Committee

A. INTRODUCTION

South Africa ratified the Convention on Nuclear Safety (CNS) in 1996, and its obligations under the Convention commenced on 24 March 1997. The objectives of the Convention as stated in Article 1 are to:

1) Achieve and maintain a high level of nuclear safety worldwide through the enhancement of national measures and international cooperation including, where appropriate, safety-related technical cooperation.
2) Establish and maintain effective defenses in nuclear installations against potential radiological hazards in order to protect individuals, society and the environment from the harmful effects of ionising radiation resulting from such installations.
3) Prevent accidents with radiological consequences, and mitigate such consequences should they occur.

As a contracting party to the Convention, South Africa is required to fulfil its obligations by demonstrating how the objectives of the Convention, especially a high level of nuclear safety, have been achieved in the country. Each contracting party is obligated to periodically prepare and submit a National Report to the Review Meeting of the International Atomic Energy Agency (IAEA). Consequently, all stakeholders with a legal responsibility for the safety of nuclear installations or their regulation in the country were invited to participate and contribute in the compilation of the 7th South African National Report, as foreseen in the Convention. In addition to this, South Africa promotes international cooperation to enhance global nuclear safety through various instruments such as bilateral and multilateral agreements.

As provided for in the Guidelines Regarding National Reports under the Convention on Nuclear Safety, INFCIRC/572/Rev. 5 [5.1], the intent of a periodic review process is to encourage the continuous improvement of safety as a whole. This does not only require reporting on changes since the last National Report review, but also notes the extent to which relevant stakeholders have been involved in the process to compile the National Report. These stakeholders included the operator and the executive authority of the NNR.

In terms of section 5 (e) of the National Nuclear Regulator (NNR) Act [1.1], the NNR is mandated to fulfil national obligations with respect to international instruments concerning nuclear safety and to act as the national competent authority in connection with the International Atomic Energy Agency's Regulations for the Safe Transport of Radioactive Material. The NNR co-ordinates and implements South Africa's contracting party (CP) obligations to the IAEA Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management.

The national policy towards nuclear energy in South Africa is expressed in the Integrated Energy Plan for the Republic of South Africa (2003) [2.1], the White Paper on Energy Policy for the Republic of South Africa (2008) [2.2], and the Nuclear Energy Policy and Strategy for the Republic of South Africa (2008) [2.3], which make provision for a planned energy mix and an increase in the nuclear energy component. The intention is to promote diversification and security of energy supply, optimal utilisation of the country's uranium resources, visible contribution to economic growth, technology and infrastructure development, job creation, and skills development. In terms of the policies, nuclear energy shall be used only for peaceful purposes and in conformity with national and international legal obligations and commitments. All nuclear energy sector activities shall take place within a legal regulatory framework consistent with international best practice, giving highest priority to nuclear and radiation safety. The Integrated Resource Plan of 2010 (IRP2010) [2.4] makes provision for the expansion of nuclear generation capacity of 9,6 GWe for electricity supply between 2023 and 2030. In anticipation of the expansion of nuclear generation, the operator, Eskom, applied to the NNR in March 2016 for the licensing of two nuclear sites, namely: Duynefontyn, an existing site; and Thyspunt, a greenfield site.

South Africa has more than 30 years of experience in the safe operation of its two-unit 1 840 MWe Koeberg nuclear power plant (NPP) and has, in addition to this, experience in research, development and use of nuclear related technology.

This report provides an update on the South African activities in compliance with the Articles of the Convention on Nuclear Safety since the last National Report was compiled in November 2013 [3.6] and presented at the 6th Convention Review Meeting in March 2014. The main issues addressed in this report relate to the Koeberg NPP, namely the periodic reviews; the post-Fukushima review; safety improvements implemented and planned; envisaged nuclear expansion in South Africa, including nuclear sites; developments in the nuclear regulatory framework; and the NNR regulatory self-assessment. The report has been updated to conform to INFCIRC/572 Rev. 5 [5.1].

B. SUMMARY

This report presents South Africa's continued efforts to achieve the objectives of the Convention on Nuclear Safety. The highlights of the report are summarised below (relevant headings are in italics as per INFCIRC/572 Rev. 5 [5.1]):

Important safety issues that have been identified since the previous National Report

The following important safety issues, which will require NNR scrutiny and oversight, have been identified since the last National Report:

1) The structural integrity of containment structures as reported in section 19.3.6.4.
2) The ageing management and long-term operation as reported in sections 14.2.3 and 19.3.6.
3) Replacement of the Unit 2 reactor vessel head as reported in section 18.3.2 and replacement of the steam generators and refueling water storage tanks at both Koeberg NPP units.
4) Arrangements for interim spent fuel storage as reported in section 19.8.2.

Future safety-related activities and programmes planned for next period until the 8th Review Meeting

1) Complete actions taken in the light of the Fukushima Daiichi accident as reported in section 14.1.4.3.
2) Replacement of major NPP components as part of the ageing management programme:
   a) Steam generators (18.3.2.1);
   b) Refuelling water storage (PTR) tanks (18.3.2.2); and
   c) Unit 2 reactor vessel head (18.3.2.3).
3) Spent fuel dry storage project for Koeberg NPP (19.8.2).
4) With the country's growing energy requirements regularly under increasing scrutiny and the increasing concern for carbon emissions from the global community, nuclear power has been presented as a viable consideration as part of the energy generation mix. Eskom is conducting assessments on new nuclear sites and applied for Nuclear Site Licenses for the Thyspunt and Duinefontyn sites (section 17.1.2).
5) The NNR is continuing with its preparations for the new build project including development of regulations, position papers and guidelines (7.2.1.3).
6) The NNR regulatory self-assessment following IAEA methodology and follow-up actions, as well as a regional project to promote regulatory self-assessments and regulatory infrastructure development as reported in section 8.1.9.2.
7) Host IRRS mission in 2016 as reported in section 8.1.9.2.
8) Establishment of the Centre for Nuclear Safety and Security (8.1.11).

Responses to the results of the previous Peer Review: suggestions and/or challenges summarised in the Rapporteurs' Reports

The various challenges noted in the Rapporteurs' Report of Country Group 4 of 28 March 2014 are covered as follows:

1) Skills attraction and retention of staff is a challenge. With the foreseeable expansion of the nuclear programme in the country, as well as the safety optimisation of some existing ageing nuclear installations, this challenge will grow:
   a) In section 8.1.6 the measures to develop and maintain competence in the Regulator is described.

b) The status of implementation of the Centre for Nuclear Safety and Security (CNSS) is provided in section 8.1.8.
c) The initiatives implemented by the Koeberg NPP to deal with high staff turnover are discussed in section 11.2.12.

2) Two major projects, involving a large number of professionals, were terminated in 2010 due to the withdrawal of the licensing application for the PBMR and the financial crisis. At the same time government decided on an energy strategy involving a large construction programme for new NPPs. The challenge is to retain the professionals until the programme takes off.
   a) Government is in the process of finalising strategies for capacity building and skills development and concluded intergovernmental agreements with potential vendor countries for new build. These agreements include skills transfer initiatives.
   b) National nuclear skills development and training programme commenced as 50 trainees from the government nuclear industry were sent to China for Phase 1 nuclear training in April 2015. Additional 50 of the 250 trainees have been sent to China in 2016 for nuclear engineering and related studies.
   c) The Russian Federation has offered five new scholarships for Master's degrees in nuclear physics.
   d) South Korea also has a standing programme to train South African students for Master's degrees in nuclear engineering.
3) The management of existing ageing nuclear installations in order to ensure safety of plant life extension is being considered by the licensee.
   a) Initiatives to prepare for the possible long-term operation of the Koeberg NPP are discussed in section 19.3.6.
4) The replacement of the steam generators (SG) at the Koeberg NPP and possible power upgrade was scheduled to commence in 2015.
   a) The status of the implementation of the steam generator replacement project is described in section 18.3.2.1.
5) Subsequent to self-assessment and implementation of related recommendations, South Africa should consider inviting an IRRS mission of the IAEA.
   a) An IRRS mission is planned for December 2016 as per section 8.1.9.2.

Significant changes to the national nuclear energy and regulatory control programmes and measures taken to comply with the Convention's obligations

The introduction (A) addresses the national nuclear energy programme. Eskom applied for the licensing of two nuclear sites in March 2016. These applications are being processed by the Regulator and will include public participation as prescribed by the NNR Act.

Discussions with the relevant stakeholders for the harmonisation of the regulation of radioactive sources are underway as discussed in section 8.2.4.

Address results of international peer review missions including IAEA missions conducted, progress made in implementing any findings, and follow-up plans

International peer review missions including those of the IAEA, the Self-Assessment of Long Term Operations (SALTO) and Operational Safety Review Team (OSART), as well as those of the World Association of Nuclear Operators (WANO) are reported in section 19.3.6.

During 30 January–8 February 2013 the IAEA conducted an Integrated Nuclear Infrastructure Review (INIR) mission based on the evaluation of the development status of the infrastructure issues described in Milestones in the Development of a National Infrastructure for Nuclear Power. The recommendations arising from the INIR mission are being addressed by the various sub-working groups functioning under the auspices of the Energy Security Cabinet Subcommittee (ESCS) being chaired by the president of South Africa. The NNR participates in the relevant sub-working groups and informs the action plans, strategies and actions to address relevant recommendations.

The Department of Energy completed an IAEA Emergency Planning Review (EPREV) mission in February 2014. The action plan is at different levels of implementation and this is reported on in section 16.1.2.2.

Address operating experience, lessons learned and corrective actions taken in response to accidents, incidents and events of significance for safety of nuclear installations

Operational experience feedback is reported in section 19.7.

Address lessons learned from emergency drills and exercises

Emergency exercises and corrective actions are reported in section 16.1.5.2.

Address actions taken to improve transparency and communication with public

Section 16.2 addresses public information on emergency planning and emergency situations.

Openness and transparency of regulatory activities are reported in section 8.1.10.

C. ARTICLES

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 that the convention becomes applicable 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 a safety upgrade cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context, and possible alternatives, as well as the social, environmental and economic impact.

Summary of changes

Section 6.2 has been updated to cover significant safety-related issues over the last three years and measures taken in response to these issues.

Section 6.3 has been updated with respect to planned programmes and measures for continued safety upgrading.

Section 6.5 has been updated to reflect the commitment to the timeous response to findings of IAEA SALTO missions.

6.1 Existing nuclear power plants

There is no change in the existing nuclear power plants. South Africa has one operating twin-reactor unit nuclear power plant (the nuclear installations) consisting of:

Reactor PRIS code:	ZA-1
Reactor name:	Koeberg Unit 1
Reactor type:	PWR
Capacity MWe Net:	921
Capacity MWe 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 MWe Net:	921
Capacity MWe 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 were found, when assessed, to require any significant corrective actions under Articles 10 through 19 of this convention. However, safety improvement initiatives have been, and still are being implemented at the nuclear installations indicated above, since South Africa ratified the convention in 1996 and it became enforceable on 24 March 1997. These safety improvement initiatives are reported in the various Articles, 6 to 19, of this report.

6.2 Significant safety-related issues and events

Over the last three years, Koeberg experienced two events of note.

The first event relates to the 400 kV breaker that opened following the operation of the restricted earth fault relay in the High Voltage yard, which occurred during the erection of scaffolding. This resulted in a reactor and turbine trip and initiated a swap over of supplies to the 132 kV backup off-site power supply. Whilst returning the unit to service following the earlier trip, the operation of the turbine generator 24 kV breaker control supervision circuit resulted in another off-site power supply 400 kV breaker opening due to incorrect operation of the 24 kV protection circuits (phase discrepancy and breaker supervision control circuits). Stringent management controls have since been implemented to ensure that access to the transformer yard is limited and only allowed after all risks have been adequately mitigated.

The second event relates to a periodic test on Unit 1, used to verify the manoeuvrability of a shutdown rod bank, which resulted in the bank D control rods stepping out automatically and the turbine governor valves changing their opening position. This triggered an alarm indicating >100% power. One of the causes was deemed to be the shutdown bank being inserted too quickly for a new core with low moderator temperature coefficient. Several actions have been implemented to prevent re-occurrence including an update of relevant operating procedures and training of relevant personnel.

There have been no safety-related issues or events at Koeberg NPP graded level two or above on the International Nuclear Event Scale (INES). For INES level one, two events were reported.

6.3 Planned programmes and measures for continued safety upgrading

Modifications conducted subsequent to the commissioning of the Koeberg units are discussed in sections 18.1.2 to 18.1.6. This includes the completion of the modifications and other corrective actions identified in the first and second periodic reviews (reported in the previous CNS reports) to align Koeberg NPP to French CP-1 plants.

The second periodic safety review of Koeberg NPP and the post-Fukushima review are discussed in section 14.1.3.3.

The ongoing steam generator replacement of both units at Koeberg NPP is discussed in section 18.3.2.

The ongoing refuelling water storage tank replacement at Koeberg NPP is discussed in section 18.3.2.

The planned Unit 2 reactor vessel head replacement at Koeberg NPP is discussed in section 18.3.2.

6.4 Identification of installations for which decisions on shutdown have been made

The NNR has not identified any installations for which decisions on shutdown were necessary.

6.5 Position of the Regulator concerning the continued operation of the nuclear installations

The NNR accepts the continued operation of Koeberg NPP based on the following:

1) The positive outcome of the assessments discussed in sections 14 and 18, which demonstrate that Koeberg NPP complies with the safety standards (section 7), including the design basis, dose and risk criteria, and fundamental principles of nuclear safety.
2) The compliance assurance programme (section 7.2.3) confirms that Koeberg NPP is in compliance with the conditions of the licence.
3) The conclusions of the IAEA, OSART and SALTO missions reported in section 19, and Eskom’s commitment to the timeous response to the findings.

This conclusion is however conditional on the following:

1) Effectiveness of the corrective actions planned or being implemented by Eskom.
2) Effectiveness of the recruitment and skills-retention programmes.
3) Continued cooperation by the local authorities in terms of urban developments in the vicinity of Koeberg NPP.

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:
   a) The establishment of applicable national safety requirements and regulations.
   b) A system of licensing for nuclear installations and the prohibition of the operation of a nuclear installation without a licence.
   c) A system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses.
   d) The enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.

The South African national legislative and regulatory framework and associated laws, regulations, and regulatory requirements address and comprehensively comply with the provisions of Article 7 of the Convention on Nuclear Safety in governing the safety of nuclear installations.

Summary of changes

Section 7.1 has been updated to provide background on previous nuclear legislation and to expand on the primary legislative framework for nuclear safety including interfacing national legislation.

Section 7.2 has further been updated and expanded on in terms of:
1) Regulations published by the Minister of Energy on financial security;
2) Regulatory documents issued by the NNR;
3) Process for development of regulations;
4) Regulatory strategy and philosophy;
5) Legal action and enforcement measures.

7.1 Establishing and maintaining a legislative and regulatory framework

7.1.1 Overview of the primary legislative framework for nuclear safety

[Overview of the primary legislative framework for nuclear safety, including interfacing national legislation]

The South African legislative framework on nuclear energy dates back to 1948 when the predecessor of the present South African Nuclear Energy Corporation (Necsa), namely the Atomic Energy Board (AEB), was established in terms of the provisions of the Atomic Energy Act. Over the years, this Act was amended to keep pace with developments in nuclear energy. The establishment of the Nuclear Installations Act, which came into force in 1963, made provision for the licensing of nuclear installations by the Atomic Energy Board.

A major change took place in 1982 when the Atomic Energy Corporation (AEC) was established and made responsible for all nuclear matters, including uranium enrichment. This change was mandated by the provisions of the Nuclear Energy Act (No. 92 of 1982). In 1988, a major amendment to the Nuclear Energy Act (Nuclear Energy Amendment Act, No. 56 of 1988) mandated the establishment of the autonomous Council for Nuclear Safety, which was responsible for nuclear licensing and separate from the AEC.

The old Nuclear Energy Act was replaced by a new Act in 1993 (Nuclear Energy Act, No. 131 of 1993). This maintained the autonomous character of the Council for Nuclear Safety, but made provision for the implementation of the Safeguards Agreement with the IAEA, pursuant to the requirements of the Nuclear Non-Proliferation Treaty to which South Africa acceded in June 1991.

At present, the nuclear sector in South Africa is mainly governed by the Nuclear Energy Act (No. 46 of 1999) [1.2], the National Nuclear Regulator Act (No. 47 of 1999) [1.1] and the National Radioactive Waste Disposal Institute Act (No. 53 of 2008) [1.5]. The Department of Energy administers these Acts. In addition, the Department of Health administers the Hazardous Substances Act (No. 15 of 1973) [1.3] related to Group III and Group IV hazardous substances.

Further legislation that has relevance for the nuclear industry includes the following:

- National Radioactive Waste Management Act (No. 53 of 2008);
- Minerals and Petroleum Resources Development Act (No. 28 of 2002);
- Mine Health and Safety Act (No. 29 of 1996);
- National Water Act (No. 36 of 1998);
- Water Services Act (No. 108 of 1997);
- Environment Conservation Act (No. 73 of 1989);
- Environment Conservation Amendment Act (No. 50 of 2003);
- National Environmental Management Act (No. 107 of 1998);
- National Environmental Management: Integrated Coastal Management Act (No. 24 of 2008);
- Occupational Health and Safety Act (No. 85 of 1993);
- Non-Proliferation of Weapons of Mass Destruction Act (No. 87 of 1993);
- National Strategic Intelligence Act (No. 39 of 1994);
- National Key Points Act (No. 102 of 1980);
- Protection of Constitutional Democracy Against Terrorist and Related Activities Act (No. 33 of 2004);

- Dumping at Sea Control Act (No. 73 of 1980).

The NNR operates within the following national legislative and regulatory frameworks:

1) The Constitution of the Republic of South Africa (Act No. 108 of 1996);
2) Nuclear Energy Act (No. 46 of 1999);
3) Public Finance Management Act (No. 1 of 1999) and associated Treasury Regulations;
4) Promotion of Access to Information Act (No. 2 of 2000);
5) Promotion of Administrative Justice Act (No. 3 of 2000);
6) RSA Government Gazette 8755 – Safety Standards R.388, 28 April 2006; and
7) RSA Government Notice 927 – The Regulations on Licensing of Sites for New Nuclear Installations, 11 November 2011.

The NNR enters into co-operative governance agreements to give effect to the principles of co-operative government and intergovernmental relations as contemplated in the regulations in terms of section 6 (3) of the National Nuclear Regulator Act (No. 47 of 1999) [1.1] and in terms of section 239, Chapter 3 of the Constitution of the Republic of South Africa (Act No. 108 of 1996).

The South African regulatory body, the NNR, is established by the NNR Act. Its mandate is described under Article 7.2.2.1. Additionally, the Department of Health: Radiation Control Directorate administers the Hazardous Substances Act (No. 15 of 1973) [1.3], related to Group III and Group IV hazardous substances, which include all radioactive material which is intended to be used for medical, scientific, agricultural, commercial or industrial purposes.

The National Radioactive Waste Disposal Institute (NRWDI) was established by the National Radioactive Waste Disposal Institute Act (No. 53 of 2008) [1.5]. This act applies to all radioactive waste in the Republic of South Africa destined to be disposed of in an authorised waste disposal facility. The NRWDI Act further establishes the NRWDI to be a Schedule 3 public entity in terms of the Public Finance Management Act (No. 1 of 1999). The NRWDI will be regulated by the NNR. In March 2014 the appointed Board of Directors was inaugurated and the process of appointing the management structures has also commenced. A steering Committee to address the transitional arrangements was established and a roadmap has been put in place to ensure a smooth transfer of resources from Necsa to NRWDI in accordance with section 30 of NRWDI Act of 2008.

The Nuclear Energy Policy and Strategy for the Republic of South Africa [2.3] was published in June 2008. As described in the introduction to this report, the document presents a policy framework within which prospecting, mining, milling and use of nuclear materials, as well as the development and utilisation of nuclear energy for peaceful purposes by South Africa shall take place. The document covers the prospecting and mining of uranium ore and any other ores containing nuclear materials, as well as the nuclear fuel cycle in its entirety, focussing on all applications of nuclear technology for energy generation. One of the 16 principles of this policy is that nuclear energy shall be used as part of South Africa's diversification of primary energy sources, and to ensure the security of energy supply.

7.1.2 Ratification of international conventions and legal instruments related to nuclear safety

South Africa has been a member state of the IAEA since 1957 and has the following multilateral agreements in force:

1) Agreement on the Privileges and Immunities of the IAEA [5.2];
2) Convention on the Physical Protection of Nuclear Material and the 2005 Amendment [5.3];
3) Convention on Early Notification in Case of a Nuclear Accident [5.4];
4) Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [5.5];
5) Convention on Nuclear Safety [5.6];
6) Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [5.7];
7) Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA) [5.8];
8) African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) – Fourth Extension [5.9];
9) Safeguards Agreement between the IAEA and the Government of the Republic of South Africa for Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, 1744 [5.10];
10) Protocol Additional to the Agreement between the Government of the Republic of South Africa and the IAEA for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons [5.11].

South Africa ratified the Convention on Nuclear Safety (CNS) [5.6] in 1996 and its obligations under the CNS commenced on 24 March 1997. In November 2006, South Africa acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [5.7] and its obligations commenced in February 2007.

As a member state of the IAEA, South Africa is required to fulfil its respective international obligations and promote international cooperation to enhance global nuclear safety. In terms of section 5 (e) of the NNR Act [1.1], the NNR is mandated to fulfil national obligations with respect to international instruments concerning nuclear safety, and to act as the national competent authority in connection with the IAEA Regulations for the Safe Transport of Radioactive Material [5.12].

The NNR coordinates and implements South Africa’s contracting party (CP) obligations to the IAEA Convention on Nuclear Safety [5.6] and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [5.7].

7.2.1 National safety requirements and regulations

7.2.1.1 Overview of the secondary legislation for nuclear safety

Regulations on National Safety Standards and Regulatory Practices (SSRP) [1.7] were promulgated on 28 April 2006 and these regulations are enforced for all nuclear authorisations holders and applicants for nuclear authorisations in the country. These regulations are based on international safety standards and regulatory practices.

Regulations on the Siting of New Nuclear Installations (R.927) [1.8] were promulgated in 2011.

In terms of section 29 of the NNR Act and based on the recommendation of the NNR board, the Minister of Energy published government notice 581 on 7 May 2004 [1.9] on the Categorisation of Nuclear Installations, the Level of Financial Security to be Provided by

Operators of Nuclear Installations and the Manner in which that Financial Security is to be Provided. The NNR has reviewed the level of operator liability to be provided in case of nuclear damage and has made recommendations to increase the level of operator liability to the Minister of Energy.

The Department of Energy published draft regulations on the control of developments surrounding the Koeberg NPP for public comment in November 2010, under Government Notice No. 33678. Comments from the public and local authorities have been received and reviewed. The delay in finalising the regulations is due to protracted engagements with the local authorities.

7.2.1.2 Overview of regulations and guides issued by the regulatory body

In support of these regulations the NNR presently has Regulatory Requirements documents, which are referenced in the various nuclear authorisations granted to the nuclear facilities regulated by the NNR, as well as supporting Regulatory Guidance documents. The NNR also issues Position Papers providing the NNR's position on emerging issues. The following regulatory documents, relevant to nuclear installations, have been issued:

Number	**Requirements Documents**
RD 013	Requirements on Public Information document to be produced by applicants for new authorisations
RD 014	Emergency Preparedness and Response Requirements for Nuclear Installations
RD 016	Requirements for Authorisation Submissions Involving Computer Software and Evaluation Models for Safety Calculations
RD 018	Basic Licensing Requirements for the Pebble Bed Modular Reactor
RD 019	Requirements for the Core Design of the Pebble Bed Modular Reactor
RD 022	Dose Limitation for Koeberg Nuclear Power Station
RD 024	Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations
RD 025	Emergency Communication with the National Nuclear Regulator
RD 026	Decommissioning of Nuclear Facilities
RD 034	Quality and Safety Management Requirements for Nuclear Installations
Number	**Licence Documents**
LD 1000	Notification Requirements for Occurrences Associated with Koeberg Nuclear Power Station
LD 1012	Requirements in Respect of Proposed Modifications to the Koeberg Nuclear Power Station
LD 1077	Requirements for Medical and Psychological Surveillance and Control at Koeberg Nuclear Power Station

LD 1079	Requirements in Respect of Licence Change Requests to the National Nuclear Regulator
LD 1081	Requirements for Operator Licence Holders at Koeberg Nuclear Power Station
LD 1092	Requirements for Initial Operator Licensing at Koeberg Nuclear Power Station
LD 1093	Requirements for the Full Scope Operator Training Simulator at Koeberg Nuclear Power Station
Number	**Regulatory Guides (RGs)**
RG-006	Guidance on Physical Protection Systems for Nuclear Facilities
RG-007	Guidance on Management of Safety in Nuclear Facilities
RG-008	General Transport Guidance
RG-011	Interim Guidance for the Siting of Nuclear Facilities
RG-012	Interim Guidance on Construction Management for New Nuclear Facilities
RG-014	Guidance on Implementation of Cyber or Computer Security for Nuclear Facilities
RG-015	Interim Guidance on the Registration of Nuclear Power Plant Reactor Operators
RG-016	Guidance on the Verification and Validation of Evaluation and Calculation Models used in Safety and Design Analyses
Number	**Licence Guides (LGs)**
LG 1041	Licensing Guide on Safety Assessments of Nuclear Power Reactors
LG 1045	Guidance for Licensing Submissions Involving Computer Software and Evaluation Models for Safety Calculations
Number	**Position Papers**
PP-0008	Design Authorisation Framework
PP-0009	Authorisations for Nuclear Installations
PP-0012	Manufacturing of Components for Nuclear Installations
PP-0014	Considerations of External Events for New Nuclear Installations
PP-0015	Emergency Planning Technical Basis for New Nuclear Installations
PP-0016	Conformity Assessment Framework for Pressure Equipment in Nuclear Service
PP-0017	Design and Development of Digital Instrumentation and Control Systems for Nuclear Installations

The conditions of the nuclear licence for Koeberg NPP, and the associated regulatory requirements and regulatory guides address the following:

1) Plant description, design and configuration;
2) Control of plant design and configuration;
3) Modifications;
4) Safety assessment, including probabilistic safety assessment (PSA);
5) Scope of activities that may be undertaken;
6) Controls and limitations on operation;
7) Maintenance, in-service inspection and testing;
8) Operational radiation protection;
9) Effluent management;
10) Radioactive waste management;
11) Environmental monitoring;
12) Accident management;
13) Emergency planning and preparedness;
14) Transport of radioactive material;
15) Nuclear security;
16) Decommissioning;
17) Financial security;
18) Inspection programme;
19) Quality and safety management;
20) Licensing of reactor operators;
21) Acceptance and approval;
22) Reporting;
23) Safety culture; and
24) On-site developments.

7.2.1.3 Process of establishing and revising regulatory requirements

[Overview of the process of establishing and revising regulatory requirements, including the involvement of interested parties]

In terms of regulatory requirements issued as regulations, the process may be summarised as follows. The NNR prepares and submits draft regulations to the Minister of Energy via the NNR board. The Department of Energy publishes the draft regulations for comment by interested and affected parties. The NNR reviews and responds to the comments in writing and prepares a report on the outcome of the public process. This report, with proposed changes, is submitted to the Minister via the board. The Minister then issues the regulation.

In terms of regulatory requirements issued, either directly in the nuclear licence or in requirements documents referenced in the authorisation, these are developed and updated as necessary after consultation with the relevant authorisation holders, and ratified by the NNR board.

The NNR and the Directorate of Radiation Control (RADCON) in the Department of Health (DoH) completed self-assessments in the 2011/2012 financial year based on the IAEA Self-Assessment Tool (SAT). One of the conclusions of the self-assessment was that the nuclear and radiation regulatory framework needs to be improved through the development of additional regulations and guidelines or the revision of existing regulations and guidelines. To this end the NNR has proposed amendments to the NNR Act to the Minister for consideration and developed a suite of regulations that have been submitted to the Minister for promulgation. Regulations have been revised and developed for nuclear installations to: incorporate the regulatory requirements presently referenced in the nuclear authorisations, address gaps identified during the self-assessment and lessons learnt with the licensing of the Koeberg NPP and the PBMR project, and to take into consideration ongoing international developments and trends regarding standards and regulatory practices. This should provide greater clarity, consistency and predictability in the nuclear regulatory process.

Arising from the Fukushima assessment (section 14.1.4.3), the NNR has identified areas for improvement of the regulatory standards and regulatory practices which have been included in the new regulations. These improvement relate to:

1) The robustness of the design of nuclear installations as well as emergency response and accident management facilities against external events;
2) Inclusion of design extension conditions as part of the design basis of new nuclear installations;
3) Consideration of simultaneous impacts on multiple facilities on the site;
4) Reliance on off-site services in the short term is not permitted; and
5) Testing and inspection of equipment credited in accident management.

The NNR and RADCON in the Department of Health have recently conducted Lifecycle 2 self-assessments based on the IAEA Self-Assessment of Regulatory Infrastructure for Safety (SARIS) tool, reported in section 8.1.9, in anticipation of an IRRS mission scheduled for December 2016. Due to capacity constraints, the NNR has facilitated and assisted RADCON in the conduct of their Lifecycle 2 self-assessment.

7.2.2 System of licensing

7.2.2.1 Overview of the licensing system

The mandate of the NNR is given in section 8.1.2, and authorities and responsibilities is featured in section 8.1.3, including those activities which require a nuclear authorisation.

Liability for nuclear damage and the provisions for financial security are dealt with in chapter 4 of the NNR Act [1.1]. Safety and emergency measures, as well as the powers and duties of inspectors, are embodied in chapter 5 of the NNR Act.

Section 23 of the NNR Act empowers the NNR to impose such conditions as it deems necessary or desirable for the purpose of safeguarding 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 NNR Act provides for the appointment of inspectors. The provisions of the NNR Act confer the necessary authority and powers in order for the inspector to, inter alia, gain access to sites, information and documentation. The provisions relating to inspectors are comprehensively set out in section 41 of the NNR Act.

Relicensing

Although relicensing per se is not conducted, periodic reviews are required at a frequency acceptable to the NNR (every 10 years) as described in section 14. Based on these reviews, corrective actions are identified and conclusions are drawn on the continued operation of the plant.

The draft regulations, as discussed in section 7.2.1.3, include specific requirements on periodic safety reviews, ageing management and long-term operation of nuclear installations. These regulations were subject to an IAEA expert mission conducted in May 2016.

7.2.2.2 Involvement of the public and interested parties

The NNR Act [1.1] requires that the chief executive officer (CEO) directs the applicant for a nuclear installation or vessel licence to serve a copy of the application upon every municipality affected by the application, and any other such body or person as the CEO determines, and that a copy of the application is published in the Government Gazette and two newspapers circulating in every such municipality.

The act allows any person who may be directly affected by the granting of a nuclear installation or vessel licence, pursuant to an application, to make representations to the board relating to health, safety and environmental issues connected with the application within 30 days of the date of publication in the Gazette.

Further, if the board is of the opinion that further public debate is necessary, it may arrange for such hearings on health, safety and environmental issues as it determines. For this purpose the NNR prepares a public information document following the initial review of the safety analysis report.

Subject to the board's approval, the CEO may refuse an application for a nuclear installation or vessel licence and must provide the applicant with the reasons for the refusal in writing. Or the CEO may grant a nuclear installation licence or nuclear vessel licence subject to such conditions as may be determined.

The NNR Act further places the responsibility on the licence holder to establish a Public Safety Information Forum (PSIF) to inform persons living in the municipal area (for which an emergency plan has been established) on nuclear safety and radiation safety matters, as reported in section 9.4.

7.2.2.3 Legal provisions to prevent the operation of a nuclear installation without a valid licence

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

7.2.3 System of regulatory inspection and assessment

7.2.3.1 Overview of regulatory strategy

The regulatory strategy is provided in the Regulatory Philosophy [2.5] of the NNR. The NNR's approach to the regulation of nuclear safety and security takes, amongst others, the following into consideration: the potential hazards associated with the facility or activity, safety-related programmes and their importance, and the need to exercise regulatory control

over technical aspects (such as the design and operation of a nuclear facility in ensuring safety and security). On this basis, the NNR sets fundamental safety limits relating to dose and risk to the public and workers and specifies regulatory requirements. The licensee is also held to various processes, in particular a safety screening and evaluation process that identifies which modifications or changes to a facility require regulatory approval.
South Africa does not have national nuclear industry codes and standards. The NNR is therefore non-prescriptive when it comes to the use of industry codes and standards. As a general rule for nuclear facilities of standard design, the NNR requires that well recognised, proven codes and standards, preferably those of the vendor country, are complied with and augmented where necessary to address NNR requirements and local conditions provided the NNR considers these acceptable.

The holder submits a safety case to demonstrate compliance to these regulatory requirements in accordance with guidelines issued by the NNR. This includes inter alia the Safety Analysis Report (SAR), Operating Technical Specifications (OTS), and operating and accident procedures.

The NNR assesses the safety case and issues a nuclear licence that enforces the safety standards and holds the applicant to their commitments and undertakings referenced in the safety case. The NNR establishes and conducts an annual inspection programme against the licence conditions, including environmental surveys and emergency exercises, and conducts enforcement as prescribed by the NNR Act.

7.2.3.2 Overview of the regulatory inspection and assessment process

The applicant or holder is required to submit the following safety assessments:
1) Safety assessment for a site licence;
2) Safety assessment for authorisation to manufacture components;
3) Preliminary Safety Analysis Report for a construction licence (may be combined with 1);
4) Safety Analysis Report for an operating licence;
5) Safety assessment for modifications;
6) Safety assessment for nuclear authorisation changes (e.g. changes to licence binding procedures);
7) Safety assessment for new safety issues;
8) Periodic safety assessments; and
9) Safety assessment for decommissioning.

The requirements for the above are provided in the respective regulations, requirements documents, nuclear licences, position papers and guidelines.

Submissions are received by the programme manager and, after screening, are assigned to a technical division comprising various groups covering design safety, operational safety, environment and radiation protection, and nuclear security. The review process is described in internal procedures which address, amongst others, responsibilities, authorities and general review and assessment requirements. The outcome of the assessment is coordinated by the heads of these groups in conjunction with the programme manager who submits the final response to the holder.

For large projects a detailed licensing schedule is developed in conjunction with the holder, which includes timelines for preparation and review of documents by the holder and the regulator, and the overall context in the safety case.

Periodic safety reviews are required and the NNR follows up on the implementation of modifications and corrective actions.

New authorisations require a resolution by the NNR board to the CEO to approve the application.

The NNR structure includes a Compliance Assurance and Enforcement Division (CAE) responsible for conducting compliance inspections against the conditions of the licence as well as enforcement.

7.2.3.3 Basic features of inspection programmes

The annual baseline Compliance Assurance Plans (CAPs), which cover all facilities and actions regulated by the NNR involving radioactive materials, are developed and implemented by the CAE in accordance with the respective regulatory process.

The CAP is aligned to the areas of operation, design, environment, radiation protection, emergency planning and nuclear security. The CAP takes the following into consideration:

1) Trending and grading of inspection findings;
2) Modifications and changes to the plant;
3) Operational experience feedback; and
4) International experience feedback.

The scope of inspections includes:

1) Compliance assurance audits and inspections to determine compliance with regulatory requirements;
2) Investigations and occurrences;
3) Regulatory emergency and nuclear security exercises;
4) Environmental surveillance; and
5) Follow-up on findings and/or non-compliances.

The overall cumulative impact of the inspection findings is used to provide an indication of the overall state of health of the nuclear installation. A summary of the compliance and safety status of nuclear facilities are included in the regulator’s annual report.

The NNR has five inspectors and a Chief Inspector dedicated to Koeberg NPP that are based at a site office near the plant.

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

7.2.4 Enforcement of applicable regulations and terms of licenses

7.2.4.1 Power to take legal action

The NNR Act [1.1] confers the necessary powers on the NNR to take legal action.

7.2.4.2 Overview of enforcement measures available to the regulatory body

Offences, and the appropriate sanction for the commission of such offences, are contained in the provisions of sections 52 (1), (2) and (3) of the NNR Act [1.1]. These include fines or imprisonment.

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

7.2.4.3 Experience with legal actions and enforcement measures

The NNR has not taken any legal action over the reporting period with regard to nuclear installations. However, enforcement actions have been taken such as:

1) Notices of non-compliance; and
2) Directives.

Examples of directives issued include the adequacy of the processes in terms of the performance of the Integrated Leak Rate Test (ILRT) identified during an inspection and an investigation into non-compliances and findings associated with Outage 121.

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 fulfil its assigned responsibilities. 2) Each contracting party shall take the appropriate steps to ensure an effective separation between the functions of the NNR and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.

Summary of changes

The following sections have been amended:

- 8.1.4;
- 8.1.5;
- 8.1.6;
- 8.1.7;
- 8.1.9;
- 8.1.10;
- 8.2.3;
- 8.2.4;
- 8.2.5; and
- 8.2.6 has been added.

8.1 Establishment of the regulatory body

8.1.1 Legal foundations and statute of the regulatory body

The South African regulatory body, the National Nuclear Regulator, was established by the NNR Act (No. 47 of 1999) [1.1] to regulate nuclear activities; to provide for Safety Standards and Regulatory Practices for the protection of persons, property and the environment against nuclear damage; and to provide for related matters.

8.1.2 Mandate, mission and tasks

The NNR is mandated by the NNR Act [1.1] to provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices, the granting of nuclear authorisations, and implementation of a system of compliance inspections and enforcement. 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 NNR therefore exercises regulatory control over the safety of nuclear installations, nuclear vessels, radioactive waste, irradiated nuclear fuel, the mining and processing of radioactive ores and minerals, and any actions involving radioactive material capable of causing nuclear damage.

The Directorate of Radiation Control of the Department of Health is responsible for the regulatory control of electronic generators of ionising and non-ionising radiation (Group III hazardous substances) as well as radionuclides (Group IV hazardous substances) intended to be used for medical, scientific, agricultural, commercial or industrial purposes.

8.1.3 Authorities and responsibilities

The authorities and responsibilities of the NNR are defined in chapters 2 and 3 of the NNR Act [1.1].

Chapter 2 of the NNR Act specifies that the objects of the Regulator are to:

1) Provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices.
2) Exercise regulatory control related to safety over:
   a) The siting, design, construction, operation, manufacture of component parts, and decontamination, decommissioning and closure of nuclear installations; and
   b) Vessels propelled by nuclear power or having radioactive material on board which is capable of causing nuclear damage, through the granting of nuclear authorisations.
3) Exercise regulatory control over other actions, to which this act applies, through the granting of nuclear authorisations.
4) Provide assurance of compliance with the conditions of nuclear authorisations through the implementation of a system of compliance inspections.
5) Fulfil national obligations in respect of international legal instruments concerning nuclear safety.
6) Ensure that provisions for nuclear emergency planning are in place.

The powers of the NNR, under the NNR Act, embrace all actions aimed at providing the public with confidence and assurance that the risks arising from the undertaking of actions involving radioactive material, to which the NNR Act applies, remain within acceptable safety limits. In practice, this has led to the NNR's establishment of Safety Standards and Regulatory Practices including: doses and risk limits, as well as derived operational standards; conducting proactive safety assessments; determining conditions of authorisation, and obtaining assurance of compliance thereto.

Requirements on applications to the NNR for authorisations are provided in chapter 3 of the NNR Act. In summary, this chapter states that no person may site, construct, operate, decontaminate or decommission a nuclear installation, except under the authority of a nuclear installation licence issued by the NNR.

Similarly, other actions are listed which require other types of authorisations or certificates of exemption.

8.1.4 Organisational structure of the regulatory body

The NNR, established as an independent juristic person by the NNR Act, is comprised of a Board of Directors, a chief executive officer and staff. Its mandate and authority are conferred through sections 5 and 7 of the act, setting out the objectives and functions of the NNR.

The structure of the NNR is depicted in Figure 8-1, which includes reporting to the Minister of Energy.

8.1.4.1 The Board of Directors

The executive of the regulatory body reports to a board, which is appointed by the Minister of Energy. The board consists of twelve directors, including an official from the Department of Energy, an official from the Department of Environmental Affairs, a representative of organised labour, a representative of organised business, a representative of communities that 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 reappointment.

A person is disqualified from being appointed to or remaining a director of the board if he or she, inter alia, is:

1) A holder of a nuclear authorisation or an employee of such a holder; or
2) Becomes a member of parliament, provincial legislature, municipal council, the cabinet or the executive council of a province.

8.1.4.2 The chief executive officer (CEO)

The CEO is appointed by the Minister of Energy and is also a director of the board. The CEO is the accounting officer of the board and has the responsibility to ensure that the functions of the NNR are performed in accordance with the NNR Act and the Public Finance Management Act. The CEO holds office for a period not exceeding three years, as specified in the letter of appointment, and may be reappointed upon expiry of that term of office.

8.1.4.3 The staff of the NNR

The NNR’s organisational structure is configured to perform the following core functions (Figure 8-1):

1) Standards, Authorisation, Review and Assessment (SARA).
    a) The SARA group renders technical assessment functions to all the divisions and consists of four functional subgroups:
        i) Design Safety (14 staff members);
        ii) Operational Safety (11 staff members);
        iii) Environmental and Radiation Protection (11 staff members);
        iv) Emergency Preparedness (two staff members); and
        v) Nuclear Security (two staff members).
    b) The functional responsibilities of the SARA group include:
        i) Reviewing submissions from holders or applicants as requested by the programme managers (NPP, NTWP, NORM).
        ii) Conducting safety assessments.
        iii) Assisting in enforcement/compliance assurance on request from CAE.
        iv) Performing nuclear security assessments and advising on nuclear security related matters.
        v) Performing independent assessments of nuclear emergency preparedness at nuclear installations.
    c) In addition, a Special Projects Team (two staff members) coordinates the following activities:
        i) Regulatory research;
        ii) Development of regulatory guidance documents;
        iii) Development of safety regulations;
        iv) Development of position papers;
        v) Review of international standards, trends and best practices; and
        vi) Establishment of nuclear and radiation safety infrastructure for the NNR.

2) Compliance Assurance and Enforcement (CAE).
    a) The CAE group is responsible for conducting compliance inspections and enforcing authorisations on the holders. It is currently comprised of the following Programmes:
        i) Nuclear Power Plants (NPP) (five inspectors);
        ii) Nuclear Technology and Waste Products (NTWP) (eight inspectors); and
        iii) Naturally Occurring Radioactive Material (NORM) (11 inspectors).

3) Management of regulatory programmes.
    a) Currently the NNR has three regulatory programme managers (NPP, NTWP, NORM) who are responsible for planning assessment activities and liaison with the authorisation holders.
        i) The NPP Programme Manager is responsible for exercising regulatory control over nuclear power plant projects, including Koeberg NPP.
        ii) The NTWP Programme Manager is responsible for exercising regulatory control over activities undertaken by Necsa at the Pelindaba Site (covering research reactors, nuclear fuel fabrication facilities and nuclear technology applications) and the disposal of low and intermediate level waste at the Vaalputs site.
        iii) The NORM Programme Manager is responsible for exercising regulatory control over naturally occurring radioactive material arising primarily from the mining and mineral processing of radioactive ores.

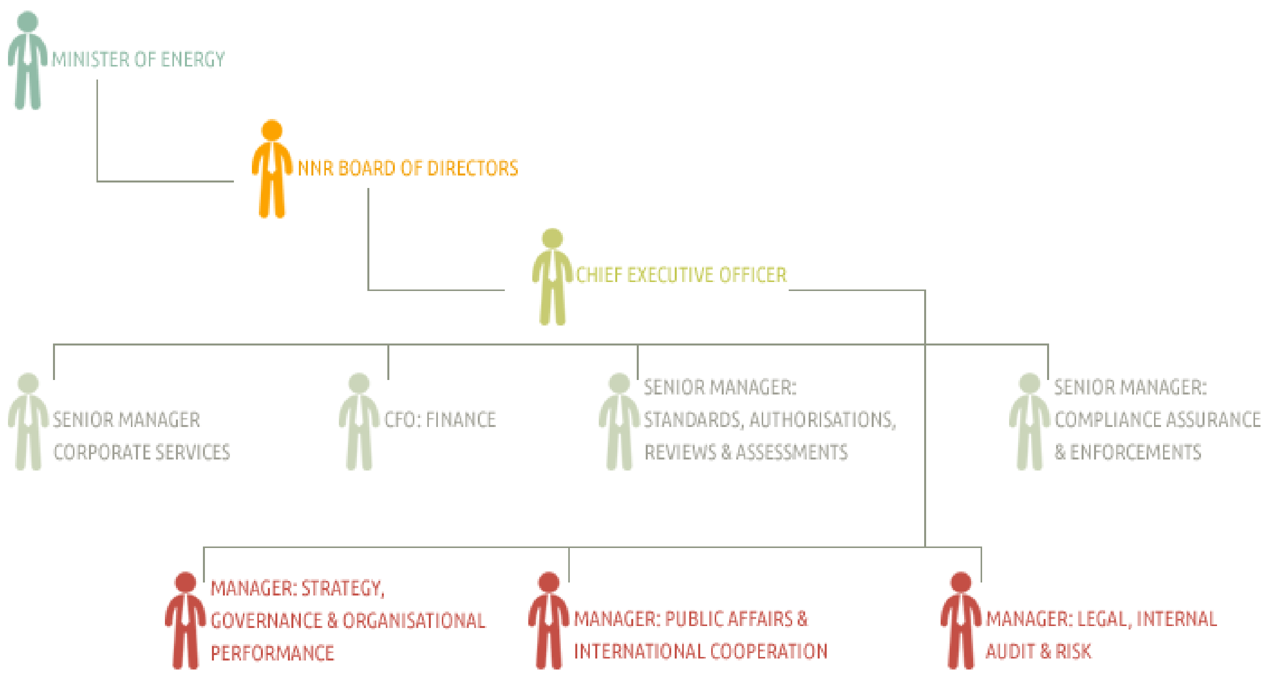
4) Support services.
   a) Support services includes the following divisions:
      i) Finance;
      ii) Corporate Services;
      iii) Strategic Planning;
      iv) Communications and Stakeholder Relations; and
      v) Legal Counsel.

Overall, the staff complement of the NNR comprises management (22), technical/professional staff (67) and support staff (32). The NNR plans to increase its overall complement by approximately 60 staff members for the nuclear expansion programme.

8.1.5 Development and maintenance of human resources over the past three years

Over the past three years, the NNR has been able to recruit staff in core technical areas such as science and engineering, but, due to competition for scarce skills both locally and abroad, retention of staff has to be adequately managed. The NNR ensures that staff are remunerated competitively and develops young professionals in their area of expertise. The NNR has increased its technical staff complement from 61 to 67 over the past three years. In addition, it is supporting 12 bursary students in various fields of science and engineering at higher learning institutions in South Africa.

Figure 8-1. NNR Organisational Structure and Reporting Line



8.1.6 Measures to develop and maintain competence

In support of its capacity building strategy and to deliver on its core business, the NNR runs an internship programme and offers bursaries with the objective of addressing the inadequate supply of appropriate technical skills.

The NNR strives to maintain high competency levels for the technical employees through continuous participation in local and international workshops and seminars, including those conducted by the IAEA.

The NNR participates in the European Nuclear Safety Training and Tutoring Institute programme which offers training in general safety, human and environmental radiation protection, reactor safety, fuel cycle safety, crisis management, and nuclear security. The NNR has sent young professionals for various courses in a drive to develop competence.

NNR staff also actively participate in:
1) Regional training initiatives provided by the Forum of Nuclear Regulatory Bodies in Africa (FNRBA) and its international partners; and
2) IAEA Technical Cooperation programmes.

8.1.7 Developments with respect to financial resources over the past three years

The capacity of the NNR continues to be supported through both its autonomous establishment and its funding provisions, which consist of monies appropriated from parliament, fees paid to the NNR in respect of nuclear authorisations and donations, or contributions received by the NNR with the approval of the minister.

The NNR has determined that in light of the envisaged nuclear expansion programme planned in South Africa, its funding levels will be inadequate. In this respect it will need to have access to additional funding from all sources.

The NNR appointed additional staff to perform reviews, assessments and inspections relating to the steam generator replacement project and is recovering these funds from the operator through a licensing fee. The additional staff will be available to support new projects such as the nuclear expansion programme once the steam generator replacement project is completed.

8.1.8 Statement of adequacy of resources

The NNR will require additional resources to cope with upcoming projects such as the thermal power uprating, spent fuel dry storage facility project at Koeberg NPP, and the envisaged nuclear expansion programme. For this purpose a staff expansion programme has been implemented with additional funding provided from licence fees.

In some technical areas, where in-house expertise is not readily available, the NNR makes use of external Technical Support Organisations (TSOs) both locally and internationally.

8.1.9 Quality management system (QMS) of the regulatory body

8.1.9.1 Overview of the NNR QMS

As indicated in sections 1 and 8, the NNR operates within a well-defined framework of national legislation and international conventions and agreements. In order to meet these obligations, the NNR has a well-defined organisational structure and a quality management system including a comprehensive set of policies and procedures as illustrated in Figure 8-2. However, the present system needs to be aligned with the IAEA Management System Standard GSR Part 3. In order to do this the NNR has adopted a phased approach for an integrated management system. The three main phases are as follows:

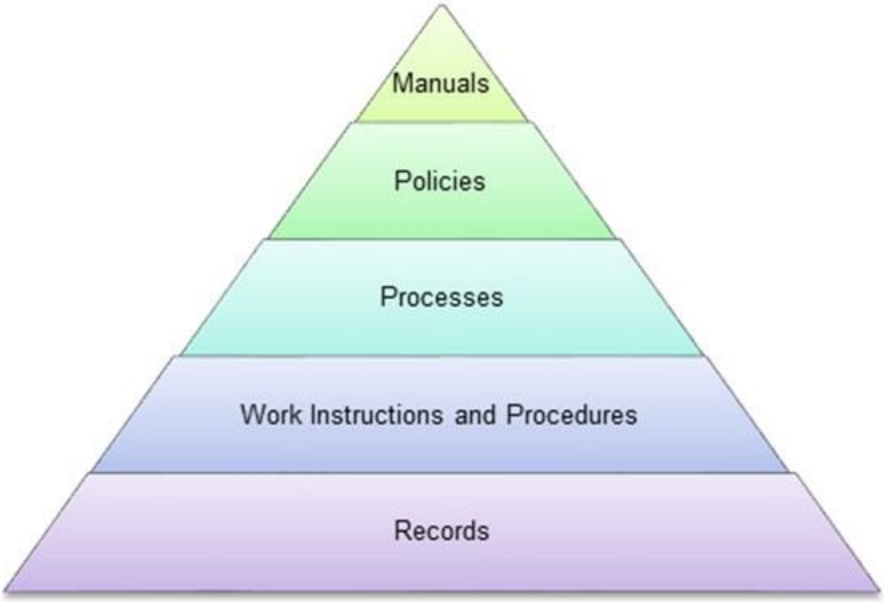
Phase 1: A preparatory phase consisting of a project definition step, analysis, planning, and the creation of key documents that comprise the system.

Phase 2: Activities to update the existing elements of the management system by evaluation and implementation of the system requirements. The drafting of new components and the creation of a comprehensive integrated management system.

Phase 3: The roll-out of the system across the organisation and the training of staff on the management of the system and the evaluation of the effectiveness of the implementation of the system.

The NNR has commenced with the preparatory phase of the project and has given itself three years to update the system.

Figure 8-2. NNR Document Structure



8.1.9.2 NNR self-assessment and framework development

The NNR has made significant progress regarding the completion of the priority actions identified in the Self-Assessment Lifecycle 1. The following was developed: an NNR training programme with national and regional cooperation mechanisms, a radioactive source register, strategies for technical services and remediation as well as a suite of new regulations and key regulatory guides. Additional guides are being progressed. A project to develop the integrated management system was also initiated.

Both regulatory bodies (the NNR and RADCON) are participating in an IAEA regional project, RAF9049 Enhancing and Sustaining the National Regulatory Bodies for Safety, which involves conducting a self-evaluation against the latest IAEA standards and using the

IAEA Self-Assessment methodology and Self-Assessment of Regulatory Infrastructure for Safety (SARIS) tool. This evaluation, in the form of Lifecycle 2, is also used to prepare for the IAEA Integrated Regulatory Review Service (IRRS) mission which will be conducted from 27 November to 9 December 2016.

The Advanced Reference Material for the IRRS mission includes the self-assessment report and legislative and regulatory documents, which should be made available to the IAEA IRRS team by 30 September 2016. Due to capacity constraints, the NNR is facilitating and assisting RADCON in the Department of Health to conduct its Lifecycle 2 Self-Assessment. A total of 17 SARIS Core and Thematic Modules are being assessed by each regulatory body and the completion of the evaluation is on track. The self-assessment using the SARIS tool is being fast-tracked for 2016/17 by utilising dedicated resources on a full-time basis. Action plans and summary reports are being prepared for each module, in accordance with the IAEA IRRS guidelines and templates.

8.1.10 Openness and transparency of regulatory activities

[Openness and transparency of regulatory activities, including actions taken to improve transparency and communication with the public]

1) Stakeholder involvement in the regulatory process

The NNR continually strives to implement quality stakeholder engagement to improve decision-making and build stakeholder trust and confidence in the nuclear safety regime. Our graded approach to stakeholder participation ranges from informing, involving, consulting, collaborating and empowering. These levels of stakeholder involvement are based on the nature of the project and the relevant legal requirements. The following key legislation is considered when determining the level of stakeholder involvement in the NNR's regulatory process:

1) The NNR Act confers certain powers on the Regulator, in the execution of its duties to regulate nuclear activities, to make or take decisions, which may affect the rights or legitimate expectations of other persons.
2) The Constitution of the Republic of South Africa, Act No. 108 of 1996 ("the Constitution") provides in section 33 (1) and 33 (2) that everyone has the right to administrative action that is lawful, reasonable and procedurally fair and that everyone whose rights have been adversely affected by administrative action has the right to be given written reasons.
3) The Promotion to Administrative Justice Act [1.10] gives effect to the right to administrative action that is lawful, reasonable and procedurally fair and to the right to written reasons for administrative action as contemplated in section 33 of the Constitution.

The NNR develops and implements stakeholder programmes for sharing information, participating at public forums, meeting with interested and affected parties, convening workshops, implementing public consultation and participation requirements as per the NNR Act and other relevant legislation.

2) Public Safety Information Forums (PSIF)

In accordance with section 26 (4) of the NNR Act, the holder of a nuclear installation licence must establish a Public Safety Information Forum to inform the persons living in the relevant municipal area where an emergency plan has been established, in terms of section 38 (1) of the Act on nuclear safety and radiation safety matters related to the relevant nuclear installation. The PSIF serves as an effective platform to share information on nuclear safety.

3) Promotion of Access to Information Act (PAIA)

The Promotion of Access to Information Act [1.6] was enacted to give effect to the right of access to information contained in the Bill of Rights section 32 (2) of the Constitution of the Republic of South Africa. The public can utilise the PAIA mechanism to request information from the NNR. The NNR will consider the request using PAIA in conjunction with the NNR Act to respond to specific requests made by the public.

4) Information sharing with civil society

The NNR implements an annual programme of meetings with civil society representatives from different regions in South Africa. These meetings are aimed at information sharing and engagement on issues. The NNR makes presentations on its regulatory activities and addresses areas of concern from the civil society.

5) Website and social media

The NNR website is the primary tool for sharing information with all external stakeholders. The user-friendly website is updated as new information becomes available. The website also contains clear instructions on how to request information using PAIA and how to register a complaint with the NNR. The NNR's social media efforts are evolving and Facebook, Twitter and LinkedIn platforms are used to share information with the public.

8.1.11 External technical support

As indicated in section 8.1.4.3, the technical safety assessment function of the NNR is carried out within the organisation. The NNR is not supported by a permanent external Technical Support Organisation (TSO). The NNR does however contract the support of consultant companies, both locally and internationally.

The NNR is sensitive to possible conflicts of interest and requests to be provided with the assurance and evidence, during the selection process, that these companies are not connected with any other organisations, e.g. licence holders, which could lead to such a conflict. The use of external consultants does not relieve the NNR of any of its responsibilities in its regulatory decision-making process.

In addition, the NNR has access to technical support on Pressurised Water Reactor (PWR) technology from other regulatory authorities with whom it has entered into bilateral agreements (8.2.5.1).

The NNR has also embarked on an initiative to establish a centre for nuclear safety and security (CNSS). The aim of the centre is to support:

1. The development of sustained research and development and academic capacity in nuclear safety to support the NNR and the nuclear industry;
2. Increasing the number of graduates (including bursars) and internships as well as improving the quality of training of nuclear science and engineering professionals;
3. Targeted research aligned with the needs of the nuclear industry, with particular focus on the needs of the NNR; and

4. Provision of technical support, expert advice and consultancy services in nuclear safety, security and radiation protection.

The project launch and operations of the CNSS has been delayed due to instability at potential partner institutions of higher learning. Lack of financial commitment and support by the State continues to be one of the biggest threats to the ability of the NNR to drive this project with the pace and vigour envisaged.

8.1.12 Advisory committees

The Technical Committee of the NNR board was established in 2011. It comprises three non-executive directors and two external members who are experts in technical, legal or environmental matters. The role of the committee is to review the policies and practices as well as specific technical issues regarding regulatory control over nuclear installations, and to advise the board accordingly.

8.2 Status of the regulatory body

8.2.1 Place of the regulatory body in the governmental structure

The NNR is directly accountable to parliament, through the Minister of Energy, on nuclear and radiation safety issues and operates independently of government, to the extent that it is able to carry out its mandate without undue influence being brought upon it.

8.2.2 Reporting obligations

[Reporting obligations to parliament, government and specific ministries]

Section 7 of the NNR Act [1.1] requires that the NNR produce and submit an annual public report to the Minister of Energy, to be tabled in parliament, on the health and safety of workers, the public and the environment associated with all the regulated actions.

Additionally, section 6 of the NNR Act requires cooperative governance agreements between the NNR and other relevant organs of state with functions relating to the monitoring and control of radioactive material or exposure to ionising radiation. These agreements are critical to the pursuance of the NNR's responsibilities in fulfilling its mandate, as well as to avoid duplication of efforts in ensuring the effective monitoring and control of nuclear hazards. Agreements have been completed and implemented with several organs of state with such functions.

8.2.3 Regulatory independence

[Means by which effective separation of the regulatory body from the agencies responsible for promotion of nuclear energy is ensured]

The independent authority of the NNR is de jure entrenched in the NNR Act, to the extent that powers are conferred on the Minister of Energy to appoint the governing, non-executive Board of Directors and the chief executive officer.

The NNR operates independently from the government when carrying out its mandate to ensure that public health is assured for all South Africans that are exposed to nuclear and radiation hazards. The purpose of this independence is to ensure that regulatory decisions are made free of other interests that may conflict with safety. Eskom, the electrical utility in South Africa that operates Koeberg NPP, reports to the Minister of Public Enterprises.

The NNR Act makes provision for a comprehensive appeals process and specifically forbids any representative of an authorisation holder or political structure from being appointed as a director of the NNR board.

From the examples above, it is clear that the de jure independent status of the NNR is adequately provided for in the NNR Act.

With regard to the de facto independence of the NNR, the NNR Act provides that if the minister rejects a recommendation of the board on the contents of regulations to be published, the minister and the board must endeavour to resolve their disagreement. In the absence of the resolution of such a disagreement, the minister has the power to make the decision. No such failure to resolve a disagreement has thus far emerged regarding recommendations from the board.

The NNR is directly accountable to parliament through the Minister of Energy on nuclear and radiation safety issues and operates independently from government to the extent that it is able to carry out its mandate without undue influence being brought upon it.

The executive authority, based on the recommendation of the NNR, is considering the following amendments of the founding legislation of the NNR (the NNR Act) in a concerted effort to further strengthen the independence of the Regulator:

The Regulator shall:

- *Have sufficient authority and sufficient competent staffing;*
- *Have access to sufficient financial resources for the proper and timely discharge of its assigned responsibilities;*
- *Be able to make independent regulatory judgements and regulatory decisions, at all stages in the duration of activities and the lifetime of facilities until release from regulatory control, under operational states and in accidents and incidents;*
- *Be free from any undue influences that might compromise safety, such as pressures associated with political circumstances or economic conditions, or pressures from government departments, authorised persons or other organisations;*
- *Be able to give independent advice and provide reports to government departments and governmental bodies on matters relating to the safety of activities and facilities; and*
- *Be able to liaise directly with regulatory bodies of other states and with international organisations to promote cooperation and the exchange of regulatory related information.*

8.2.4 Interfaces with other national institutions

[*This section is not required by INFCIRC/572*]

The NNR is listed as a national public entity in Schedule 3 Part A of the Public Finance Management Act (No. 1 of 1999, as amended). The Board of Directors is the Accounting Authority in terms of the Public Finance Management Act. In terms of Section 8 (1) and (2), the Regulator is governed and controlled, in accordance with the NNR Act, by a Board of Directors to ensure that the objects of the Act are carried out and to exercise general control over the performance of the Regulator's functions. In view of the above, the NNR has formal interfaces for reporting purposes with the National Department of Energy and the National Treasury of South Africa.

To give effect to the principles of cooperative government and intergovernmental relations contemplated in Chapter 3 of the Constitution of the Republic of South Africa (Act No. 108 of 1996), all organs of state, as defined in section 239 of the Constitution, on which functions in respect of the monitoring and control of radioactive material or exposure to ionising radiation are conferred by this Act or other legislation, must cooperate with one another in order to:

1) Ensure the effective monitoring and control of the nuclear hazard;
2) Coordinate the exercise of such functions;
3) Minimise the duplication of such functions and procedures regarding the exercise of such functions; and
4) Promote consistency in the exercise of such functions.

As such, the NNR's cooperative governance activity is carried out within the explicit legal framework in accordance with section 6 of the NNR Act.

In order to give effect to cooperative governance, the NNR enters into strategic cooperation agreements with intergovernmental competent authorities for the purposes of strengthening the nuclear safety and security regulatory regime in South Africa. Currently the NNR has agreements with 10 intergovernmental entities that have overlapping functions and responsibilities in respect of the monitoring and control of radioactive material or exposure to ionising radiation as conferred by respective legislation.

The NNR has entered into the following national intergovernmental cooperative governance agreements:

1) Department of Mineral Resources: Mine Health and Safety Inspectorate;
2) Department of Energy: Electricity and Nuclear;
3) Department of Health: Directorate of Radiation Control;
4) Department of Water Affairs;
5) Department of Environmental Affairs;
6) Department of Transport: South African Civil Aviation Authority;
7) Department of Transport: South African Maritime Safety Authority;
8) Department of Transport: Railway Safety Regulator;
9) Department of Transport: Road Traffic Management Corporation; and
10) Department of Labour.

<u>Harmonising the regulation of radioactive sources</u>

Following the completion of the self-assessments by the NNR and the DoH, and considering the recommendations arising from the EPREV mission, initiatives are being implemented to harmonise the regulation of radioactive sources.

These initiatives include the:

1) Review of the legislative framework and regulations for regulatory control of Group III and Group IV hazardous substances;
2) Benchmarking of international approaches to the regulation of Group III and Group IV; and
3) Development of a business model for regulation of Groups III and IV.

A memorandum of understanding is being discussed between the Department of Health (DoH), Department of Energy (DoE) and NNR on the possible transfer of this function to the NNR.

8.2.5 International cooperation

[*This section is not required by INFCIRC/572*]

As the competent authority in nuclear safety regulation, the NNR is required to fulfil South Africa's obligations with respect to international instruments concerning the IAEA's Regulations for the Safe Transport of Radioactive Material and to coordinate and implement South Africa's CP obligations to the IAEA Convention on Nuclear Safety (CNS) and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

To support the achievement of strengthening the regulatory framework in South Africa, the NNR participates in a number of international meetings, fora and bilateral cooperation initiatives with the aim of achieving the following primary objectives:

1) Developing information exchanges with its foreign counterparts related to regulatory systems and practices, as well as problems encountered in the field of nuclear safety and radiation protection, with a view to enhancing its regulatory approach;
2) Improving and strengthening its position in technical discussions with the authorisation holders;
3) Building its internal capacity through international training programmes as well as the exchange of personnel with other regulators; and
4) Playing an active role in international work to harmonise nuclear safety and radiation protection principles and standards.

The NNR pursues these objectives within the framework of international regulatory fora, bilateral agreements with regulators of other countries, and through its participation in the work coordinated by international bodies such as the IAEA.

The IAEA facilitates the establishment of international conventions on nuclear safety. These are legally binding international instruments which are required to be ratified by country legislatures before they can be implemented. The conventions place obligations on member states. South Africa is a signatory (contracting party) to:

1) The Convention on Nuclear Safety; and
2) The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

In terms of section 5 (e) of the NNR Act one of the objectives of the Regulator is to "fulfil national obligations in respect of international legal instruments concerning nuclear safety". The NNR is the competent national organisation with respect to implementing the above two Conventions.

8.2.5.1 Convention on Nuclear Safety

South Africa ratified the Convention on Nuclear Safety in 1996 and its obligations under the CNS commenced on 24 March 1997. The obligations of the Contracting Parties are based on the principles contained in the IAEA Safety Fundamentals document, The Safety of Nuclear Installations. These obligations cover aspects such as siting, design, construction, operation, the availability of adequate financial and human resources, the assessment and verification of safety, quality assurance and emergency preparedness.

The CNS is an incentive instrument and is based on the common interest of CPs to achieve higher levels of safety that will be developed and promoted through regular meetings of the Parties. The CNS obliges Parties to submit country reports on the implementation of their obligations for peer review at meetings of the Parties to be held at the IAEA.

8.2.5.2 The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

South Africa acceded to the Joint Convention in November 2006 and its obligations under the Joint Convention commenced in February 2007. The Joint Convention applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications, and military or defence programmes if and when such materials are transferred permanently to and managed exclusively within civilian programmes, or when declared as spent fuel or radioactive waste for the purpose of the Joint Convention by the contracting party. In addition, the Joint Convention applies to planned and controlled releases of liquid or gaseous radioactive materials from regulated nuclear facilities into the environment.

The obligations of the Contracting Parties with respect to the safety of spent fuel and radioactive waste management are based, to a large extent, on the principles contained in the IAEA Safety Fundamentals document, The Principles of Radioactive Waste Management, published in 1995. They include, in particular, the obligation to establish and maintain a legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management and the obligation to ensure that individuals, society and the environment are adequately protected against radiological and other hazards, inter alia, by appropriate siting, design and construction of facilities and by making provisions for ensuring the safety of facilities both during their operation and after their closure. Contracting Parties also have the obligation to take appropriate steps to ensure that disused sealed sources are managed safely.

8.2.5.3 International Regulatory Forums

1) Network of Nuclear Regulators (NERS)

NERS is an international network of nuclear regulators and inspectors who are dedicated to the free exchange of nuclear regulatory information and its dissemination. NERS is a forward-looking independent organisation that provides a means of communication between regulators of countries with small nuclear programmes who experience unique problems and a specific common need. It is complementary to any bilateral engagement or agreements a regulatory body may have. The following countries participate in NERS:

- Argentina;
- Belgium;
- Czech Republic;
- Finland;
- Hungary;
- Netherlands;
- Pakistan;
- Slovak Republic;
- Slovenia;
- South Africa; and
- Switzerland.

2) FRAREG Nuclear Regulators Association

The FRAREG Nuclear Regulators Association (Framatome Reactor Regulators) was officially created in May 2000, during the inaugural meeting held in Cape Town. It includes the heads of the Belgian, Chinese, South African, South Korean and French Safety Authorities. Its main objectives are to exchange experience gained from supervising the operation of reactors designed by the same company and to compare approaches adopted to deal with generic problems and assess installation safety.

3) Forum of Nuclear Regulatory Bodies of Africa (FNRBA)

The FNRBA is represented by 28 member countries in Africa. South Africa plays a leadership role in the FNRBA that gained impetus by the commencement of the Pelindaba Treaty, which promotes and commits member countries to non-proliferation in the continent. Regionally, the NNR participates on the technical steering committee of the FNRBA that seeks to provide for the enhancement, strengthening and harmonisation of the regulatory infrastructure and frameworks amongst member states in Africa.

The significance of networking through cooperation and collaboration amongst regulatory bodies in the African region is regarded as a very effective instrument for enhancing the sharing of knowledge and experience essential to the prevention of accidents and to the implementation of radiation safety and security measures. The FNRBA is regarded as a primary vehicle to establish a framework for cooperation and collaboration amongst national regulatory bodies in the African region.

4) Multinational Design Evaluation Programme (MDEP)

The Multinational Design Evaluation Programme (MDEP) was started in 2006 to develop innovative approaches to leverage the resources and knowledge of the national regulatory authorities that will be conducting a review of new reactor power plant designs. The MDEP is organised under the auspices of the Organisation for Economic Cooperation and Development (OECD) Nuclear Energy Agency, which performs the technical secretariat function for the programme. The regulatory authorities of Canada, China, Finland, France, Japan, South Korea, Russia, South Africa, the United Kingdom and the United States of America participate in this multinational programme.

In accordance with the MDEP, nuclear regulators are aiming to enhance safety worldwide via increased cooperation. Enhanced cooperation amongst regulators will improve the efficiency and the effectiveness of the design review process, which is aimed at an increased convergence of regulatory practices. However, the participating countries will at all times retain their sovereign authority over all licensing and regulatory decisions. The programme is directed by a Policy Group, comprising the heads of regulatory authorities of the participating countries. A Steering Technical Committee, comprising senior level representatives from the ten participating regulatory authorities, was established to implement these activities.

The NNR's participation in this programme is important in terms of South Africa's envisaged nuclear expansion programme which will require the NNR to licence the construction and operation of additional nuclear power plants in the future.

8.2.5.4 Bilateral cooperation agreements

Bilateral agreements provide the NNR with a mechanism for information sharing and technical cooperation with international counterparts on various aspects of nuclear safety. The NNR has bilateral agreements with international nuclear safety authorities such as France (ASN), the United States of America (NRC), Canada (CNSC), the United Kingdom (ONR), South Korea (KINS), Finland (STUK), China (CNNSA) and Russia (Rostechnadzor).

8.2.5.5 Meetings of the IAEA Safety Standards Committees

The IAEA Safety Standards have served as references and benchmarks for South African nuclear safety and radiation protection. This largely comprises reference to the IAEA safety standards in regulatory requirements and guidance documents. Further, indirect use of the IAEA material is also made in the development of standards and regulations and sometimes in dealing with issues for which there is no established South African standard.

The NNR participates actively in the following IAEA Safety Standards Committees:

1) Commission on Safety Standards (CSS);
2) Nuclear Safety Standards Committee (NUSSC);
3) Radiation Safety Standards Committee (RASSC);
4) Waste Safety Standards Committee (WASSC), and
5) Transport Safety Standards Committee (TRANSSC).

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

Minor editorial changes have been made.

9.1 Holder's prime responsibility for safety – legislation

[Formulation in the legislation (quotation) assigning the prime responsibility for safety to the licence holder]

In terms of section 3.7.1 of the Regulations on Safety Standards and Regulatory Practices (SSRP) [1.7], "The holder of a nuclear authorisation is responsible for radiation protection and nuclear safety, including compliance with applicable requirements such as the preparation of the required safety assessments, programmes and procedures related to the design, construction, operation and decommissioning of facilities."

9.2 Holder's prime responsibility for safety – implementation

[Description of the main means by which the licence holder discharges the prime responsibility for safety]

Eskom is the owner and operator of the Koeberg NPP in South Africa. The strategy followed by Eskom was to develop a document called the Koeberg Licensing Basis Manual (KLBM) [4.10] that includes all relevant change control processes for modifications, waivers, procedure changes, etc., and serves as a roadmap of the overall safety case for Koeberg NPP. This includes:

1) Eskom policies relating to nuclear safety;
2) Statutory requirements;
3) Nuclear safety criteria, codes and standards;
4) Documented processes and procedures to meet these safety standards; and
5) Monitoring of compliance with safety requirements, including reports to the NNR.

The KLBM forms an integral part of all the conditions of the Koeberg nuclear installation licence and details the complete set of nuclear safety requirements, 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 NPP. Provisions are also included to cover submission of safety cases, reports and communication standards. Interfaces with the NNR and the establishment of a process to ensure all regulatory requirements are made known, understood and complied with by all applicable personnel at the nuclear installation are also included.

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

The holder's safety policies, safety culture programmes and development, arrangements for safety management, arrangements for safety monitoring and self-assessment, independent safety assessments, and quality management system are further described in section 10.

9.3 Holder's prime responsibility for safety – regulatory enforcement

[Description of the mechanism by which the regulatory body ensures that the licence holder discharges its prime responsibility for safety]

The NNR ensures that the licence holder discharges its prime responsibility for safety as follows:

1) The NNR issues a nuclear installation licence which includes conditions referring to regulatory requirements (with guidelines as appropriate) (See 7.2.1).
2) These conditions require the holder to report on compliance as described below.
3) The NNR assesses the KLBM, described in section 9.2 above, to ensure that the holder's policies and procedures adequately conform to the regulatory requirements described in Articles 7.1 and 7.2.
4) The NNR includes the KLBM as a condition of licence.
5) The NNR ensures compliance to the licence through a system of regulatory assessment and inspection, as described in section 7.2.3.

In addition to the technical assessment reports referred to in section 7.2.3 and Article 14, the nuclear installation licence holder is required, by the NNR Act and the SSRP regulations, and through a condition of the licence, to make available reports and other information to the NNR. These include the following:

1) Incidents and accidents are required to be reported in terms of section 37 of the NNR Act and in terms of section 4.10.2 of the SSRP.
2) In terms of section 4.10.2 of the SSRP, operational reports must be submitted to the NNR at predetermined periods and must contain such information as the NNR may require on the basis of the safety assessments. These include:
   a) Problem notification, occurrence, quality assurance and audit reports, including close-out reports;
   b) Environmental monitoring reports;
   c) Reports on gaseous and liquid effluents from the plant;
   d) Medical and psychometric testing reports;
   e) Fuel performance reports;
   f) Specific reload safety evaluation reports;
   g) In-service inspection reports; and
   h) Routine licence basis compliance reports.

9.4 Holder's public communication processes

[Description of the mechanisms whereby the licence holder maintains open and transparent communication with the public]

The NNR Act places responsibilities on the licence holder to establish a Public Safety Information Forum, to inform persons living in the municipal area (where an emergency plan has been established) on nuclear and radiation safety matters. The Promotion of Access to Information Act also makes provision for the public to request information from the operator or the NNR in the interest of openness and transparency.

The Koeberg Public Safety Information Forum meetings take place on a quarterly basis and address concerns by the public. Each meeting is chaired by a member of the public and is attended by all major role players involved in the integrated nuclear emergency plan as well as members of the general public. The NNR participates in 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

Article 10 has been updated in terms of:

1) Regulatory safety regulations and guidance referred to in Article 7 (10.1).
2) Safety culture programmes at the nuclear installation (10.2.2.1).
3) Safety culture monitoring and feedback (10.2.2.2).
4) Arrangements for safety monitoring and self-assessment (10.2.4).
5) Safety and security culture referred to and the means used by the regulatory body to prioritise safety in its own activities (10.4).

10.1 Requirements to prioritise safety in design, construction and operation

[Overview of the contracting party's arrangements and regulatory requirements regarding policies and programmes to be used by the licence holder to prioritise safety in activities for design, construction and operation of nuclear installations]

The safety requirements are given in the SSRP's, Siting regulations and requirements documents (Articles 7 and 13), which address:

1) Safety regulations and guidance;
2) Safety policies;
3) Safety culture programmes and development;
4) Arrangements for safety management;
5) Arrangements for safety monitoring and self-assessment;
6) Independent safety assessments; and
7) A process-oriented (quality) management system.

10.2 Measures to prioritise safety

[Measures taken by licence holders to implement arrangements for the prioritisation of safety, such as those above and any other voluntary activities and good practices]

10.2.1 Safety policies

Within South Africa, the national electricity generator, Eskom, owns and operates the only nuclear power station currently in the country. The company has adopted a corporate policy on nuclear safety and the Nuclear Generation Department within the company has also developed a policy to comply with all its safety obligations.

At the corporate level, a policy was developed which has been set down in a corporate directive. The directive commits to compliance with regulatory requirements and openness to inspection by the NNR and international peer review groups. Good engineering practice is employed in the design and operation of nuclear installations and in any modifications to them, with a thorough root cause analysis of failures or operational anomalies. Eskom, through the directive, 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 complied with. 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 manage the nuclear installation in line with national regulatory and corporate requirements, and complying with 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 placed on them and the potential impacts of their function. This policy is manifested in obligations to meet job requirements, systems for error prevention and corrective action, a performance standard of zero deviation and a systematic improvement process.

The scope of activities that the utility is authorised to undertake is specified in the nuclear installation licence, together with the plant technical specifications and operational programmes it is obliged to implement. The regulation No. R.388 (SSRP) [1.7], as well as the nuclear installation licence, detail the reports that the licence holder must submit to the NNR.

10.2.2 Safety culture programmes and development

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

10.2.2.1 Safety culture programmes at the nuclear installation

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

The licence holder, Eskom, with involvement of the NNR, developed a safety culture survey tool, partially based on the IAEA INSAG-4 publication, the Institute for Nuclear Power Operators (INPO) TECDOC-1329 and the INPO Principles for Strong Nuclear Safety Culture. Surveys were conducted in 2006, 2007, 2009 and 2011, involving utility personnel and contracting staff. The results and recommendations of the surveys were shared openly with the installation staff and the NNR.

Most recently, INPO/WANO revised its safety culture framework and published the revised nuclear safety culture traits in 2013. These traits were published in INPO 12-012. These safety culture traits have also been incorporated into the World Association of Nuclear Operators (WANO) Performance Objectives and Criteria in 2013, which forms the basis on which WANO conducts its international peer reviews at member nuclear organisations. The revision of safety culture traits by INPO/WANO necessitated a similar revision of the Koeberg NPP nuclear safety culture framework. In this instance, the Koeberg NPP adopted the safety culture traits of INPO/WANO as its own nuclear safety culture framework.

In 2014, a new safety culture survey tool was designed based on research and current best practice on nuclear safety culture models and frameworks as well as the revised nuclear safety culture traits. The survey involved utility personnel and contracting staff. The results and the recommendations of the survey were shared openly with the installation staff and the NNR.

10.2.2.2 Safety culture monitoring and feedback

To aid in identifying adverse trends in safety culture, Eskom carries out analyses of occurrences from operations, outage work and other activities. The results of these analyses are presented in graphical format for departments and groups and discussed with nuclear installation staff at safety improvement sessions and safety culture promotion initiatives. 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 to the nuclear installation staff on safety culture topics and the licence holder convenes periodic nuclear safety awareness seminars, which are attended by all staff and include many safety presentations, videos and discussion groups, covering a wide range of nuclear safety matters, including safety culture.

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

1) Establishing dialogue with worker representatives and trade unions on safety issues;
2) Promoting meetings and visits involving public and local authorities;
3) Improving visibility and accessibility of managers to workers;
4) Improving NNR/Eskom communications – NNR project concept;
5) Safety Hero Programme – a rewards and recognition programme linked to the safety culture traits with the objective of encouraging nuclear safety professionalism;
6) Permanent psychologist on-site;
7) Rewards system for recognition of safety issues;
8) Nuclear safety concern process;
9) Human performance drive;
10) Outage safety focus and dedicated safety plan;
11) Safety engineer function supporting operating shifts and providing oversight to the station's safety committees;
12) Human performance corporate consultant dedicated to the nuclear division;
13) WANO human performance fundamental training for managers;
14) Human performance training for all Koeberg NPP staff and contractors; and
15) WANO and EDF leadership support missions.

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 pressing demands for production and cost savings can influence individuals to tolerate potentially unacceptable conditions. As indicated above in Article 9, the NNR has moved to a more process-orientated licensing approach, which demands an increased discipline and safety culture from staff of the nuclear installation and increased vigilance from the NNR to detect incipient weaknesses or any deterioration of the safety commitment.

10.2.3 Arrangements for safety management

A corporate Nuclear Safety Assurance (NSA) group has been established within Eskom and provides independent safety assurance directly to the Group Executive (Generation). Further details are given in section 12.3.

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, with the primary goal of enhancing safety and procuring commitment from the installation's staff.

Examples of Eskom's commitment to safety have been evidenced by 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 reassessments completed.

The main initiatives implemented by Eskom to strengthen its commitment to nuclear safety are summarised below in sections 10.4.2 to 10.4.5.

10.2.4 Arrangements for safety monitoring and self-assessment

10.2.4.1 Safety indicators

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

10.2.4.2 Safety engineer function

As reported in previous reports, Eskom (Koeberg) has established five safety engineer posts based on the French EDF model. Their responsibilities are as follows:

1) Safety function confirmation.
   This is performed on a daily basis and is a direct service to the shift manager. Their duties include:
   a) Trending critical plant parameters during normal operation to detect early warnings of potential safety problems;
   b) Providing an independent level of monitoring of safety system performance and making recommendations accordingly;
   c) Confirming the availability of safety-related systems;
   d) Assisting in the development of Technical Specifications for beyond-design-basis equipment not covered in the normal Operating Technical Specifications;
   e) Approving the plant work plan after a risk evaluation; and
   f) Confirming the compliance to nuclear safety requirements before plant state changes when called upon during unplanned shutdowns.

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

2) Plant outage safety.
   a) Assist and advise during the outage-planning phase to ensure compliance to the Operating Technical Specifications.
   b) Participate in deterministic risk analyses and propose mitigation methods.
   c) Confirmation that the equipment is correctly requalified.
   d) Confirm that the surveillance programme is complied with.
   e) Confirm compliance to nuclear safety requirements during plant state changes or during the outage.
   f) Preparation of the outage safety plan.
   g) Confirmation of compliance to the outage safety plan.
   h) Compile an outage experience feedback report for the continuous improvement of nuclear safety.

3) Technical advice and recommendations.
   a) During normal operations, provide advice to the shift manager on operability determinations, suitable responses to potential unsafe conditions and similar conditions of uncertainty and ambiguity.

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

4) Safety documentation review and assessment.
    a) Review changes to the OTS and surveillance requirements.
    b) Participate in the safety review of plant modifications and safety cases.
    c) Participate in the Koeberg Operating Review and Operational Safety Committees (KORC and KOSC).
    d) Participate in appropriate audits and evaluations.

10.2.5 Independent safety assessments

Independent safety assessments of the design and operation of Koeberg NPP are undertaken by the Nuclear Safety Assurance (NSA) group through a programme of evaluations. Strengths and Issues Requiring Attention (IRAs) are identified and discussed with the relevant line group, and proposed corrective actions are identified. The results of the evaluations are reported to the oversight safety committees and directly to the Eskom Group Executive (Generation).

10.2.6 Process-oriented (quality) management system

The NNR has required Eskom to develop an integrated quality and safety management system that complies with Requirements Document RD-0034 [4.5]. The requirement comes from Principle 3 of the Fundamental Safety Principles of the IAEA Safety Standards, which states that “Effective leadership and management for safety must be established and sustained in organisations concerned with, and facilities and activities that give rise to radiation risks.” The publication further states that “Leadership for safety must be demonstrated at the highest levels in an organisation and safety has to be achieved by means of an effective management system.” These statements form the basis for the new requirements which define, over and above the requirements for a multilevel concept approach for an integrated management system, requirements for safety culture implementation.

Further details are provided in Article 13.

10.3 Regulatory oversight processes

[Regulatory processes for monitoring and oversight of arrangements used by the licence holders to prioritise safety]

The NNR has a dedicated team of site inspectors and examiners within close proximity to the nuclear installation. This enables the NNR to maintain improved communication with

Eskom's staff, management and off-site bodies, and to gauge the level of commitment to safety demonstrated in all aspects of the installation's operations. The NNR is therefore better informed to assure the public that the installation's staff is committed to the pursuit of safety, and that the NNR is equally committed to effective vigilance and appropriate action.

The system of regulatory control at the nuclear installation that ensures and enforces the priority given to nuclear safety has been discussed in Articles 7 and 9, but can be summarised as follows:
The NNR ensures that the licence holder meets its commitment to nuclear safety by:

1) The enforcement of the legislative requirements of the NNR Act;
2) The establishment of nuclear safety standards and regulatory practices;
3) The granting of a nuclear installation licence and regulatory directives/letters on demonstration by the licence holder of compliance to the conditions of licence; and
4) Providing an independent regulatory assurance of compliance with the conditions of the nuclear installation licence, through the implementation of a system of compliance inspections, the latter comprising inspections, surveillances and audits as well as various forums for interaction with the licence holder (the compliance assurance programme of the NNR is described further in Article 14).

10.4 Means used by the regulatory body to prioritise safety in its own activities

The NNR uses a system of annual performance plans, with quarterly and annual reports around the achievement of these plans, applying indicators which reflect achievement in the key performance areas covering the various aspects of regulatory control and internal processes. This enables the NNR to assess its performance on a quarterly basis and to refocus its activities accordingly.

The regulatory approach has evolved to one that enforces processes for safety management and that includes safety screening and evaluation by the holder. This tends to limit the safety submissions from the holder to those that are safety significant.

10.4.1 Promotion of a strong safety culture for the NNR

The NNR has developed and implemented a safety and security culture policy. The intent of this policy is to promote and support a strong safety and security culture in the way the organisation conducts its business internally and externally in the exercise of its regulatory authority and oversight over nuclear facilities and activities. It is the expectation that all NNR management and staff, as well as the individuals and organisations at all facilities and activities that fall under the regulatory authority of the NNR, shall establish, promote, support and maintain a positive and strong safety culture, commensurate with the safety and security significance of their activities, and the nature and complexity of their organisations and functions.

To this end, the NNR has established a Safety Culture Working Group (SCWG) to develop its framework for promoting and supporting a strong safety and security culture. The primary roles and responsibilities of the SCWG are the following:

1) NNR safety and security culture framework development: the primary responsibility of the group is to assist the development of the NNR framework for promoting and supporting a strong safety and security culture, including the associated processes

and tools to enable the NNR to fulfil the integrated management system requirements for a safety and security culture.

2) NNR safety and security culture champions and ambassadors: the group will receive training to form a critical mass of NNR staff to act as promoters and advocates for a strong safety and security culture.
3) Training: the SCWG will receive train-the-trainer training to enable them to train other NNR management and staff on the safety and security culture.
4) Communication: the SCWG will disseminate information on the safety and security culture, including information on issues and the status or progress regarding the development of the NNR safety and security culture framework for their respective departments, and the NNR as a whole.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

Each contracting party shall take the appropriate steps to ensure that:
1) Adequate financial resources are available to support the safety of each nuclear installation throughout its life.
2) 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

Article 11 has been updated in terms of:
1) Inclusion of a section on arrangements for financial resources in the event of a radiological emergency (11.1.4).
2) Requirements concerning staffing, qualification, training and retraining (11.2.1).
3) Initial training and retraining of operations staff (11.2.3).
4) Assessment of a holder’s staffing levels (11.2.7).
5) Status of the national capacity in nuclear science and technology (11.2.10).
6) Regulatory review and control activities (11.2.12).

11.1 Financial resources

11.1.1 Provision of financial resources to the licence holder

[Mechanism for the provision of financial resources to the licence holder or applicant in order to ensure the safety of the nuclear installation throughout its lifetime]

11.1.1.1 Financing of safety improvements

[Principles for the financing of safety improvements to the nuclear installation over its operational lifetime]

Eskom is a very large electricity utility with a tried and tested financial planning process. All planning is based on Eskom’s continued ability to be a financially viable concern. Although financial plans are inclusive of all the Eskom power plants, the nuclear installation is not planned for in isolation. 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.

Eskom utilises a technical planning process to allocate financial resources for improvements to the plant. Nuclear safety modifications are in a separate category and specific provision is made for these. Eskom finances safety improvements in the same manner as any other improvement to the plant. Owing to the nature of the industry, improvements are made on a continual basis throughout the life of the installation, and nuclear safety improvements are no exception.

All improvements to the installation are financed centrally by Eskom’s treasury department. The funding requirements of the organisation are derived from the financial plans and are determined annually and reviewed monthly.

11.1.1.2 Financial provisions

[Principles for financial provisions during the period of commercial operation, for decommissioning and management of spent fuel and radioactive waste from nuclear installations]

Decommissioning of the nuclear installation is currently scheduled for after 2025. However, several projects are underway to demonstrate the safety of the facility to safely continue operation until 2035. Financial provision for the decommissioning (as well as 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 Eskom. These financial statements are audited in accordance with South African national legislation.

In terms of decommissioning financial plans, the amount of decommissioning and spent fuel provision made each month is determined by the present valuing of future estimated cash

flows. These financial plans are reviewed regularly and adjusted annually, and informed by 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 therefore included in the business and financial plans.

11.1.2 Statement on the adequacy of financial provisions

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

11.1.3 Contracting party's processes to assess the financial provisions

The holder is required, by condition of the licence, to provide proof to the NNR that any claim for compensation, to an amount contemplated in section 30 (2) of the NNR Act [1.1], can be met. They also need to demonstrate the availability of sufficient resources to enable the implementation and completion of decommissioning activities.

The regulations that are presently being developed (section 7.2.1.3) also include a requirement to demonstrate the availability of sufficient resources for the long-term operation of the nuclear installation.

11.1.4 Arrangements for financial resources in the event of a radiological emergency

[*Description of the contracting party's arrangements for ensuring that the necessary financial resources are available in the event of a radiological emergency*]

South Africa's civil liability for nuclear damage is governed by the NNR Act. Specifically, chapter 4 of the NNR Act deals with financial security and liability and addresses aspects such as:

1) Financial security by the holder of a nuclear installation licence.
2) Strict liability of the holder of a nuclear installation licence for nuclear damage.
3) Special provisions for liability of nuclear damage caused by vessels.
4) Liability of the holder of a certificate of registration for nuclear damage.
5) Claims for compensation in excess of maximum liability.
6) Prescription of actions.
7) Compensation for injuries of the Regulator's employees.

In accordance with the provisions of section 29 of the NNR Act, on the recommendation of the NNR board and by notice in the Gazette on 7 May 2004 [1.9], the Minister has determined:

1) The level of financial security to be provided by holders of nuclear installation licences in respect of each of those categories; and

2) The manner in which that financial security is to be provided, in order for the holder of a nuclear installation licence to fulfil any liability which may be incurred in terms of section 30 of the Act.

The NNR has subsequently benchmarked the provisions in the NNR Act against the latest international instruments relating to operator liability. The amendments to the NNR Act, as discussed in section 7.2.1.3, includes changes to the definition of nuclear damage to cover costs associated with reinstatement measures of impaired environment, costs of preventive measures, and different forms of economic loss as a result of the nuclear accident, in line with international conventions.

The NNR has also reviewed the level of operator liability and has advised the Minister of Energy to increase the level of operator liability currently applicable.

11.2 Human resources

11.2.1 Requirements concerning staffing, qualification, training and retraining

[Overview of the contracting party's arrangements and regulatory requirements concerning staffing, qualification, training and retraining of staff for nuclear installations]

The regulatory requirements are given in the requirements on safety management (Articles 7 and 13), which address the holder's and suppliers' personnel selection, training and competence. It is required amongst others in RD-0034 that "An adequate number of competent, qualified and trained staff must be responsible for carrying out the functions associated with radiation protection and nuclear safety and for maintaining an appropriate safety culture". It is further required that a systematic process to establish technical and behavioural competence requirements must be implemented.

The minimum training and qualification requirements, specifically for radiological protection personnel, radiation workers and reactor operators, are prescribed by the nuclear installation licence.

The licensing standards of the NNR for reactor operators are fully aligned to the US NUREG-1021 [6.2]. The content and scope of examinable subjects, for initial licensed operator training, are driven by the knowledge and abilities as required by the NUREG-1122 [6.3] catalogue. The nuclear installation licence requires minimum shift staffing levels and notification to the NNR of any organisational changes.

Once an individual has obtained a reactor operator licence, it is a licence condition that they attend requalification training. The training and evaluation are performed by Eskom, however, the programme content and standard are monitored and approved by the NNR. Full requalification examinations are given biennially. Operator licenses are reissued for a further two-year period provided that operators meet all the NNR requirements and remain fit for duty. Any contravention of the operator licence requirements is immediately reportable to the NNR.

11.2.2 Analysis of competence requirements and training needs

[Methods used for the analysis of competence requirements and training needs for all safety-related activities in nuclear installations]

Eskom implements a systematic process to: establish technical and behavioural competence requirements; employ appropriate training methods to ensure that individuals are aware of the relevance and importance of their activities in achieving the safety objectives; and conduct formal assessments of competence, which evaluate training, appropriate supervision and monitoring, until full competence is achieved.

11.2.3 Initial training and retraining of operations staff

[Arrangements for initial training and retraining of operations staff, including simulator training]

It is a condition of the nuclear installation licence that only individuals licensed by the NNR may manipulate the controls of the reactors. In order to obtain either a Reactor Operator (RO) or Senior Reactor Operator (SRO) licence, the individual is required to pass the following examinations approved by the NNR:

1) Written examinations in the areas of nuclear power plant fundamental theory and in normal, abnormal and incident plant operation;
2) Simulator examinations in normal, abnormal and incident conditions;
3) In-plant walk-through examinations; and, for SRO candidates,
4) In-plant examinations in the performance of emergency controller duties.

Training and competency standards are monitored through training records, auditing, assessment of results and the analysis of occurrences for root causes.

At the end of 2012, Koeberg NPP was successful in achieving the second accreditation renewal for its entire operator training programme with the USA-based Institute of Nuclear Power Operators (INPO). Koeberg NPP was the first nuclear power station outside of the USA to achieve this accreditation in 2003. The ongoing assessment and periodic accreditation renewal (2007 and 2012) provides a high level of assurance that the quality of operator training will be maintained at an international best-practice level. The next accreditation assessment is due in 2018.

This initiative resulted in an overall improvement to the operator training programme, which included the following:

1) Yearly INPO assist visits to review and recommend improvements to the programme based on INPO best practice;
2) Improved operator performance at the plant;
3) A Systematic Approach to Training that caters for review of plant modifications and process changes to ensure that the training process and material are appropriate; and
4) Additional specialist training resources needed to implement an improved training programme.

The operator training at Koeberg NPP is further independently accredited by the South African Qualifications Authority (SAQA) in accordance with national requirements and standards.

11.2.4 Capabilities of plant simulators

[Capabilities of plant simulators used for training, with regard to fidelity to the plant and scope of simulation]

Two upgraded full scope control room simulators were installed in a new operations training facility in 2013.

All initial and requalification training and performance evaluations are performed on a full scope replica control room simulator situated on site. The quality of the simulators are prescribed through the nuclear installation licence to a standard of ANSI/ANS-3.5. Failure to meet the NNR criteria for simulator fit-for-purpose results indicates noncompliance with the NNR training standards and has a direct impact on operator qualification.

11.2.5 Training of maintenance and technical support staff

[Arrangements for training of maintenance and technical support staff]

The training, qualification and ongoing training requirements for the production support groups (maintenance, chemistry, radiation protection, nuclear fuel management and plant engineering) are set by Eskom. Eskom follows a practice, based on formal on-the-job training and examinations, of formally authorising staff to perform tasks on safety-related plant systems.

11.2.6 Improvements to training programmes

[Improvements to training programmes as a result of new insights from safety analyses, operational experience, development of training methods and practices, etc.]

Eskom has implemented a Systematic Approach to Training that covers all facets of technical training at Koeberg NPP (11.2.3).

11.2.7 Assessment of the holder's staffing levels

[Methods used to assess the sufficiency of staff at nuclear installations]

The NNR requires that changes in the licensee organisation, including structure, staffing levels and resources, be evaluated to ensure that they will not adversely impact safety. Any changes that may impact nuclear safety must be submitted to the NNR for acceptance prior to implementation.

Personnel at Koeberg NPP who undertake safety-related work are required to have a minimum level of qualification and experience. The minimum number of personnel per position is also determined. This includes personnel required for severe accident management. The sufficiency of staff numbers is measured and monitored through a Competency Index, which provides an indication of actual numbers against minimum staffing levels.

11.2.8 Policy on contracted personnel

[Policy or principles governing the use of contracted personnel to support or supplement the licensee's own staff]

Long-term contracted personnel are used to supplement Eskom's own staff. They are subject to the same qualification and experience requirements and to the same work control measures.

11.2.9 Assessment of a contractor's personnel

[Methods used to assess the qualification and training of a contractor's personnel]

Minimum qualification and training of a contractor's personnel are included in the contract and checked by Eskom's contract managers. All contractor personnel are also required to pass a fit-for-duty test where artisan's trade skills are assessed.

11.2.10 Status of national capacity in nuclear science and technology

[Description of the national supply of, and demand for, experts in nuclear science and technology]

The availability of certain specialised categories of expertise in nuclear science and technology remains limited within South Africa. When required, such expertise is sourced offshore through Eskom's support agreements with companies such as Areva and utilities such as Électricité de France (EDF).

11.2.11 Analysis of competencies for severe accident management

[Methods used for the analysis of competence, availability and sufficiency of additional staff required for severe accident management, including contracted personnel or personnel from other nuclear installations]

Any person required to perform a task, whether contractor or additional staff, needs to satisfy the qualification and competence requirements for that position.

The emergency plan is staffed by people who are qualified in the associated area of expertise within the organisational structure. Their normal job outputs are therefore the same as what their responsibilities are in the emergency plan organisation. In their normal functions they receive retraining and qualification through rigorous processes.

11.2.12 Regulatory review and control activities

As reported in Article 19 (5), the NNR requires the holder to conduct an annual assessment on its staffing and competency levels and to report to the Regulator accordingly. This process is further covered by the Regulator's compliance assurance programme.

It is a requirement of the nuclear installation licence that the efficacy of these training programmes is audited on a regular basis. Participation in these audits is actively undertaken by the NNR.

Eskom periodically experiences problems with a high turnover of staff including engineers, operators and technicians. Since 2014 there have been instances where specialised staff left Koeberg NPP for lucrative international new build options. The impact has been effectively managed as required. Intervention strategies include the recruitment of learners into apprenticeship programmes as well as operator and radiation protection trainee programmes. Most recently (2016), 100 learners commenced training in the learnership programme. Additionally, a second full scope simulator has been commissioned to support Koeberg's engineering and operator training programmes.

The NNR is satisfied that all safety-related work is performed by competent individuals. However, as this issue has the potential to impact on nuclear safety in the long run, the NNR will continue to monitor staffing and competency levels at Koeberg NPP.

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

Changes to article 12 are limited to minor editorial improvements.

12.1 Requirements on human factors and organisational issues

[Overview of the contracting party's arrangements and regulatory requirements to take human factors and organisational issues into account for the safety of nuclear installations]

Human factors influence all aspects of safety, not only in operations but also in maintenance and engineering, as human error could directly affect the safe operation of the plant. The requirements to take human factors and organisational issues into account for the safety of nuclear installations are covered by the requirements on management of safety (section 13). RD-0034 [4.5] details the requirements for a process-based Integrated Management System (IMS) for licensees, licence applicants, designers and suppliers involved in the operation, modification or application of a nuclear licence for a nuclear installation in South Africa under the NNR Act, and addresses:

1) A multilevel-concept approach for an Integrated Management System.
2) Quality and safety management requirements to ensure that safety is appropriately taken into account in all activities and decisions by licensees, designers and suppliers, in the operation, modification or application of a nuclear installation licence.
3) Principles for safety culture implementation in the respective organisations.

12.2 Human factors in the design and modifications

[Consideration of human factors in the design of nuclear installations and subsequent modifications (see also Article 18 (3) of the Convention)]

The requirements to take human factors and organisational issues into account for the design and modification of nuclear installations are covered by the requirements on management of safety (section 13).

Design changes or modifications to be implemented are reviewed to ensure that the end user is taken into consideration. A design checklist ensures that the designer takes human-factor engineering into account.

12.3 Human error in operation and maintenance

[Methods and programmes of the licence holder for analysing, preventing, detecting and correcting human errors in the operation and maintenance of nuclear installations]

12.3.1 Analysis

12.3.1.1 Root cause analysis and trending of human errors

Eskom uses an electronic problem management system to provide a comprehensive database, ActionWay, 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 creation of a safety culture. Human performance errors are analysed according to specific event codes, for example, communication, management, skills, rule adherence and knowledge. Each of these is further analysed in various subcategories to define specific areas of concern. The development of any trends based on event codes is identified. A station trend report is compiled on a quarterly basis.

12.3.1.2 Safety culture analysis

Safety culture assessments are performed on an annual basis to assess the health of the safety culture across the station, and nuclear safety awareness seminars are conducted to promote improvements in the safety culture.

12.3.1.3 Human Reliability Analysis (HRA)

Human Reliability Analysis methods are applied at Koeberg NPP, as part of the probabilistic safety assessment (PSA) methodology, to identify human actions that can have an effect on system reliability or availability. Level 1 HRA deals with actions conducted Pre Core Damage and Level 2 HRA deals with the actions Post Core Damage. The outcomes of the PSA are benchmarked against other international PSA studies.

12.3.1.4 Man–machine interface

The discrepancies between human capabilities and the demands of the working environment are investigated and minimised through 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. 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 [6.1] are adhered to. On an installation-wide level, the enhancement of user familiarity with plant equipment is actively encouraged. (Refer to section 18.3 for a further discussion of man–machine interface considerations in plant design changes).

12.3.2 Prevention

Human related errors that may affect the safe operation of the plant are kept to a minimum through continuous training efforts, use of procedures, and error reduction techniques, which are used to ensure the reliability of all actions by plant personnel responsible for operating and maintaining the plant.

Operator actions in support of safety are feasible and properly supported through procedures and continuous training. The operators are expected to use the correct Human Performance Tools, which include three-way communication, self-checking, first check, place keeping, peer checking and pre-job briefing.

Knowledge of, and the use of operator fundamentals (the basics of operating), is also a management expectation and forms part of the operator training programmes.

Training of operating, engineering and maintenance personnel is used to emphasise the maintenance and improvement of personnel knowledge. Ongoing training becomes necessary when work conditions change and operating experience and lessons learned need to be conveyed. In maintenance, the work packages are governed by procedures that expect adherence to human performance error-reduction tools. Supervisors perform pre-task walk-throughs and assess potential error traps by using the TWIN[1] analysis principle. During training, maintenance personnel have to demonstrate the use of Human Performance Tools. In operations, the actions that are required to be performed in the control room are regularly rehearsed during training exercises. The application of the Human Performance Tools is expected and will be adhered to.

12.3.3 Detection

Identification of human errors and potential human errors is achieved through a combination of various methods. Operational experience is continuously investigated by means of condition report analyses for installation incidents and non-conformances. Safety culture assessments on the other hand, provide 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 requalification 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.

12.3.4 Correction

The identification and implementation of appropriate corrective actions are based on the feedback from operational experience, the results of performance monitoring and human error analyses, as well as the training department and incident investigation committees of the nuclear installation. Requalification training for licensed operators and non-licensed operators provides ongoing correction and enhancement of operating skills.

12.4 Self-assessment of managerial and organisational

[Self-assessment of managerial and organisational issues by the operator]

The self-assessment programme is a way for the organisation to identify potential issues before they result in an event and to conduct investigations into their causes, so that corrective and restorative actions can be taken. It is a line-owned process that follows a structured approach to assessing the effectiveness of programmes, processes, or performance against specific criteria. It is also a management tool, and managers have ownership of the process. Self-assessment is performed for the following reasons: to identify gaps between current performance and excellence; to improve safety, reliability and regulatory performance; to reduce costs; and to verify effectiveness of corrective actions.

The managerial structure of Eskom 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 fulfil these

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[1] TWIN is a memory aid that stands for **t**ask demands, **w**ork environment, **i**ndividual capabilities, and human **n**ature

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 from 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 Eskom independent corporate safety group, the Nuclear Safety Assurance (NSA) group (previously known as the Generation Nuclear Safety and Assurance group), has been operational for approximately 14 years and has positively contributed to the enhancement of the overall licence holder nuclear safety governance and to a more efficient and focused interface with the NNR.

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

12.5 Experience feedback on human factors and organisational issues

[Arrangements for the feedback of experience in relation to human factors and organisational issues]

12.5.1 Operating experience feedback

The Operating Experience (OE) group within Eskom is responsible for external experience feedback and the management of the OE system, which includes:
1) Endorsement by station management of all Corrective Actions (CAs) at a Corrective Action Review (CAR) meeting;
2) Tiered approach to event investigations;
3) Reporting of world events to the organisation;
4) WANO cause categorisation;
5) Off-site reporting guidelines; and
6) Prioritisation of all CAs.

All significant operating event reports (SOERs) received from WANO and INPO are formally tracked and generic studies by EDF are processed via CAR meetings to formalise a Koeberg position. Event reports from the Nuclear Energy Agency (NEA)/IAEA Incident Reporting System (IRS) are scrutinised for lessons learned from feedback of international operational experiences.

12.5.2 Performance objectives and criteria

Performance objectives and criteria are designed to promote excellence in the operation, maintenance, safety and support of nuclear power stations.

Operating experience criteria are as follows:
1) Managers are appropriately involved in promoting and reinforcing the use of OE through activities.

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

12.6 Regulatory review and control activities

The NNR has overall independent responsibility for the licensing of the installation's reactor operators. This is detailed in several regulatory documents that form an integral part of the conditions of the nuclear installation licence [4.2 to 4.3].

All radiation workers, including reactor operators, are subject to the requirements of a medical and psychological surveillance and control programme implemented at the installation. The NNR exercises oversight over the programme and utilises the services of consultant medical and psychological experts, as the need arises, to provide independent advice, monitoring and evaluation of nuclear installation staff.

As part of the programme, Eskom conducts an initial psychological assessment of candidate reactor operators and ongoing psychological monitoring of licensed reactor operators. Every six months, Eskom produces a psychological monitoring report that is evaluated by the NNR.

In the Second Periodic Safety Reassessment (SRA II) of Koeberg NPP, the NNR required that the Human Factors Review incorporate the human factors engineering aspects of process control and maintenance. The first aspect required a comprehensive Human Factors Engineering Control Room Design Review that incorporated control room habitability aspects. The second entailed an assessment of the safety and reliability aspects of human performance in maintenance activities.

The reassessment concluded that the methods and programmes for analysing, preventing, detecting and correcting human errors in the operation and maintenance of Koeberg NPP comply with accepted good practices when benchmarked against international standards, and that appropriate consideration of human factors has informed the design of Koeberg and subsequent modifications to the installation.

ARTICLE 13: QUALITY ASSURANCE

Each contracting party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented, in order to provide confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

Summary of changes

Article 13 has been updated in terms of:

1) The regulatory requirements documents for quality assurance and quality management (13.1); and
2) Audits of vendors and suppliers by licence holders (13.5).

13.1 Requirements on quality assurance programmes

[Overview of the contracting party's arrangements and regulatory requirements for quality assurance programmes, quality management systems, or management systems of the licence holders]

One of the principle nuclear safety requirements in section 3.10 of the Safety Standards and Regulatory Practices [1.7] is that a quality management programme be established, implemented and maintained in order to ensure compliance with the conditions of the nuclear authorisation. This safety requirement, related to the licence holder's quality assurance responsibilities, was issued as licence requirements in LD-1023 [4.4], and further entrenched in the Requirements Document RD-0034 [4.5], which was issued in 2012. In terms of these documents, the implementation of a safety management system, including a quality management programme, is required to provide adequate confidence in the validity of the operational safety assessment and safety assurance processes. A written policy stating the quality objectives to be attained during various stages of the installation's life, is required and has been provided by the licence holder.

13.2 Status of implementation of holder integrated management systems

[Status with regard to the implementation of integrated management systems at nuclear installations]

Eskom's quality management and operational quality assurance (QA) programmes presently satisfy both the international standards and codes and those of the NNR.

In preparation for a nuclear expansion programme, Eskom has established a Nuclear Division within which safety and management systems have been developed. The documentation is based on ISO 9001:2008, supplemented by ASME NQA-1 [6.4] and IAEA document GS-R-3 [5.13]. The safety and management systems are also compliant with the NNR's Requirements Documents LD-1023 [4.4] and RD-0034 [4.5].

13.3 Main elements of quality assurance programmes

[Main elements of a typical quality assurance, quality management or management system programme covering all aspects of safety throughout the lifetime of the nuclear installation, including delivery of safety-related work by contractors]

Eskom's QA programme, including the Quality Policy Directive is specified in the Safety and Quality Management Manual of its Nuclear Division. Oversight of the operations is provided by the QA programme of Koeberg NPP. This programme is based, as a minimum, on the IAEA Safety Code 50-C/SG-Q and the licensing requirements as per NNR documents LD-1023 and RD-0034. The Eskom Nuclear Division Safety and Quality Management Manual is also used as a basis for the QA programme.

Eskom follows a national system of certification of auditors, which is aligned with international certification systems. A formalised training programme is in place to facilitate certification. Auditors are required to have previous experience in the core functions of the nuclear installation and/or nuclear-specific training in plant operations and nuclear fundamentals. The composition of audit teams ensures that qualified auditors are responsible for the execution, while making allowance for training of unqualified auditors.

Achievement and maintenance of quality are verified by means of audits, reviews and surveillances. These are conducted in accordance with authorised procedures and are performed by certificated auditors, using approved checklists. Personnel performing QA monitoring activities are independent of direct responsibility for the activity being monitored.

QA Monitoring Activity 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 reports of monitoring activities are maintained as quality assurance records. The QA monitoring activity results are also recorded on an electronic database.

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

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

13.4 Audit programmes of the licence holders

Eskom has established a comprehensive audit programme of planned, periodic monitoring for the nuclear installation to conform to the NNR's licensing requirements. This programme is informed by indicators, which include audit findings, inspection non-compliances, operating experience and problem reports. The audit programme is discussed with the NNR and takes into account the Regulator's planned audit and inspection programme to ensure that an integrated monitoring programme is established.

The QA monitoring programme for Koeberg NPP is developed in accordance with the regulatory requirements in consultation with the NNR. It covers, inter alia, the following areas:

1) Radiological protection programme;
2) Maintenance programme;

3) Conformance to Operating Technical Specifications;
4) In-Service Inspection Programme;
5) Radioactive waste management and effluent discharge control programme;
6) Chemistry programme;
7) Nuclear engineering design and modification programme;
8) Emergency plan;
9) Physical security system;
10) Civil works monitoring programme;
11) Environmental surveillance and meteorological programme;
12) Fuel integrity evaluation, storage, handling and transportation;
13) Fire prevention and protection plan;
14) Training/qualification of operating and technical staff;
15) Quality activities and functions of the management programme (including control of deficiencies and corrective actions);
16) Documentation and records system; and
17) Compliance with risk assessment and safety criteria of the NNR.

13.5 Audits of vendors and suppliers by the licence holders

Vendors are classified according to a three-tier quality level system based on the services or products being provided and the safety and quality classification of the affected structures, systems and components (SSCs), as described in regulatory guidance document RD-0034. Safety-level one vendors (high importance to nuclear safety) are required to have a nuclear safety culture programme in addition to ISO 9001 as basis and other pertinent nuclear QA criteria and regulatory requirements.

13.6 Regulatory review and control activities

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

1) Corrective action close-out;
2) Incidents and problems notifications;
3) Audit findings;
4) Non-conformance reports; and
5) Work orders.

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

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

Audit findings and concerns are used as input to the utility’s safety indicator systems. The indicators are used to prioritise future monitoring activities.

During plant refueling outages, Eskom generates a dedicated surveillance programme, which is designed, implemented and controlled by its Quality Assurance Department. NNR inspectors identify those surveillance activities that are of importance to monitor and observe. Results of these surveillances are reviewed by the installation's Operations Review Committee, responsible for identifying concerns, and initiating appropriate corrective actions.

In terms of the requirements of the NNR Act, the NNR-appointed inspectors are required to be trained and certificated. This training and certification is carried out according to a modular Inspector Training Programme. The modules cover the legislation and associated regulations, basic inspection techniques and reporting, and a facility-specific training module.

ARTICLE 14: ASSESSMENT AND VERIFICATION OF SAFETY

Each contracting party shall take the appropriate steps to ensure that:

1) 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.
2) 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 within operational limits and conditions.

Summary of changes

Article 14 has been updated in terms of:

1) Regulatory requirements for periodic safety assessments (14.1.3.1);
2) Baseline risk graphic for Koeberg (14.1.3.2);
3) Koeberg second periodic review (14.1.3.3);
4) Implementation of improvement actions identified as part of Fukushima safety reassessments (14.1.4.3);
5) Regulatory requirements (14.2.1);
6) Status of reactor vessel surveillance programme (14.2.4);
7) Risk insights in decision-making (14.2.2.8); and
8) Ageing management programme (14.2.3).

14.1 Assessment of safety

14.1.1 Requirements on safety assessment

[Overview of the contracting party's arrangements and regulatory requirements to perform comprehensive and systematic safety assessments]

The NNR Act stipulates that any person wishing to site, construct, operate, decontaminate or decommission a nuclear installation must apply to the NNR for a Nuclear Installation Licence.

The fundamental criteria and principles that must be met to ensure safety in any nuclear installation are legislated in the Regulations on Safety Standards and Regulatory Practices (SSRP) [1.7]. Requirements with respect to nuclear safety assessments for siting, design, construction, and operation are presented in section 3.3 of the SSRP, which stipulates that a prior safety assessment must be performed that is suitable to identify all significant radiation hazards and that evaluates the nature and expected magnitude of the associated risks. Measures to control the risk of nuclear damage must be determined on the basis of this safety assessment. Dose and risk limits are prescribed by this legislation.

The NNR has issued requirements and guidelines [4.1–4.9] that are established to fulfil the principles contained in the SSRP. The design of the facility and the measures taken to ensure compliance to the legislated requirements are described in the Safety Analysis Report (SAR). The SAR has to comply with the contents of the various requirements documents and is submitted to the NNR as part of the application process of the Nuclear Installation License for the operation of a new nuclear facility.

The fundamental criteria referred to above include limits on the annual risk or dose to members of the public and workers due to exposure to radioactive material as a result of accident conditions or normal operations.

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

An installation description and documentation relating to compliance with the safety standards are provided in the Koeberg SAR. The Koeberg SAR is required to be maintained in a current state, in line with international norms and practices.

The implementation of these requirements is through the conditions of the Koeberg nuclear installation licence, which requires that any plant and process changes affecting safety-related systems, components and activities are approved by the regulatory body, prior to implementation.

The licensee's modification standards, approved by the regulatory body, require proper design, independent review, control and implementation of all permanent and temporary modifications, as well as the appropriate review of the safety analyses that have been performed before the installation of the modification is put in place.

The nuclear installation licence requires that all modifications to the installation or any of the operating, maintenance and testing procedures be assessed in terms of both their impact on deterministic aspects of the safety analyses and on risk. By doing so, 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.

Regulations on the siting of new nuclear installations (R.927) [1.8] require that, in terms of section 21 of the Act, the applicant for a nuclear installation licence for the siting of a nuclear installation must submit, in support of its application, a Site Safety Report (SSR) to the Regulator.

14.1.2 Safety assessments for different licensing stages

[Safety assessments within the licensing process and Safety Analysis Reports for different stages in the lifetime of nuclear installations (e.g. siting, design, construction, operation)]

14.1.2.1 General requirements

For nuclear installations, the following safety assessments are required:
1) Safety assessment for site licence;
2) Safety assessment for authorisation to manufacture components;
3) Preliminary Safety Analysis Report for a construction licence;
4) Safety Analysis Report for an operating licence;
5) Safety assessments for modifications;
6) Safety assessments for nuclear authorisation changes (e.g. changes to licence-binding procedures);
7) Safety assessments for new safety issues;
8) Periodic safety assessment; and
9) Safety assessment for decommissioning.

Guidelines are provided in licencing document LG-1041 [4.8].

14.1.2.2 Site licence

The applicant for a nuclear installation licence for the siting of a nuclear installation must submit, in support of its application, a Site Safety Report to the Regulator in conformance with the siting regulation [1.8].

14.1.2.3 Authorisation to manufacture components

For an authorisation to manufacture components, the applicant is required to conform to quality and safety management requirements [4.5], and, with regard to safety assessment aspects, to provide the following:
1) Safety assessment;
2) Detailed design of the components;
3) Justification of the design specifications, in relation to the safety assessment;
4) Justification of compatibility and interfaces of the components with the installation; and
5) Classification (safety, quality, seismic and environmental) process or processes.

14.1.2.4 Design and construction

With regard to safety assessment aspects for an authorisation to construct a nuclear installation, the applicant is required to provide a preliminary Safety Analysis Report and Site Safety Report, accompanied by the following:

1) Topical reports;
2) Safety classification document;
3) Quality and safety management documentation;
4) Preliminary probabilistic safety assessment (PSA);
5) Preliminary emergency plan;
6) Nuclear security plan;
7) Arrangements for regulatory control;
8) Commissioning plan; and
9) Decommissioning strategy.

14.1.2.5 Initial operation

For an authorisation to operate a nuclear installation, in terms of the safety assessment aspects, the applicant is required to provide a SAR, SSR, PSA [4.1], quality and safety management documentation [4.5], and a commissioning programme with results according to hold-and-witness points established in agreement with the Regulator.

14.1.2.6 Operational safety assessments

The holder of a nuclear installation licence is required to document and implement a methodology to maintain the validity of the safety assessment, including the PSA, on an ongoing basis, addressing any issue giving rise to changes in safety, and shall include the identification of those changes requiring submission of a safety case, including a PSA [4.1], to the Regulator.

The holder is required to implement a system of risk management to ensure that the nuclear installation is operated in conformance with the risk criteria given in the regulations on safety assessment [1.7].

14.1.3 Periodic safety assessments of nuclear installations

[Periodic safety assessments of nuclear installations during operation, using deterministic and probabilistic methods of analysis as appropriate, and conducted according to appropriate standards and practices]

14.1.3.1 Regulatory requirements

The holder is required to conduct systematic, periodic safety reassessments of the nuclear installation throughout its operational lifetime, at a frequency acceptable to the Regulator, taking into account the operating experience and significant new safety information from relevant sources.

The holder is required to use the periodic safety reassessment to determine the extent to which the existing, current licensing basis remains valid as well the adequacy and effectiveness of the provisions that are in place to ensure plant safety until the next PSR or until the end of planned operation.

The periodic safety reassessment must take into account the actual status of the plant, operating experience, predicted end-of-life state, current analytical methods, applicable safety standards and current state of knowledge. On the basis of the results of the periodic safety reassessment, the holder shall implement reasonably practical corrective actions, modifications and safety improvements for compliance with applicable standards and internationally recognised best practices.

As indicated in section 7.2.1.3, the NNR has initiated the process to revise its current suite of regulations and has submitted these revised regulations to the Minister of Energy for promulgation. These regulations have been revised to include requirements on the standards to be used for the periodic safety review and the implementation of reasonably practical safety improvement measures.

14.1.3.2 Koeberg first periodic safety reassessment

The first Periodic Safety Reassessment of Koeberg NPP commenced in April 1995 and was submitted to the NNR in December 1998. The NNR completed its review in July 1999. Eskom submitted the close-out report in October 2011. This was reviewed by the NNR and accepted in January 2013. The 1995 revision of the EDF family of French nuclear power plants' CP-1 safety referential was used as a benchmark. The reassessment identified a number of plant improvements that were necessary to bring the level of safety of Koeberg to a comparable level to that of the CP-1 reference. However, it was recognised that following the next ten-year safety reassessment, a further batch of modifications would need to be implemented in order to maintain a comparable level of safety with the CP-1 reference, which in turn was being subject to ongoing safety upgrades.

Eskom took a strategic decision to aim for a closer alignment to the CP-1 hardware referential. Over and above the modifications identified from the safety reassessment, additional plant modifications (79) were identified for implementation. These were selected to provide strategic benefits in terms of sustaining an acceptable and demonstrable level of nuclear safety for the remainder of the operational life of Koeberg NPP, and to maximise business and safety benefits of the support contract Eskom has with EDF. The premise was that safety issues affecting Koeberg NPP can be resolved in a similar manner to which EDF resolves the same issues for the CP-1 plants.

Over the following ten years, the so-called CP-1 modifications were implemented in phases. These included:

1) Improvements to the plant to align the General Operating Rules;
2) Containment safety enhancement (improve system isolation potential, ventilation system, measuring of activity and improvements in system leak tightness);
3) Equipment qualification (seismic and/or environmental qualification of equipment identified as essential during an incident to ensure safe shutdown of the reactors);
4) Reliability enhancement (reliability of the plant systems by improving system start-up times, improving the control function of the systems, and by automating critical actions to avoid functional failure in an accident scenario);
5) Plant operation under accident conditions (operating condition of the power plant under accident operation, and in some instances under normal operation, by installation of: additional plant–operator interface equipment, a safety parameter display console, equipment to prevent accident conditions from arising, and equipment to prevent human error that may have adverse consequences);
6) Protection against hazards (protection against high-energy pipe breaks, internal flooding, earthquakes for passive equipment and fire); and

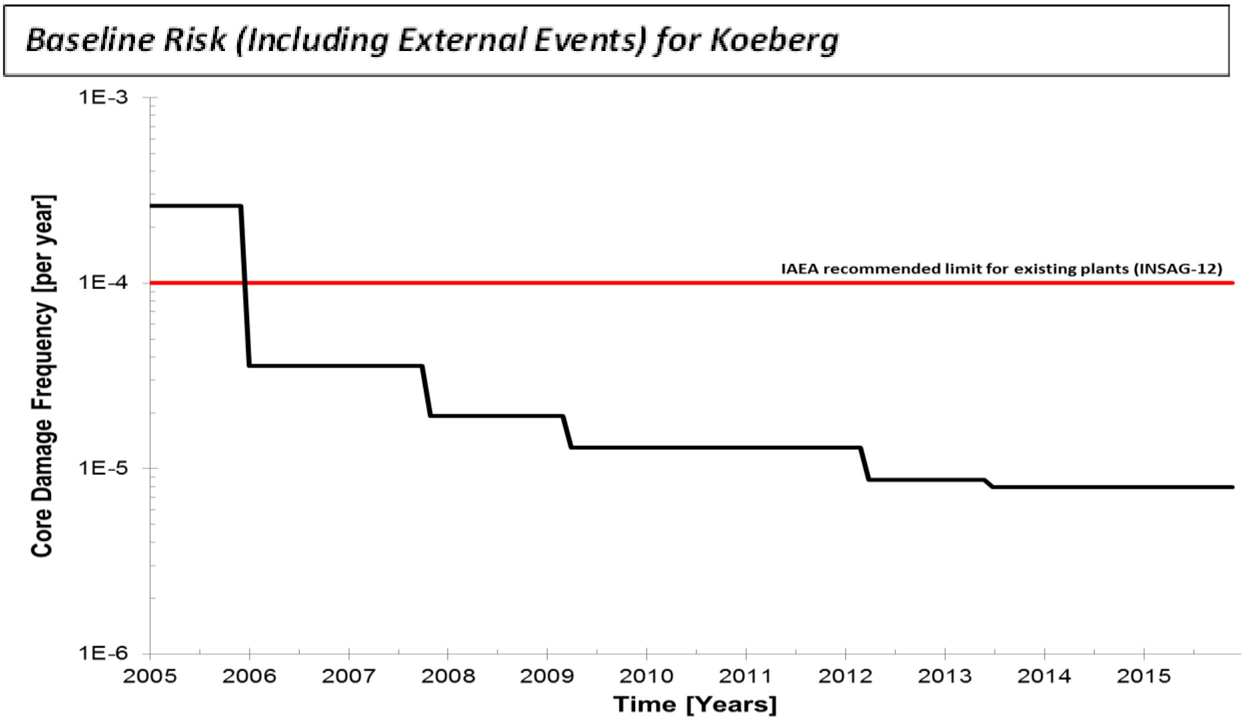
7) Modifications identified by EDF during their second safety reassessment (VD-2).

The improvements in safety over this period were quantified from ongoing probabilistic risk assessments, in terms of core damage frequency, as shown in the diagram below. Large early release frequencies follow a similar trend.

Some 800 modifications and safety improvements implemented on EDF CP-1 plants (lot 93 and so-called VD-2 scope of modifications) were reviewed for applicability to Koeberg NPP. Of these, 500 differences were identified. Following screening analyses, detailed assessments were performed for 140 differences, resulting in 600 individual close-out actions being identified. Of these, nine issues were ranked of 'medium' safety significance, and 105 ranked 'low'. Overall, 79 modifications were identified for implementation.

The need for rules for accident analysis was identified. The Accident Analysis Manual (AAM) [4.11] was developed and updated in preparation for future projects. The rules address both design basis and beyond design basis accidents.

The NNR concluded that the main objectives of the Koeberg Safety Reassessment (KSR) project were achieved and that continued operation of the plant was justified. This programme of improvements has since been implemented.



14.1.3.3 Koeberg second periodic safety reassessment

The second safety reassessment commenced in 2008, once the scope of the assessment was agreed upon by Eskom and the NNR.

The review methodology was largely based on comparison with the latest EDF CP-1 safety referential, with a focus on any safety changes EDF had made since the 1995 revision of the referential, which was used as the benchmark for the first periodic safety reassessment.

The scope was based on IAEA guide NS-G-2.10 [5.14]. In addition, a global cross-functional review was undertaken by EDF that included a benchmarking exercise with EDF CP-1 plants in terms of the so-called VD-3 scope of modifications conducted on the French plants.

The scope of the Koeberg NPP second periodic review included the following:

1) Plant design;
2) Actual condition of structures, systems and components;
3) Equipment qualification plant;
4) Ageing (focus area);
5) Deterministic safety analysis;
6) Probabilistic safety assessment;
7) Hazard analysis;
8) Safety performance;
9) Use of operating experience;
10) Organisation and administration;
11) Procedures;
12) Human factors;
13) Emergency preparedness; and
14) Radiological impact.

A number of plant hardware and programmatic improvements have been identified and these are being implemented in accordance with an agreed schedule. Significant hardware modifications include the replacement of safety injection system valves to alleviate a risk of blockage of the high head safety injection system due to possible debris present in the containment sump, and a modification to avoid the risk of an overflowing steam generator during a steam generator tube rupture accident.

Modifications and procedural updates are recommended to mitigate the risk of a hydrogen explosion. The accident studies should also be reanalysed and the scope of accidents increased using more up-to-date methodologies and assumptions. The Site Safety Report needs to be updated to incorporate the latest analytical methodologies.

The assessment was completed in October 2011. Eskom has started the implementation of some of these recommendations and modifications. The accident analysis is being redone as part of the steam generator replacement project. Site Safety Report has been updated, except for the seismic analysis chapter, and is currently under review with the Regulator. The update to the seismic chapter is in progress.

14.1.4 Overview of safety assessments

[Overview of safety assessments performed, and the main results of those assessments for existing nuclear installations, including the summary of significant results for individual nuclear installations, not only according to their type and generation]

14.1.4.1 Koeberg first periodic review

Refer to section 14.1.3.2.

14.1.4.2 Koeberg Second Periodic Safety Reassessment

Refer to section 14.1.3.3.

14.1.4.3 Reassessment of Koeberg NPP following the Fukushima accident

A summary of the post-Fukushima reassessment of Koeberg NPP is given below. Further details are given in Annexure D3.

Following the Fukushima accident on 11 March 2011, the NNR established a task team in April 2011, and in May 2011 directed Eskom to reassess the capability of Koeberg NPP to withstand external hazards, specifically regarding the following:

1) Compliance to the current design basis for external events;
2) Stress tests (robustness against external events beyond the design basis); and
3) Adequacy of accident management and emergency planning.

Eskom had previously established an External Events Review Team (EERT) and had begun implementing guidelines issued by INPO and WANO, focussing on the above aspects, but predominantly addressing plant equipment, people, procedures and nuclear safety culture. The EERT approach was to assess operability determinations, temporary alterations and the plant readiness, through a review of system health indicators as well as all non-conformance reports.

In parallel, the 5th International Convention on Nuclear Safety (CNS) Meeting took place in April 2011 to formulate an international response to the Fukushima accident. The NNR directive and the Eskom response covered all the requirements proposed by the CNS.

Eskom submitted their safety reassessment report in December 2011.

The scope of the reassessment covered the design basis (reactor and spent fuel storage) in terms of external events and combinations of events, as well as the robustness of the facility and cliff-edge effects for a similar scope of beyond design basis events. These include prolonged total loss of electrical power and ultimate heat sink. Measures or design features to mitigate these effects were identified. The scope included on-site and off-site aspects of accident management and emergency response.

The NNR completed the review of the report in March 2012, concluding that the reassessment did not reveal any major shortcomings in the safety of Koeberg NPP in respect of external events. However, a number of modifications and operating procedure changes to further improve safety were identified, as well as additional studies beyond the current design basis.

Koeberg NPP was one of the first nuclear power plants to implement Severe Accident Management Guidelines (SAMGs), and the NNR is the first regulator to include these in the regulatory process. These guidelines were updated following the Fukushima event. The NNR has consistently enforced conservative emergency planning zones around Koeberg, informed by risk analysis, beyond what has been internationally required until now. The NNR has also consistently applied restrictions on developments in the formal emergency planning zones of Koeberg, also informed by risk analysis, beyond present international requirements. To date, the City of Cape Town Disaster Management and Spatial Planning authorities have been supportive in this regard.

The NNR finalised the South African National Report [3.5], which was submitted to the IAEA for the Second Extraordinary Meeting of the CNS held in August 2012.

The NNR position may be summarised as follows:

1) The assessments conducted by Eskom conform to the NNR directive and are in accordance with (and in excess of the scope of) international practice.
2) The nuclear installations are adequately designed, maintained and operated to withstand all external events considered in the design basis.
3) There were no findings to warrant curtailing operations, or to question the design margins of these facilities.
4) The safety reassessments identified a number of potential improvements to further reduce risk beyond the design requirements.
5) The NNR has identified areas for improvement of the Safety Standards and Regulatory Practices which have been included in the revision and update of the regulations. These regulations are currently with the Minister of Energy for promulgation.

Improvements to the regulations relate to:

1) The robustness of the design as well as emergency response and accident management facilities against external events;
2) Inclusion of design basis extension conditions as part of the design basis of new nuclear installations;
3) Consideration of simultaneous impacts on multiple facilities on the site;
4) Reliance on off-site services in the short term is not permitted; and
5) Testing and inspection of equipment credited in accident management.

Eskom has subsequently updated the report and submitted a fourth revision of the External Events Safety Reassessment Interim Report and associated safety reassessment reports covering additional external events, additional studies, as well as addressing NNR comments. Eskom has also submitted a strategy for maintenance and testing of equipment needed to respond to beyond design basis accidents. The NNR has reviewed and commented on these submissions.

In the meantime, Eskom has implemented a number of short-term corrective actions, such as portable equipment (e.g. pumps, power supplies, communication equipment, etc.), and has communicated additional short-term actions to the NNR to be implemented during 2013, 2014 and 2015 (including for example, portable back-up water sources, tank strengthening or extension, portable back-up water connections, portable emergency equipment storage facility, hardened instrumentation to monitor critical plant parameters, mobile diesel generator connection points, and electrical connection points for mobile electrical supply).

In line with progress made internationally, Koeberg NPP now has all the equipment required in order to sustain an extended loss of all AC power for at least two weeks, without off-site support. Eskom has furthermore expanded the firefighting capabilities and the ability to access the buildings where ground floor access might be inhibited. This is achieved through the use of a new ladder turntable vehicle to provide roof access and an elevated firefighting platform. Procedures have been put in place to provide additional configurations and authorised flow paths for mitigating adverse plant conditions following a severe event.

In the longer term Eskom will screen, evaluate and implement the balance of the proposed corrective actions, subject to regulatory review and approval. Overall, long-term external event related projects are expected to be completed by 2022. This work, although related to the Fukushima improvement actions, is in the implementation phase of the safety reassessment process.

14.1.4.4 Design basis accident consequence calculations

Eskom has reanalysed the radiological consequences of design basis accidents (DBAs) using more up-to-date models and assumptions, including the dose contributions from ingestion pathways and from the ground shine and inhalation from the resuspension of deposited radionuclides pathways. Results to date show that the modelled dose results for all DBAs using the PC Cosyma code deterministically comply with the current Koeberg SAR dose criteria.

For the steam generator replacement project, Eskom will be revising the DBA dose criteria to reflect a total effective dose equivalent (TEDE) and to be consistent with the IAEA International Basic Safety Standards GSR Part 3 [5.15] that specifies a maximum reference level dose of 100 mSv for sources that are not under control. Eskom will also be updating the DBA consequence analysis methodology to align with the United States NRC Alternative Source Term approach as provided in Regulatory Guide 1.183 [6.5].

14.1.5 Regulatory review and control activities

The NNR reviews the scope, calculation and evaluation methodologies and the safety analyses to verify compliance with the regulations on safety standards and regulatory practices, as well as specific requirements in the conditions of licence, including the international benchmark (French CP-1 safety referential) and other international practice.

The NNR produces a report on the outcome of the reviews performed and uses the results of the periodic review to consider any regulatory action, such as directives to resolve issues, restrict or curtail operation.

The NNR also reviews the corrective action plan and follows up on the implementation thereof.

14.2 Verification of safety

14.2.1 Regulatory requirements for verification of safety

[Overview of the contracting party's arrangements and regulatory requirements for the verification of safety]

The SSRP requires that operational safety-related programmes, limitations and design requirements be established on the basis of the operational safety assessment. The SSRP further requires that an appropriate maintenance and inspection programme be established. The maintenance and inspection programme must ensure that the reliability and integrity of installations, equipment and the plant are commensurate with the dose and risk limits. RD-0034 also requires that these programmes be periodically reviewed and updated according to the design specifications and applied codes and standards to maintain the reliability of the product according to its safety classification throughout service.

The Koeberg Nuclear Installation Licence requires the following operational safety-related programmes for plant condition management at the Koeberg NPP:

1) Maintenance of valid and updated safety and risk assessment;
2) Operating surveillance requirements (including OTS compliance);
3) In-service inspection;
4) In-service testing;
5) Reactor vessel surveillance;
6) Plant maintenance;
7) Civil monitoring;
8) Physical security;
9) Fire safety;
10) Occurrence and incident reporting; and
11) Quality management.

14.2.2 Programmes for continued verification of safety

[Main elements of programmes for continued verification of safety (in-service inspection, surveillance, functional testing of systems, etc.)]

14.2.2.1 Routine ongoing safety review at the nuclear installation

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, Eskom is able to verify that the nuclear installation conforms to applicable criteria of reliability, availability and integrity within the original design requirements.

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

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

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

14.2.2.2 In-Service Inspection Programme (ISIP)

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

The ISIP activities are governed by an In-Service Inspection (ISI) standard, which is approved by the NNR and therefore part of the conditions of the nuclear installation licence. The ISI requirements are primarily derived from the ASME Code, Section XI, Division 1 [6.6] rules as amended for implementation by the United States Code of Federal Regulations, Title 10, Part 50, Section 55a [6.7]. Those examinations that are required by ASME Section XI are addressed in the Basic Scope of the In-Service Inspection Requirements Manual (ISIPRM). Examinations identified to be performed, due to criteria outside of the ASME Section XI, are addressed in the Augmented Scope of the ISIPRM. Augmented ISI requirements may be identified and imposed by the NNR due to industry operating experience, or plant-specific conditions that may challenge the structural reliability of the installation.

14.2.2.3 In-Service Testing Programme (ISTP)

A comprehensive ISTP is developed, implemented and controlled at the nuclear installation. This comprises a programme of examinations and tests conducted on nuclear safety-related plant structures, systems and components to assess the operational readiness of certain components important to nuclear safety.

These requirements apply to:

1) Pumps and valves required to perform a specific function in shutting down the reactor to the safe shutdown condition, in maintaining the safe shutdown condition, or in mitigating the consequences of an accident;
2) Pressure relief devices that protect systems or portions of systems that perform one or more of the three functions mentioned above; and
3) Dynamic restraints (snubbers) used in systems that perform one or more of these three functions, or to ensure the integrity of the reactor coolant pressure boundary.

Testing and examination of the components described above took place during the second interval and was controlled by and documented in the ISIPRM. Revision of the ISIPRM for the third interval included relocating modules related to the in-service testing into the In-Service Inspection Testing Requirements Manual (ISTPRM). Separation of the in-service inspection and in-service testing requirements into different requirements manuals for the third in-service interval followed separation of the ASME codes – ASME Section XI for in-service inspection and ASME OM Code for in-service testing. The ISTP activities are governed by an In-Service Inspection Standard, which is approved by the NNR and therefore forms part of the conditions of the nuclear installation licence. Implementation of the rules of the ASME OM Code is as per limitations and modifications identified in the

United States Code of Federal Regulations, Title 10, Part 50, Section 55a (10CFR50.55a) [6.7].

14.2.2.4 Reactor Vessel Surveillance Programme (RVSP)

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

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

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

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

14.2.2.5 Maintenance and testing programme

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

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

A major emphasis of an ongoing optimisation process, is to determine and to document the basis for maintenance for all SSCs important to nuclear safety and to ensure a dynamic maintenance programme, with controlled changes. This process, which focuses on maintaining the safety-related functional capabilities of SSCs important to nuclear safety, is based on the Reliability Centred Maintenance (RCM) philosophy and principles. As part of this approach every change in the maintenance basis (maintenance scope or frequency) is to be based on a justification by utilising sound engineering practice. The entire process is to be monitored by a system–component failure and reliability monitoring programme that will 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 or potential 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 will be assessed by reviewing the trends of functional failures that can be prevented through maintenance.

14.2.2.6 Occurrence and incident reporting programme

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

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

14.2.2.7 Quality assurance inspections and audits

A systematic programme of inspections and audits is carried out by Eskom. Areas to be inspected or audited are selected on the basis of operational feedback and safety significance in terms of compliance with the Safety Standards and Regulatory Practices and installation safety. The outcome of the inspections or audits may result in corrective action by Eskom and will also feed back into the risk assessment process. Refer to Article 13 for more details.

14.2.2.8 Risk insights in decision-making

It is a principal radiation protection and nuclear safety requirement that the nuclear installation demonstrate compliance with the risk limits of the SSRP.

Thus it is a requirement of the nuclear installation licence for the Koeberg NPP that its safety assessment must include a probabilistic safety assessment for the demonstration of compliance with these risk limits. In compliance with the regulatory requirements, Eskom has developed and maintains a PSA for the Koeberg NPP.

In order to ensure validity and accuracy, a comprehensive comparison of the Koeberg PSA against internationally recognised standards was completed as part of the Koeberg Periodic Safety Reassessment, as reported in 14.1.3. This process identified some improvements to be made to the Koeberg PSA 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 and continues to be updated with plant modifications, procedure changes and reliability data.

The Koeberg PSA is extensively used in decision-making where nuclear safety could be impacted. The safety cases for any proposed plant change must include a probabilistic safety assessment. Operating Technical Specification changes are also reviewed using

PSA insights. Other plant applications where risk insights are used include optimisation of outage work schedules, prioritisation of safety modifications and plant maintenance activities.

On a routine basis, precursor analyses are performed on actual operational events and presented to Eskom safety review committees. This facilitates the utilisation of risk insights.

Given the importance and prominence of the PSA in safety decision-making, the PSA has been subjected to a number of reviews as part of the confirmation process that the quality and scope of the PSA is appropriate for its use in risk-informed decision-making.

14.2.3 Elements of ageing management programme(s)

Eskom has elected to follow Électricité de France's ageing management programme combined with its own existing suite of operational and monitoring programmes for Koeberg NPP. An equipment degradation or ageing matrix has been developed for Koeberg from the EDF programme and is being adapted to Koeberg specifics as integrity assessments are performed. In addition to the formalised ageing programme, degradation of the plant's structures, systems and components is being managed within existing processes and procedures that include the maintenance programme, the In-Service Inspection Programme, plant health system reports, life of plant plans, life cycle management programmes and transient monitoring.

The following major components are being replaced as part of the plant's ageing management programme:

1) Eskom is planning to replace the steam generators of both Koeberg units if it is to sustain the plant lifespan, and is currently in the manufacturing and planning phase of this project. The current steam generators contain components (tubing) that are susceptible to corrosion. By 2016, Eskom will be the only nuclear power station in the world still operating with the older type of steam generators. Eskom has specified the rules for undertaking the associated accident studies in line with the latest international practice to form part of this project.
2) The reactor cavity and spent fuel pit cooling system (PTR) tanks, which are susceptible to through wall cracks due to stress corrosion cracking, are being replaced. In view of the premature ageing of the tanks, the NNR issued a requirement to Eskom in February 2011 instructing them to replace the tanks. Eskom has since initiated the replacement and the new tanks are currently under construction on the site. The tanks in their present state do not pose an unacceptable risk as Eskom has been able to maintain their integrity with the approval of the NNR.

The following major components have been replaced as part of the plant's ageing management programme:

(i) The turbine governing and turbine safety systems have been replaced using digital technology.
(ii) The rod control system.
(iii) Low Pressure turbine retrofit.
(iv) Station transformer.
(v) Generator stator rewind.
(vi) Unit 1 reactor pressure vessel head.

14.2.4 Holder's review of safety cases

[Arrangements for internal review by the licence holder of safety cases to be submitted to the regulatory body]

All safety cases to be submitted to the NNR undergo an internal independent review by Eskom. A safety screening, safety evaluation and justification process is followed by qualified and authorised personnel. Prior to submission to the NNR, the safety case and the results of the safety screening, justification and evaluation are presented to the Koeberg Operational Review Committee for approval. On certain occasions it is also presented to the Safety Documentation Review Committee, which is a subcommittee of the Oversight Safety Committee.

14.2.5 Regulatory review and control activities

14.2.5.1 Incident reporting

The SSRP and the conditions of the nuclear installation licence require the licence holder to report events or incidents. Depending on the level of severity the NNR may conduct inspections or investigations accordingly. The NNR also exercises regulatory control by means of approvals, required in terms of the nuclear installation licence, and the compliance assurance inspections programmes outlined below.

14.2.5.2 NNR approval process

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

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

14.2.5.3 Surveillance and Compliance Inspection Programme

A comprehensive Surveillance and Compliance Inspection Programme has been developed by the NNR to ensure compliance with the safety standards and the requirements of the conditions of the nuclear installation licence, and to identify any potential safety concerns. The NNR compliance assurance inspection programme, which is independently implemented by the Compliance Assurance and Enforcement Division of the NNR, is described in section 7.2.3.3.

14.2.5.4 Licensing of control room reactor operators

As indicated in section 11.2.3 and 12.6, the licensing of reactor and senior reactor operators is subject to NNR approval, prior to commencement of duties.

14.2.5.5 International experience feedback analysis

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

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

ARTICLE 15: RADIATION PROTECTION

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

Summary of changes

Article 15 has been updated in terms of:

1) Legal requirements (15.1.1);
2) Dose limits (15.1.2);
3) Main results for doses to workers (15.3.1);
4) Release of radioactive material to the environment (15.3.2);
5) Environmental monitoring (15.3.4); and
6) Regulatory review and control activities (15.4).

15.1 Requirements on radiation protection

[Overview of the contracting party's arrangements and regulatory requirements concerning radiation protection at nuclear installations, including applicable laws not mentioned under Article 7]

15.1.1 Legal requirements

The Regulations on Safety Standards and Regulatory Practices contain specific requirements for all radiological protection aspects, including compliance to radiation dose limits. The regulations ensure that criteria are in place for all radiation protection oversight and authorisation activities and is provided for in section 4.5 of the SSRP that addresses, amongst others, optimisation of protection, dose constraints, annual authorised discharge quantities and dose limitation.

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

Section 4.5.1 of the SSRP requires that measures commensurate with the magnitude and likelihood of exposure are implemented to ensure that the exposures are ALARA. Furthermore, the optimisation of safety must be subject to dose constraint specific to the action. These requirements of the SSRP are implemented through the conditions of the Koeberg nuclear installation licence.

15.1.2 Dose limits

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

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

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

1) An (average) effective dose of 20 mSv per year averaged over five consecutive years (100 mSv in five years);
2) A (maximum) effective dose of 50 mSv in any single year;
3) An equivalent dose to the lens of the eye of 150 mSv in a year (work is currently in progress to implement an equivalent dose to the lens of the eye of 20 mSv per year averaged over five consecutive years, and a maximum of 50 mSv in any single year); and
4) An equivalent dose to the extremities (hands and feet) or the skin of 500 mSv in a year.

Furthermore, the SSRP [1.7] specifies dose limits for: apprentices and students, women, emergency workers, visitors, and non-occupationally exposed workers at sites.

15.1.3 Public exposure

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

For the Koeberg NPP the dose constraint, applicable to the average member of the critical group within the exposed population, is 0.25 mSv per year.

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

The SSRP requires that the magnitude of doses to individuals, the number of people exposed, and the likelihood of incurring exposures must be kept as low as reasonably achievable, while also taking economic and social factors into account.

Section 4.7 of the SSRP [1.7] requires that an appropriate environmental monitoring and surveillance programme must be established, implemented and maintained to verify that the storage and disposal, or effluent discharge of radioactive waste complies with the conditions of the nuclear authorisation.

Section 2.5 of the SSRP specifies that radioactive materials which fall within a Nuclear Installation Licence, Nuclear Vessel Licence or Certificate of Registration may be cleared from further compliance with the requirements of the nuclear authorisation, provided that such materials meet the considerations for exemption, as detailed in section 2.2 of the SSRP, or have been given approval by the NNR on a case-by-case basis.

15.2 Regulator expectations on holder's ALARA processes

[Regulatory expectations for the licence holder's processes to optimise radiation doses and to implement the ALARA principle]

The NNR requires the implementation of an effective operational radiation protection programme, of which the ALARA programme forms part.

Section 4.5.3 of the SSRP specifies that the NNR may, for the purposes of controlling radioactive discharges from a single authorised action, determine source-specific Annual Authorised Discharge Quantities (AADQs) in the nuclear authorisation, which must take into account the dose constraint applicable to the average member of the critical group within the exposed population.

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

15.3 Implementation of radiation protection programmes by the licence holders

15.3.1 Dose limits, main results for doses to exposed workers

[*Observation of dose limits, main results for doses to exposed workers*]

Effective control of occupational exposure requires compliance with the dose limits, together with a system that ensures that all exposures are kept ALARA.

Table 15.3-1 provides information on the occupational doses received at Koeberg NPP. Trends in recent collective doses may be attributed to the increased work scope, completion of a high-volume material inspection programme as part of the ten-year In-Service Inspection Programme, implementation of modifications, rework on active components, and component replacements and additional maintenance due to plant ageing.

The general reductions in the average annual dose to the occupationally-exposed workers over the years, are mainly due to integration of dose management into the work management programme and performance management system at Koeberg NPP. Line groups and departments are successfully managing personnel dose exposure, in accordance with weekly, monthly and annual dose targets. The dose targets are derived in consultation with line groups and departments and daily dose reviews are performed by the ALARA group at Koeberg NPP.

Table 15.3-1: Summary of Koeberg occupational exposure data from 1999 to 2015

Year	No. of individuals exceeding 20 mSv	Annual collective dose man-mSv	Average annual dose to the occupationally-exposed worker mSv
1999	1	1726.4	0.983
2000	0	848.5	0.448
2001	0	2308.4	1.020
2002	0	1585.4	0.750
2003	0	2044.3	0.998
2004	0	860.7	0.471
2005	0	2260.4	0.908
2006	0	1595.5	0.658
2007	0	1471.7	0.5906

2008	0	1498.6	0.5863
2009	0	1482.1	0.5244
2010	0	1035.9	0.3912
2011	0	1066.8	0.3886
2012	0	1533.1	0.5491
2013	0	498.7	0.1949
2014	0	562.7	0.2410
2015	0	2056.3[2]	0.729

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 ALARA target. Table 15.3-1 provides data for the variation of this quantity from 1999 to 2015.

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

15.3.2 Release of radioactive material to the environment

[Conditions for the release of radioactive material to the environment, operational control measures and main results]

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

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

Operational control over radioactive wastes is exercised through the radioactive waste management programme, as required by the SSRP and the conditions of the Koeberg

[2] Two major outages were conducted in 2015

nuclear installation licence. In line with the principle of the National Radioactive Waste Management Policy and Strategy, this programme allows for the identification of all sources of waste, the minimisation and optimisation of waste production, collection, handling, treatment, conditioning, quantification, storage, and transport.

Eskom has implemented a modification to bypass the evaporators in the liquid waste system, and to increase the filtration efficiency by use of a demineraliser. This modification has resulted in reductions in the volume of solid waste produced, as well as the dose resulting from effluent releases. This practice is in line with current international trends to minimise waste volumes. A project to improve the waste treatment plant as well as the efficiency of the existing evaporators is in the feasibility stage, with several options being considered.

The methods of quantification of the radioactive inventory associated with wastes vary according to the waste type. For process wastes comprising spent filters and spent resins, the beta/gamma emitting radionuclide inventory is determined in the drum by measuring the dose rate and assigning the radionuclide-specific inventory using proportionality constants. These constants are derived from measurements of primary coolant activity for a certain period and can only be applied to wastes produced during that period. For concentrates, a sample is taken and analysed for source-term specification by gamma spectrometry. The assignment of non-beta/gamma emitting activity is performed using generic scaling factors. Eskom has adopted the EDF accredited scaling factors. This has been reported in previous CNS reports and the status quo still remains.

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

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 modelling is applicable to a member of the critical group, and as such, provides a suitably conservative measure of possible public exposure. The variation in the public dose is provided by year in Table 15.3-2.

Table 15.3-2: Summary of projected annual public doses due to Koeberg NPP operational discharges from 2002 to 2015

Year	Gas (μSv)	Liquid (μSv)	Total (μSv)
2002	0.190	0.34	0.53
2003	0.339	11.874	12.21
2004	1.062	7.6640	8.73
2005	0.484	5.5025	5.99

2006	0.413	3.6006	4.01
2007	0.939	3.0443	3.98
2008	0.4687	3.8029	4.27
2009	0.2618	4.737	5.00
2010	0.3918	3.1523	3.54
2011	0.2467	2.7165	2.96
2012	0.1816	2.1050	2.29
2013	0.314	0.783	1.10
2014	0.237	1.035	1.27
2015	0.059	1.093	1.15

The annual projected dose arising from effluent discharges from the plant during 2003 was 4.8% of the NNR dose limit, compared to less than 0.54% for 2015. The reason for the decrease in projected dose in recent years can be attributed to the application of the ALARA principles in effluent management.

The variation in the total activity discharged by pathway in each year from 1999 to 2015 is detailed in Table 15.3-3.

Table 15.3-3: Total activity discharged from Koeberg NPP by year (GBq)

Year	Activity in gaseous discharges	Activity in liquid discharges	Total activity discharges
2002	9.81 E+04	2.69 E+04	1.25 E+05
2003	2.63 E+04	2.08 E+04	4.71 E+04
2004	1.01 E+05	2.12 E+04	1.22 E+05
2005	2.81 E+04	1.96 E+04	4.77 E+04
2006	2.26 E+04	1.34 E+04	3.60 E+04
2007	4.79 E+04	3.28 E +04	8.08 E+04
2008	3.00 E+04	3.43 E+04	6.44 E+04
2009	1.65 E+04	2.29 E+04	3.93 E+04

2010	2.43 E+04	3.07 E+04	5.50 E+04
2011	1.45 E+04	4.15 E+04	5.60 E+04
2012	1.08 E+04	2.28 E+04	3.36 E+04
2013	1.92 E+04	3.74 E+04	5.67 E+04
2014	1.48 E+04	2.64 E+04	4.12 E+04
2015	0.30 E+04	1.83 E+04	2.13 E+04

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

15.3.3 ALARA processes

[Processes implemented and steps taken to ensure that radiation exposures are kept as low as reasonably achievable for all operational and maintenance activities]

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 for the formalised system of feedback. The most critical features of the ALARA programme are:

1) The integration of the ALARA checkpoint into the normal system of operational radiation protection. For all job conducted inside the controlled zone, there is an ALARA checkpoint where input is required to ensure the dose is evaluated. This is entrenched in the plant processes such as work control and outage planning but also for procedure reviews and some procedures have hold points or warnings before some steps to include ALARA considerations.
2) A tiered approach to pre-task review based on the anticipated collective dose.
3) 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.
4) 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.

The regulatory body requires that ALARA targets are implemented for public doses. Historical information was consulted in this regard and ALARA public dose targets were established as 10 µSv annually for one outage, and 15 µSv annually for two outages. These are formalised in licence holder procedures. In accordance with Table 15.3-4, it is evident that the annual projected public doses are well below the mentioned ALARA targets for the previous years.

The following operational practices have been implemented at the nuclear installation to reduce occupational exposure ALARA:

1) Operation at reduced temperature (discussed in Article 14).
2) Operation at high pH reduces corrosion and therefore the formation of activated corrosion product radionuclides in the primary circuit.
3) 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.
4) Reactor cavity decontamination reduces the potential for exposure due to resuspension by ventilation air currents causing an internal contamination hazard.
5) Reactor building contamination control during an outage involves de-zoning of the reactor building prior to outage work, confining the contamination to point-of-origin using the step-off pad principle, and an appropriate dress-out policy.
6) Nuclear auxiliary building and fuel building contamination control includes an aggressive decontamination policy, coupled to a valve-tracking programme that identifies leaking valves, implements corrective action, and tracks the effectiveness of the corrective action. The floor surface contamination areas of the nuclear auxiliary building and reactor building have been reduced from 13% to 1%. This is as a result of major attempts at reducing leaks in the plant.
7) Koeberg NPP implemented the practice of injecting Zn into the primary circuit to alleviate or displace activation product contamination in the primary circuit materials.
8) A serious hot spot reduction programme has been adopted by all Koeberg departments. This entails recognising various methods i.e. flushing, cutting or shielding and their consequences and means of improvement.
9) A full radiation worker training simulator has been established at the Koeberg NPP training centre that entails full practical training requirements for radiation workers encompassing step-off pads, waste handling, instruments, access control, dosimetry, etc.
10) Dose management is integrated into the work management programme and performance management system at Koeberg. Line groups and departments have responsibilities and ownership to manage the personnel dose in accordance with weekly, monthly and annual dose targets. The RadPro computer access control system was upgraded to compliment dose management.
11) Replacement of the whole body counter and obtaining an additional whole body counter, which was necessary due to the replacement of obsolete components with newer ones. This upgrade has resulted in more accurate measurements based on the latest international references.
12) The radiation protection access control software and electronic dosimeters were replaced to allow for self-access into radiological controlled zones for general duties. This modification provides better dose management capabilities and dose statistics, and dose estimation tools are readily available to line groups via the intranet dose management website. The access control system is linked to turnstile gates that allow for personnel access into radiological controlled zones after confirmation that the electronic personal dosimeters (EPDs) are fully functional. The EPD system is also linked to the portal contamination monitors at the exit areas to radiological controlled zones. Personnel dose and contamination information is automatically recorded upon exit from radiological controlled zones and downloaded into the RadPro system.

Refer to section 15.3.1 for details on the achievement of ALARA targets for worker doses.

15.3.4 Environmental monitoring and main results

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

The operational environmental surveillance programme provides for the monitoring of any long-term trends in environmental radioactivity as a result of normal reactor operation, and specific increases in radioactivity which may be caused by unplanned releases. While the former aspect addresses the possibility of discerning any undesirable trends in environmental radioactivity levels at an early stage, the latter deals with the means for observing changes caused by unplanned releases. Accordingly, a conservative philosophy was followed in the selection of samples. Sampling sites, as well as the frequency of sampling and 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.

Eskom performed a habitation study in the vicinity around the plant to update current eating habits, pathways of exposure and the environmental source term. This has resulted in an updated and more accurate public dose assessment. The survey was performed by a local university in the vicinity of Koeberg NPP. Information and data were obtained from members of the public about their eating and recreational habits that may result in potential exposure. Radiological environmental surveillance data and radiological monitoring data were combined with the radiological habit survey data taking the aquatic, terrestrial, direct radiation and combined pathways into account in order to review the potential dose to members of the public. The data from the habitation study will be used to update the current model to determine the dose to the most representative individual, subject to NNR acceptance.

From results obtained from the environmental surveillance programme, activity has been detected in lobster, abalone, and white and black mussels. The radionuclides detected in the past included ^{54}Mn, ^{58}Co, ^{60}Co and ^{110m}Ag. The activity concentration of ^{110m}Ag has recently been at reduced levels due to the management of effluent releases and was only detected in mussels while some of the other nuclides have not been detected for some time.

In terms of direct radiation, Table 15.3-4 shows representative average measurements of monthly external exposure at the site boundary, by year, from 2002 to 2015. The data reflect the total external dose recorded at the site boundary, and is used to trend contributions to direct radiation by the nuclear installation. The trend analysis has not revealed any significant changes in the dose rate at any location since the start of operation. Effluent modelling confirms a relatively insignificant external contribution from the plant.

Table 15.3-4: Average monthly TLD exposure measurements at site boundary

Year	Average exposure (µSv)
2002	25.0
2003	26.9
2004	24 (33.5[a])
2005	23.8 (34[a])
2006	23.2 (33.7[a])
2007	22.8
2008	25.9
2009	25.7
2010	25.4
2011	25.7
2012	25.4
2013	23.8
2014	22.3
2015	Not available at time of publishing

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 radiation treatment, who were resident in the area served by the sewage plant. In order to validate this conclusion, the NNR has required Eskom to perform an investigation using data from hospitals in the vicinity to establish whether the assumed link exists.

15.4 Regulatory review and control activities

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

The NNR ensures that licence holder radiation protection staff are involved in the planning stages of modifications and that competent persons review the changes to radiation protection standards, modifications and procedures. All changes to radiation protection standards are reviewed by the Regulator.

The regulatory body participates in the licence holder's scheduled quality assurance audits. 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. The NNR performs independent inspections on the Koeberg Radiation Protection Programme.

Other regulatory activities and initiatives include:

1) Establishment of a National Dose Register and Eskom has participated in a Steering Committee and pilot studies to oversee and upload occupational exposure records.
2) Establishment of a functional and peer reviewed NNR radio analytical laboratory to analyse environmental samples from the Koeberg site and surroundings.

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 regulator.

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 in 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 covers the activities to be carried out in the event of such an emergency.

Summary of changes

Article 16 has been updated in terms of:

1) Legal and regulatory framework (16.1.1);
2) Overall national emergency preparedness, including EPREV mission and upgrading of the Regulatory Emergency Response Centre (16.1.2.2);
3) Classification of emergencies (16.1.3.1);
4) Regulatory review and control activities, including improvements made relating to emergency planning following the Fukushima safety reassessment (16.1.5.3);
5) Nuclear emergency exercises (16.1.5.2); and
6) Arrangements to inform competent authorities in neighbouring states.

16.1 Emergency plans and programmes

16.1.1 Legal and regulatory framework

[Overview of the contracting party's arrangements and regulatory requirements for on-site and off-site emergency preparedness, including applicable laws not mentioned under Article 7]

In terms of the Disaster Management Act (No. 57 of 2002) [1.4], and as amended in 2015 (Act No. 16 of 2015), the Department of Energy (DoE) is also the national organ of state for coordination and management of matters related to nuclear disaster management at national level.

As a signatory to the international Convention on Early Notification in Case of a Nuclear Accident [5.4], South Africa will also notify the IAEA in case of a nuclear accident. The South African Nuclear Energy Corporation has been designated by the DoE as the national competent authority to service this convention and to be the designated contact point, using the 24-hour Necsa Emergency Control Centre.

The NNR Act and regulation No. R.388 (SSRP) [1.7] specify the requirements on emergency planning to ensure effective preparedness and responses to deal with nuclear accidents.

The NNR Act requires that, where the possibility exists that a nuclear accident affecting the public may occur, the NNR must direct the relevant holder of a nuclear installation 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 an emergency plan, insofar as it relates to the relevant nuclear installation. Such an emergency plan must be submitted by the holder of the nuclear installation licence for approval by the NNR.

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

Furthermore, the Minister of Energy may, on recommendation of the NNR 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 the nuclear authorisation in question must implement the emergency plan as approved by the NNR.

In terms of the decision-making arrangements regarding a nuclear accident, the authority to implement on-site protective actions rests with the nuclear installation emergency controller. In terms of the Disaster Management Act, the off-site authorities are required to verify and implement off-site protective actions as recommended by the authorisation holder, in the event of a nuclear accident, according to the procedures laid down in the emergency plan. The NNR Act is in the process of being updated and one of the proposed additional responsibilities of the NNR is to verify recommended protective actions from the facility regarding off-site actions, and also to provide advice to the Minster of Energy during a nuclear emergency.

Requirements on emergency preparedness are documented in regulatory requirement document RD-0014, Emergency Preparedness and Response Requirements for Nuclear Installations [4.7], and are enforced through a condition of the Koeberg nuclear installation licence. The requirements are based on IAEA GS-R-2, Preparedness and Response for a Nuclear or Radiological Emergency Safety Requirements [5.16], and the licence holder is required to comply and demonstrate compliance to the requirements of this document. The NNR has developed regulations on emergency preparedness and response that will supersede RD-0014 and the regulations on the Safety Standards and Regulatory Practices [1.7]. These draft regulations are based on GSR Part 7 [5.17].

As reported in section 7.2.1.1, regulations on monitoring and control of developments in the vicinity of Koeberg NPP to ensure the effective implementation of the emergency plan have been published for comment and are being finalised. One of the requirements is that the municipal authority must develop and maintain a traffic evacuation model, approved by the Regulator, for use in decisions on urban planning.

Regulations on the Siting of New Nuclear Installations (R.927) were promulgated in 2011 [1.8]. These impose requirements with regard to emergency planning zones. The NNR issued a position paper, PP-0014 in 2012 on Emergency Planning Technical Basis for New Nuclear Installations, providing guidance to new applicants on the determination of emergency planning zones. Another Regulatory Guide, RG-0011 Interim Guidance for the Siting of Nuclear Facilities, has been issued as well.

For Koeberg NPP the basis for the emergency planning zones and protective actions as derived from the technical basis, are included in the Koeberg Safety Analysis Report. It is also included in the licensee procedures, as well as the Integrated Koeberg Nuclear Emergency Plan. For effective implementation of the plan, action times are specified for the different protective actions such as sheltering, evacuation, environmental monitoring, etc.

16.1.2 National emergency plan, roles and responsibilities

[Overview and implementation of the main elements of the national plan (and regional plan, if applicable) for emergency preparedness, including the role and responsibilities of the regulatory body and other main actors, including state organisations]

The parties involved with emergency planning are primarily the nuclear installation, the local authorities within the region, the provincial authorities, the national government and the NNR. The affected authorities at national, provincial and local levels have nuclear emergency response plans in place that are exercised on a regular basis. In terms of section 38 (1) of the NNR Act [1.1], the licence holder, Eskom, has to enter into agreement with the relevant municipalities and provincial authorities to establish an emergency plan. The Memorandum of Agreement (MOA) between the three parties was signed in 2004, which specifies provisions for responsibilities, cooperation, resources and financial arrangements. This MOA was reviewed in 2015 and was found to be valid and no changes were made.

The Integrated Koeberg Nuclear Emergency Plan contains the roles and responsibilities in the agreement between the licensee and the relevant municipal and provincial authorities, as well as aspects related to all phases of an emergency. Amongst other things, the plan aims to establish an organised emergency preparedness and response system with a capability for timely, coordinated action by intervening organisations in the event of a nuclear accident, and to describe the capabilities, responsibilities and authorities of intervening organisations. The plan also aims to conceptualise the integration of these activities in the interests of public health and safety.

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

In terms of the Disaster Management Act [1.4], the local authorities are required to mobilise their civil protection capabilities, and to implement protective measures, as recommended. The provincial and national governments are required to provide coordinated support and direction as necessary. Similarly, the relevant local and provincial authorities have established the necessary resources, including emergency control centre capabilities commensurate with their required roles, compatible communication facilities, appropriate monitoring instrumentation and procedures for contamination control at isolation points, and mass care centres, as well as training and exercising programmes. Each national organ of state indicated in the national disaster management framework must prepare a disaster management plan, coordinate and align the implementation of its plan with those of other organs of state and other institutional role players, and regularly review and update its plan.

16.1.2.1 Forums

The Emergency Planning Steering and Oversight Committee (EPSOC) was established with the authorities in the vicinity of the Koeberg NPP, for liaison on emergency preparedness, planning and response. This forum provides direction, steering and oversight relating to development and implementation of emergency preparedness and response plans for Koeberg. The committee meets on a quarterly basis. The meeting is chaired by a representative from the DoE, which is the organ of state responsible for coordination of the National Nuclear Disaster Management Plan.

16.1.2.2 Overall national emergency preparedness

Although the aim of regulatory requirements is to ensure that the formal emergency planning arrangements of the licence holder and local authority would be able to cope with the early and intermediate phases of a major nuclear accident, it is recognised that a national disaster management organisation would be required to manage the late phase, owing to the need for multiparty or multidisciplinary coordination of protective and recovery measures at national level. In the case of a major nuclear accident requiring national response, the Minister of Corporative Governance and Traditional Affairs would declare a national state of disaster, as provided for in the Disaster Management Act. In terms of the Disaster Management Act [1.4], the DoE is obliged to prepare a National Nuclear Disaster Management Plan. This Plan is currently under review.

The DoE is responsible for coordination and management of matters related to off-site nuclear disasters at national level. As per section 25 of the Disaster Management Act, each national organ of state indicated in the national disaster management framework must prepare a disaster management plan, setting out the concepts and principles of disaster management.

The National Infrastructure on Nuclear Emergency Preparedness was reviewed in 2014 through the IAEA EPREV mission made recommendations based on the country's emergency plan and response programmes. Following the EPREV mission the DoE coordinated the development of an action plan to address all the recommendations and suggestions. The implementation of the action plan is being monitored at regular meetings and includes the development of regulatory guidance in certain areas. To this end the NNR has developed and issued RG-0020, Guidance on Emergency Planning and Response for Nuclear and Radiological Emergencies.

The RG specifically addresses:

1) Protection strategies;
2) Hazard assessments;
3) Protection of emergency workers;
4) Radiation monitoring;
5) Agricultural countermeasures; and
6) Termination and post-accident measures of nuclear or radiological emergencies.

Authorisation holders of nuclear installation licenses will be required to review and update their respective emergency plans in accordance with the guidance provided, if required.

The aim is to ultimately have an amended integrated National Nuclear Disaster Management Plan considering both nuclear and radiological emergencies.

South Africa is a member of the Convention on Early Notification and Assistance in Case of a Nuclear Accident (ENAC). The national competent authority and the National Warning Point are functions delegated to Necsa. The early notification activities are part of the National Nuclear Disaster Management Plan.

The NNR is in the process of upgrading the Regulatory Emergency Response Centre (RERC) in order to fulfil its role in case of nuclear and radiological emergencies. The RERC is in the process of being upgraded and, once completed, will provide a centralised location where key NNR staff members can receive notification from authorised holders and other stakeholders, monitor the evolution of the emergency conditions, perform verification analysis, and provide advice to off-site authorities regarding decisions that are taken to protect people and the environment. The RERC will also provide the means for the NNR to communicate with the relevant stakeholders.

The new capabilities of the RERC includes information and communications technology infrastructure, audio and video communications equipment, online radiological measurement stations, plant and technical data from installations, plume modelling tools, and radiological measurement instrumentation. The refurbishment of the RERC has been completed and audio and video equipment has been installed. Emergency procedures for the RERC are being reviewed and updated while also developing new ones to align with new capabilities. The subprojects on online plant data monitoring and online radiation monitoring are ongoing and are targeted for completion by March 2017.

16.1.3 Implementation of emergency preparedness measures by the licence holders

16.1.3.1 Classification of emergencies

A system of classification of emergency situations, based upon the severity of the event, is in place at Koeberg NPP. Depending upon the severity, the actions taken vary and could range from activation of the licence holder's emergency control centre, to notification of the local, provincial and national governments.

Emergency situations, for which the classification system caters, are defined according to the following categories:

1) Unusual Event;
2) Alert;
3) Site Emergency; or
4) General Emergency.

16.1.3.1.1 Unusual Event

An Unusual Event is defined as an abnormal occurrence that indicates an unplanned deviation from normal operations, the actual or potential consequences of which require the partial or limited activation of the emergency plan. The City of Cape Town is informed of the event for information purposes only.

An Unusual Event does not result in a release of radioactive material requiring off-site assistance or monitoring, however it could be a precursor for the possible degradation of safety systems. Only notification to the NNR would be required in such a case and there would be no automatic initiation of the emergency response organisation. Should the situation deteriorate, systematic handling of subsequent information would then identify the need to elevate the classification to a higher level.

16.1.3.1.2 Alert

An Alert would be declared as a result of events that involve the actual or potential significant degradation of the level of nuclear 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 that lead to situations which necessitate the declaration of an Alert also have the potential to develop into those requiring the declaration of a Site Emergency or a General Emergency. As a result, specific actions and notifications are necessary for the purpose of bringing emergency personnel to a state of readiness. The full activation of the emergency plan is initiated which includes the licence holder's emergency response organisation, notification of the NNR and all off-site government support organisations.

These actions will ensure that:

1) A command and control structure is available to assist with on-site actions;
2) Emergency personnel are readily available to respond as required; and
3) Information is promptly provided to off-site agencies.

16.1.3.1.3 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 workers and the public. The potential for more significant releases of radioactive material exists. These releases are expected to only pose a serious radiological hazard 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 radiation monitoring may be required. In addition, public notification through the off-site organisations may also be required by making use of public media platforms, such as radio and television.

16.1.3.1.4 General Emergency

The highest level of classification is the General Emergency, and this would be declared as a result of events that 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 within affected areas will be required. 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 to the government disaster management control centre. The on-site emergency organisation will be required to provide continuous monitoring of environmental radiological levels and meteorology to ensure that the appropriate protective actions are recommended.

16.1.3.2 Main elements of the emergency plans and resources

[Main elements of the on-site and, where applicable, off-site emergency plans for nuclear installations, including, availability of adequate resources and authority to effectively manage and mitigate the consequences of an accident]

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

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

During a nuclear accident that affects the public, a general emergency is declared. The facility emergency controller normally recommends the type of protective actions that are aimed at protecting members of the public. The local authority Disaster Operations Centre (DOC) is tasked with the implementation of recommended protective actions. The main decision makers in the DOC are comprised of representatives from the local authority, the provincial authority and national government, forming the Disaster Coordination Team (DCT). A procedure has been developed that details the communication, activation and operation of the DCT.

In case technical advice or support is needed by the local authorities, the DCT could refer the local authority to the NNR for advice. The NNR would then perform technical verification and assessments using the necessary input and information as provided by the local authority or authorisation holder which could inform the final decision-making for off-site protective actions.

16.1.3.2.1 Identification and activation of emergency organisation

The identification of emergency situations which pose a potential or actual threat to the installation is performed from the licence holder control room where the on-shift emergency controller, normally the supervisor in charge of the operating shift, is responsible for the initiation of the 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 an Alert condition to a General Emergency, mustering and activation at the emergency control centre should happen within one hour of initial notification. In addition, the notification to off-site authorities is also given at this time and activation of their respective emergency organisations will take place concurrently.

16.1.3.2.2 On-site response

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

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

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

16.1.3.2.3 Off-site emergency situation

Identification and activation

Under the Disaster Management Act, the management of an off-site nuclear emergency affecting the public is the responsibility of the government authorities. The off-site emergency organisations involved are emergency organisations from the local, provincial and national government.

Initial notification of an Alert, Site or General Emergency at the Koeberg NPP is communicated to the City of Cape Town (CoCT) Disaster Operations Centre from the on-site ECC. The declaration of a General Emergency as per the licence holder procedure KAA-811, The Integrated Koeberg Nuclear Emergency Plan, implies a threat to the public which requires the implementation of off-site protective actions by government authorities. From the Disaster Management Centre notification of the responders from all three spheres of government takes place. The decision-making team (Disaster Coordination Team) is comprised of the head of the Disaster Management Centre (CoCT), and representatives from the provincial government of the Western Cape (Disaster Management) and the DoE.

Implementation of protective actions

The Koeberg NPP operating shift manager and/or the standby Koeberg emergency controller recommend protective actions in accordance with a Protective Action Form to the Disaster Coordination Team. The Disaster Coordination Team participates in joint decision-making, joint coordination and joint management of a nuclear emergency.

The joint coordination team recommends a declaration of a national disaster to the National Disaster Management Committee, following the declaration of a General Emergency at Koeberg NPP. The Disaster Coordination Team reviews the recommended protective actions and the technical basis for them against protective actions addressed and procedures approved by the NNR, followed by the implementation of protective actions as required. In principle, the head of the Disaster Management Centre may implement the recommendations from the Koeberg emergency controller in the absence of representatives from the national and provincial governments.

Late-phase plan

As part of the continuous improvement of emergency preparedness, the late-phase aspects of the emergency plan have been enhanced and further developed. The late-phase aspects of the emergency plan typically commence several days after the accident, when work commences to reduce radiation levels in the environment to permanently acceptable levels, and cover aspects such as food banning and decontamination of the environment. The late-phase aspects have now been embedded in the integrated nuclear emergency plan. This includes the requirements, processes and responsibilities applicable to late phase nuclear emergency response. The aspects have been compiled in conjunction with the relevant municipalities and provincial authorities in accordance with international standards and guidelines. The integrated nuclear emergency plan is supported by a suite of operational procedures specifically for the late phase, which are sufficiently detailed to identify resources, infrastructure, and actions that may be required during the late-phase response. Late-phase exercises are conducted on a continuing basis, as part of the licensee programme of emergency exercises. Improvements in the late-phase aspects in the plan are also conducted through the regulatory emergency exercises.

Work on selected late-phase aspects, namely infrastructural decontamination, has been finalised after being informed by international experience feedback, and is being benchmarked with international developments. Late-phase operational intervention levels have been derived, based on international guidelines, and a recovery document was compiled and implemented.

Review of traffic model

As part of the Koeberg evacuation plan, to monitor population developments around the facility up to the boundary of the urgent protective zone (UPZ), the City of Cape Town has reviewed the traffic model and submitted it to the NNR for approval. The traffic model was approved by NNR in 2015 on condition that the Traffic Evacuation Model (TEM) be updated annually to account for infrastructure and population changes. Refer to section 16.1.1 for the requirements on the TEM.

16.1.3.3 Holder facilities for emergency preparedness

[Facilities provided by the licence holder for emergency preparedness (if appropriate, give reference to descriptions under Article 18 and Article 19 (4) of the convention, respectively)]

From 2007, Eskom and the local authorities embarked on projects to upgrade and improve their respective emergency response centres. Improvements in the centres include furnishing, lay-out and improved technologies. Communication and data transfer system upgrades were also implemented on and off-site. A new computerised Geographical Information System (GIS) emergency planning system was developed during 2009 to improve emergency communications between the various emergency control centres. This common system of electronic data transfer constitutes an accurate means of information transfer. Previous methods such as telephones and faxes will be retained and used as a backup. This system has been used successfully for six years and also receives periodic upgrades in order to keep up with technological advances.

16.1.4 Training, exercises, and main results

[Training and exercises, evaluation activities and main results of performed exercises including lessons learned]

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

Under the Emergency Planning Committee (EPC), a Training Working Group (TWG) has been established to coordinate the needs of all intervening organisations of the Koeberg Emergency Plan. TWG meetings are held, at which intervening organisations' training representatives can address specific training needs. Emergency preparedness and response training programmes at Koeberg NPP are aligned with the Systematic Approach to Training system which is in line with international best practice.

Koeberg internal emergency exercises

Every year Eskom prepares a programme of drills and emergency exercises for implementation. Eskom uses these drills and exercises as part of the training of emergency responders, but more importantly as a self-assessment, and for retesting previous or recurrent deficiencies. Inadequacies which are identified are corrected in accordance with an action plan. The internal emergency exercise report is submitted to the NNR, as well as an update of corrective actions taken. The NNR normally attends the licensee exercises as an observer, depending on the aspects to be tested.

16.1.5 Regulatory review and control activities

16.1.5.1 Regulatory review

The NNR reviews and approves the emergency plans submitted in terms of the requirements indicated in section 16.1.1. The NNR also reviews and approves the traffic evacuation model submitted by the municipal authorities in terms of the requirements indicated in section 16.1.1.

The NNR is in the process of upgrading its Regulatory Emergency Response Centre in order to monitor nuclear accidents and radiological emergencies, independently verify recommended protective actions and provide advice to the off-site authorities.

Eskom completed the Second Periodic Safety Reassessment (SRA II) of the Koeberg NPP in 2010 (section 14.1.3.3). The reassessment for emergency preparedness and response was a high-level evaluation of the viability of the licensee's emergency plan against the legislative and regulatory requirements. The conclusion was that the Koeberg Nuclear Emergency Plan was deemed viable and adequate to deal with potential nuclear emergencies.

16.1.5.2 Nuclear emergency exercises

As part of emergency preparedness, emergency exercises form an important component in the rehearsal of the emergency plan. Using an exercise to test the effectiveness of the emergency plan requires evaluation of the performances against defined objectives. These objectives take into account the necessity to test either distinct elements of the emergency plan, or the entire emergency plan. Because the testing of the entire plan necessarily requires the participation of off-site organisations as players, each full-scale exercise involves substantial costs and allocation of resources. Therefore, the NNR does not conduct such exercises frequently and they are currently held at intervals of 18 months to two years. As a result, reliance has to be placed on more frequent, but less extensive licence holder exercises with the objective of testing discrete parts of the emergency plan.

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

The NNR conducted an announced emergency exercise at Koeberg NPP on 22 October 2014. The findings from the previous exercises, inspections findings and occurrences, together with assessment activities were used to formulate the exercise objectives. The overall objective of the 2014 exercise was to test the response of both the on-site and off-site organisations using a simulated scenario.

Specific objectives of the exercise included testing of the following aspects of the Integrated Koeberg Nuclear Emergency Plan:

1) Communication aspects between all emergency responders;
2) Protection of emergency workers (e.g. traffic officer);

3) Simulated physical evacuation of the public that included the following:
   a) Availability of transportation;
   b) Activation, availability and operation of the mass care centre (MCC);
   c) Decontamination of evacuees; and
   d) Arrangements to provide for the evacuees at the MCC in detail;
4) Arrangements to treat persons that received radiation exposure and those injured from other causes at an external hospital (this included testing transportation, communication and relevant procedures);
5) Preparation of the press release; and
6) Conduct of the media briefing.

The NNR deployed a number of umpires at the site and off-site response locations in accordance with the simulated scenario. For all the on-site and off-site locations identified prior to the exercise, the NNR umpires recorded detailed observations and associated findings and these were captured in the exercise report.

For this exercise, the NNR invited observers to witness and observe the activities, responses and actions of the various organisations that were involved in the exercise. The post-exercise debriefing session involving umpires and observers was held on the day after the exercise, where initial impressions on the responses, lessons learned and potential areas for improvements were discussed.

The NNR validated all the findings by umpires and observers and compiled an exercise report in order to ensure adequate correction of all inadequacies. The NNR concluded that the overall response of Eskom and the intervening organisations indicated that the Integrated Koeberg Nuclear Emergency Plan is viable for the protection of persons and the environment, however specific areas were identified for improvement.

Following the issuance of the final report, Eskom and the intervening organisations were required to ensure that appropriate corrective actions are identified and implemented to address the findings as a matter of urgency, in accordance within identified timescales. The exercise findings and observations are in the close-out process.

16.1.5.3 Safety reassessment of Koeberg emergency planning considering lessons learned from the Fukushima accident

As reported in section 14.1.4.3, following the Fukushima accident in Japan in 2011, Eskom undertook an external event safety reassessment as directed by the NNR that focused on external events, both in the design basis and beyond design basis domains. The review of the emergency plan focussed on:
1) Emergency management actions and preparedness following the worst-case accident;
2) Radiological monitoring following a nuclear accident involving radiological release;
3) Public protection emergency actions; and
4) Communication and information flow in an emergency situation.

The methodology, main findings and conclusions, and proposals of the safety reassessment were summarised as follows.

Methodology

The assessment of the emergency plan arrangements was conducted by comparing the needs with the actual capacity. A needs-analysis was performed on the proposed emergency plan actions necessary to minimise radiological releases and for recovering the plant following extreme natural events and combinations of external events. The needs-analysis on the emergency plan considered the following: assessment of the facilities, resilience of facilities to external events, muster control, access control, exposure monitoring, dosimetry, medical emergency, power supplies, ventilation, lighting, support functions, step-off point, scanning, contamination control, protective clothing, personal hygiene, food and water, rest, transport, voice communications, documentation, data and information, loss of AC power, seismic impact on equipment, flooding, high winds, electronic models for the release of radioactive materials, tools and spares, procedures, local staging, and mobile options.

The safety reassessment of the Koeberg emergency plan also included the determination of the adequacy of emergency personnel and communication capabilities following an external event that results in the loss of off-site power, affecting both units. This assessment considered the resources and personnel required to fulfil the functions of the Emergency Control Centre, the Technical Support Centre, radiation protection, engineering, maintenance, operating, and firefighting at Koeberg in the case of a beyond design basis external event. The purpose of this reassessment was to determine the minimum number, and composition of the emergency response standby personnel, to implement mitigation strategies and repair actions intended to maintain or restore core cooling, containment integrity, and spent fuel pool cooling capabilities for the affected units.

Conclusion

The overriding finding was that there is currently no design basis for the facilities and equipment being used to implement, coordinate, and support the emergency plan.

It was concluded that the Koeberg emergency plan and plant recovery strategy is in line with the requirements in place. However, if the current capacity is challenged by the type of severe conditions similar to those at Fukushima, the plan will become difficult to implement. A number of upgrades and improvements are required to improve the level of response to ensure effective implementation when subjected to severe accidents, especially when accompanied by extreme external events.

The emergency personnel are considered adequate for one unit failure, but the emergency personnel are not considered adequate for failure of both units. There is sufficient means of communication during an external event.

Proposals and improvement actions

Various proposals have been made by Eskom including that a design basis be developed for the facilities and equipment being used in the emergency plan. This design basis should include consideration for external events that could potentially challenge the ability to implement the emergency plan.

Recommendations were made to address shortfalls on facilities and equipment in accordance with the needs-analysis conducted on the above areas.

Proposed improvement actions and modifications have been identified in order to increase the robustness of the existing installed communication means. These improvement actions and modifications included procuring new satellite phones, upgrading the existing installed communication equipment, enhancing the robustness of the existing communication equipment to seismic and flooding events, and installing gene-phones at key areas on site.

Eskom has established a new functional organisation known as the Operation Support Centre to control and manage plant mitigation activities. This extra support organisation will be comprised of an extra 13 positions on standby to ensure effective and timeous response to accident conditions. It is envisaged that the final implementation of this organisation will be completed in 2016. This will assist in ensuring that multiple response teams will be able to be dispatched simultaneously.

It is mandatory for all senior staff members at Koeberg to have an emergency plan role and responsibility. All other staff who may be required to respond to a Fukushima type incident have also received extra training to ensure an adequate awareness in responding to such an incident.

16.1.6 International arrangements

South Africa has signed and ratified the following international conventions that are pertinent to emergency preparedness:

1) Convention on Early Notification of a Nuclear Accident; and
2) Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Eskom is a member of Enatom and, in terms of the associated early-notification agreement, would inform affected states either directly or via the IAEA.

16.2 Information for the public and neighbouring states

16.2.1 Informing the public about emergency planning and emergency situations

[Overview of the contracting party's arrangements for informing the public in the vicinity of the nuclear installations about emergency planning and emergency situations]

After initial notification, once the licence holder's Emergency Control Centre is activated, further communication is established with the City of Cape Town Disaster Management Centre.

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:

1) 2 400 watt siren systems installed in areas close to the installation;
2) 100 watt siren units installed on farms or in farming areas situated between 5 km and 16 km;
3) Vehicles equipped with sirens and public address systems to cater for informal settlements;
4) Broadcasting of messages via local radio stations; and
5) Social media.

Within the site, and up to 5 km from the site boundary, notification is required to be effected within at least 15 minutes, throughout 360°. From 5–10 km, notification is required to be effected within 30 minutes, through a 67.5° downwind sector. From 10–16 km, notification is required to be effected within a period of 45 minutes through a 67.5° downwind sector.

The Public Warning System Upgrade Project was initiated to include a newer digital communications and telemetry system, and a number of new sirens have been added to the south-eastern sector on an ongoing basis, where the residential areas have shown substantial growth over the last few years. The system now comprises 30 farm sirens and 50 omnidirectional sirens. A number of off-site farm sirens were moved on-site and the affected areas are now covered by additional omnidirectional sirens. All off-site sirens are controlled from one of four locations, namely the Koeberg High Voltage Control Room, the Koeberg Emergency Control Centre, the Alternate Emergency Control Centre and the CoCT Disaster Operations Centre.

A dedicated Joint Media Centre (JMC) is available for representatives of Eskom and the intervening organisations to meet and finalise information that will ultimately be sent to the media to inform the public about the emergency. Representatives of the media will assemble at the JMC to receive briefings on the status of the emergency, based on data provided by the Emergency Control Centre at Koeberg. Briefings will be provided by the regional nuclear emergency manager assisted by the regional communications officer and technical staff from the Alternate Emergency Control Centre. Press releases will then be sent to the South African Broadcasting Corporation for broadcasting to the public at large. Upon the declaration of a nuclear emergency, the licence holder must notify the NNR.

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 licence holder may also notify (depending on circumstances) the IAEA via Necsa, which is the responsible South African institution in this regard.

Forums have been established, with the authorities and the public in the vicinity of the Koeberg NPP, for liaison on emergency preparedness, planning and response. These forums are summarised below.

<u>Emergency Planning Committee</u>

The EPC is a working committee instituted by Koeberg and the relevant local and provincial authorities to address implementation of the Koeberg Emergency Plan and it reports to the EPSOC on progress. It is chaired by a representative of the local authority, and meetings are held on a quarterly basis.

<u>Public Safety Information Forum</u>

As indicated in section 9.4, the NNR Act requires that the holder of a nuclear installation licence establish a Public Safety Information Forum to inform persons, living in the municipal area where an emergency plan has been established, on nuclear safety and radiation safety matters.

The established Koeberg Public Safety Information Forum meetings take place on a quarterly basis and constitute a forum where the queries of the public are addressed. The meeting is chaired by a member of the public and is attended by all major role players involved in the Integrated Nuclear Emergency Plan and members of the general public. The NNR participates in this forum.

16.2.2 Arrangements to inform competent authorities in neighbouring states

This requirement is not applicable as Koeberg NPP is located in the south-west of South Africa, far from neighbouring states.
There are no other countries within the emergency planning zones for any of the nuclear facilities. There are no arrangements in place for coordinating a response to a radiological emergency with neighbouring countries and 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. This matter will however be addressed in the revision of the National Nuclear Disaster Management Plan as new sites are being considered for new nuclear installations.

16.3 Emergency preparedness for contracting parties without nuclear installations

Not applicable.

ARTICLE 17: SITING

Each contracting party shall take the necessary steps to ensure that appropriate procedures are established and implemented:

1) For evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;
2) For evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;
3) For evaluating all relevant external man-made and natural hazards likely to affect the safety of the nuclear installation for its projected lifetime;
4) For re-evaluating as necessary, all relevant factors referred to in subparagraphs 1) and 2) so as to ensure the continued safety acceptability of the nuclear installation; and
5) 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 of the nuclear installation on their own territory.

Summary of changes

Article 17 has been updated in terms of:

1) Evaluation of site-related factors (17.1);
2) Requirements for siting and site evaluation (17.1.1);
3) Overview of assessments and criteria (17.1.1.1);
4) Overview of design provisions against external events (17.1.1.2);
5) Regulatory review and control activities (17.1.2);
6) Criteria for public and environmental safety impact (17.2.1); and
7) Re-evaluation of sites (17.3.1).

17.1 Evaluation of site-related factors

An applicant has the option to apply for a nuclear installation site licence (NISL) or a nuclear installation licence (NIL) to site, construct and operate a nuclear facility. Applications for an NISL and an NIL initiate separate but similar licensing processes. An NISL considering multiple nuclear facilities cannot be varied into an NIL once granted. If an NISL considering multiple nuclear facilities has been granted, a separate application for an NIL must still be granted for a specific facility to be sited on the site. The safety case for an NISL typically considers enveloping characteristics of all the nuclear facilities contemplated to be constructed on the site, while an NIL to site, construct and operate would be for a specific nuclear facility or reactor design at the specific site.

17.1.1 Requirements on siting and site evaluation

[Overview of the contracting party's arrangements and regulatory requirements, relating to the siting and evaluation of sites of nuclear installations, including applicable national laws not mentioned under Article 7 of the convention]

In terms of the NNR Act [1.1], nuclear authorisations are required for the siting of nuclear installations. The regulation on the siting of new nuclear installations [1.8] requires the applicant for a nuclear installation licence for the siting of a nuclear facility to submit, in support of the application, a Site Safety Report to the NNR comprising the following:

1) Motivation for the choice of the site;
2) Statement as to the proposed use of the site (maximum thermal power, general design characteristics, etc.);
3) Source term analysis;
4) Characteristics of the site, in terms of external events;
5) Probabilistic Risk Assessment (including cumulative impact of nuclear installations);
6) Analysis of the impact on the public, due to normal operations;
7) Analysis to demonstrate the viability of an emergency plan; and
8) Identification and determination of the emergency planning zones.

The SSR is required to 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, and ecology.

The following regulatory documents directly relevant to the siting of new nuclear installations have been issued by the NNR:

1) RD-0024: Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations;
2) RG-0011: Interim Guidance for the Siting of Nuclear Facilities;
3) PP-0014: Consideration of External Events for Nuclear Installations; and
4) PP-0015: Emergency Plan Technical Basis for New Nuclear Installations.

17.1.1.1 Overview of assessments and criteria

[Overview of assessments made, and criteria applied for evaluating all site-related factors affecting the safety of the nuclear installation, including multi-unit failure, loss of infrastructure, and site access following an event]

The safety case for an NISL must include the following:

1) Assessment of the suitability of the site considering, amongst others, external events and civil engineering issues;
2) Assurance of safety including concept designs and engineered safety features that will ensure an acceptable low risk of public exposure, probabilistic safety assessment and source term analysis;
3) Public and environmental impact analyses;
4) Emergency planning including the identification of emergency planning zones, preliminary work on establishment of emergency plans and proposed arrangements for control of developments;
5) Security measures;
6) Organisation for site licensing including an overview of the management system, processes and associated procedures; and
7) Site Safety Report.

The safety case for an NIL to site must:

1) Provide assurance that the nuclear safety criteria (pertaining to dose and risk) given in Regulation No. R.388 and relevant Regulatory Requirements documents, relating to the safety of the public, are complied with given the characteristics of the site and its environs, and the design and operation of the facility;
2) Demonstrate that site characteristics do not preclude the siting and construction of the facility on the site;
3) Provide the technical basis or bounding envelope of the facility design and site parameter values for the safety assessment that must be performed for the construction safety case;
4) Determine the emergency planning zones and demonstrate the feasibility of implementing emergency and security plans, given the characteristics of the site and its environs;
5) Provide for the protection of non-human species; and
6) Provide for arrangements for controlling developments in the vicinity.

In order to establish a strategic reserve of nuclear sites to support any future nuclear build programme, Eskom is qualifying two potential new sites and is reanalysing the site upon which Koeberg is constructed and operated. The sites are being qualified in accordance with the promulgated siting regulations described above.

A probabilistic seismic hazard assessment of these sites are being undertaken in accordance with NRC RG 1.208 [6.8] using the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 process.

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

17.1.1.2 Overview of design provisions against external events

[Overview of design provisions used against human-induced external events and natural occurring external events such as fire, explosion, aircraft crash, external flooding, severe weather conditions and earthquakes and the impact of related, sequential, natural, external events (e.g. tsunami caused by an earthquake, mud slide caused by heavy rain)]

The Koeberg NPP comprises two three-loop pressurised water reactor (PWR) units with their turbine generators and associated plant, and each unit is designed for a gross fission power output of 2 775 MW thermal. The plant is located in the Western Cape on the site of Cape Farm No. 34, also known as Duynefontyn, about 30 km north of Cape Town.

The studies performed for the Site Safety Report for the nuclear installation and prospective sites in South Africa show that the earthquake and tsunami hazards and their likelihood of occurrence are relatively low due to the site location relative to known faults as well as the tectonic plate structure and location. Similar to most nuclear facilities around the world, the Koeberg earthquake and tsunami hazard design basis has been established considering local conditions and historical event data.

Koeberg is situated in a region that is relatively well insulated from severe external events. Nonetheless, the plant has extensive protective features to prevent it from being impacted or affected by such eventualities.

These protective features include, amongst others, the following:

1) The nuclear island is constructed on a seismic raft that provides the capability to withstand a seismic event of up to 0.3g ground acceleration;
2) The plant can withstand winds of up to 225 km/hr; and
3) The terrace on which the plant has been constructed protects it from tsunamis up to 8 m in height.

With regard to fire protection requirements, the plant is designed in line with international codes, by physical separation of safety systems, extensive fire detection and mitigation systems and smoke extraction. A fire and rescue team is on site 24 hours a day.

17.1.2 Regulatory review and control activities

In March 2016 Eskom applied for the licensing of the Thyspunt and Duynefontyn sites in terms of the siting regulations that were promulgated in 2011. The licensing process can typically be broken down into the following partially overlapping phases:

1) Initial review of the application;
2) Preparatory phase;
3) Technical review including the public participation process; and
4) NNR Board review and decision process.

It is estimated that the licensing process, including public participation, will take up to 24 months to complete. As per clause 21 (1) of the NNR Act, the applicant must furnish such information as the Board requires.

The requirements of the NNR is currently stipulated in The Regulations on Licensing of Sites for New Nuclear Installations, Government Notice 927 of 11 November 2011. The NNR has also recently completed the phase of developing regulatory standards and processes for licensing of sites with the approval of RG-0011, Interim Guidance for the Siting of Nuclear

Facilities, and TAG-001, Technical Assessment Guide for the Siting of Nuclear Facilities. RG-0011 provides guidance to applicants on the implementation of the regulations.

The NNR Act requires the NNR to direct the applicant to publish the application in the Government Gazette and two newspapers circulating in the vicinity of the site, and to serve copies of the application to the municipalities affected by the application, and any such body as determined by the chief executive officer.

The NNR reviews the submissions for a site licence to verify compliance with the regulations on safety standards and regulatory practices, as well as the specific requirements in the regulation on site licences (refer to section 17.1.1).

The NNR then conducts a public participation process using a public information document prepared by the applicant.

Finally, the NNR prepares a report on the safety review and the public process which is submitted to the NNR Board who then directs the chief executive officer of the NNR to approve or reject the application.

Note: Independent to the NNR licensing process, the applicant is required to conduct an Environmental Impact Assessment in accordance with environmental legislation. This process culminates in a record of the decision by the Minister of Environmental Affairs.

The environmental authorisation process is performed in terms of the National Environmental Management Act [1.11] and the associated regulations.

17.2 Impact of the installation on individuals, society and environment

17.2.1 Criteria for public and environmental safety impact

[Criteria for evaluating the likely safety-related impact of the nuclear installation on the surrounding population and the environment]

The criteria for site evaluation are referred to in the regulation on siting of new nuclear installations (17.1.1).

The NNR has further stipulated limitations on urban developments in the vicinity of nuclear installation and holds regular meetings with Eskom and the local authorities in this regard. As reported in section 7.2, in terms of section 38 (4) of the NNR Act, regulations are in the process of being published on the monitoring and control of developments in the vicinity of the Koeberg NPP to ensure the effective implementation of the emergency plan. These regulations include the specific requirements applicable to the vicinity of Koeberg and will replace the regulations published in March 2004, which were generic and applicable to all nuclear installations. Similar regulations will be developed for other nuclear sites.

The environmental authorisation considers factors such as geotechnical and seismic suitability, geological risks, hydrological impacts, geohydrology, as well as the impact on flora and fauna, air quality, marine life, oceanography, heritage, noise, agriculture, economics, etc.

17.2.2 Implementation of these criteria in the licensing process

The applicant is required to submit a safety case including a Site Safety Report, demonstrating compliance with the criteria referred to in section 17.2.1.

17.3 Re-evaluation of site-related factors

17.3.1 Re-evaluation of sites

[Activities for re-evaluation of the site-related factors as mentioned in Article 17 (1) of the convention to ensure the continued acceptability of the safety of the nuclear installation, conducted according to appropriate standards and practices]

The regulation on siting of new nuclear installations (17.1.1) stipulates that in the event of an application for a construction licence on the site for which a site licence has been granted, the factors affecting the Site Safety Report would have to be re-evaluated if five years had passed since the issuance of the site licence.

Operating nuclear power plants are subject to periodic reviews every ten years, which include site-related factors.

A probabilistic seismic hazard assessment of the Thyspunt site has been undertaken in accordance with NRC RG 1.208 [6.8] using the Senior Seismic Hazard Analysis Committee Level 3 process. A similar assessment of the Duynefontyn site, also using the SSHAC Level 3 process, has been initiated.

17.3.2 Results of recent re-evaluation activities

Refer to sections 14.1.3.2, 14.1.3.3 and 14.1.4.3 on the first and second periodic reviews, and post-Fukushima reassessment respectively.

As indicated in sections 14.1.3.2 and 14.1.3.3, two ten-yearly periodic safety re-assessments have been undertaken of the Koeberg NPP. As part of these re-assessments internal and external hazards were re-assessed. For the latter re-assessment the hazards listed in the IAEA Safety Guide No. NS-G-2.10 (2003) [5.14] and the internal hazards studied by EDF for their VD3 project were used. The re-assessment included a review of design provisions used against man-made external events and natural occurring external events such as fire, explosion, aircraft crash, external flooding, severe weather conditions and earthquakes and the impact of related sequential, natural external events.

As indicated in section 14.1.4.3, following the Fukushima accident in 2011, an external event safety re-assessment was undertaken as directed by the NNR. The scope of the re-assessment included:

1) A review of the provisions taken in the design basis concerning flooding, earthquake, other extreme natural phenomena and combinations of external events applicable to the Koeberg site.
2) A review of the robustness of the Koeberg design to maintain its safety functions beyond the design basis hazards, including earthquakes and flooding exceeding the

design basis, other extreme external conditions challenging the site and a combination of events.
3) A review of the consequential loss of safety functions following a prolonged loss of electrical power and a prolonged loss of the ultimate heat sink, which for Koeberg is seawater cooling.
4) The identification of potential cliff-edge effects in the assessment of external events and potential measures or design features to mitigate these effects.
5) Emergency management and response.
6) Accident management.

The re-assessment included safety considerations for operation of multiple units at the same facility site. The findings of the re-assessment are summarised in section 14.1.4.3.

17.3.3 Regulatory review and control activities

The NNR reviews the scope, terms of reference and the safety analyses to verify compliance with the regulatory requirements, including the international benchmark (French CP-1 safety referential), and other international practices.

The NNR produces a report on the outcome of the periodic review and uses the results to consider any regulatory action, such as directives to resolve issues, or to restrict or curtail operation.

The NNR reviews the corrective action plan, and follows up on the implementation thereof.

17.4 Consultation with other contracting parties likely to be affected by the installation

17.4.1 International arrangements

South Africa's nuclear sites are far removed from boundaries with other countries, and therefore such consultation is not required.

17.4.2 Bilateral arrangements with neighbouring states, as applicable and necessary

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: 1) 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 mitigating their radiological consequences should they occur; 2) The technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis; and 3) The design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration for human factors and the man–machine interface.

Summary changes

Article 18 has been updated to conform to INFCIRC/572 Rev. 5 and includes the following new sections:

1) Requirements for new nuclear installations (18.1.1.3); and
2) Implementation of measures to maintain integrity of containment (18.1.5).

Article 18 has also been updated in terms of:

1) Status of implementation of defence-in-depth (18.1.2);
2) Implementation of design measures for beyond design basis accidents (18.1.4);
3) Design improvements implemented (18.1.6);
4) Regulatory review and control activities (18.1.7, 18.2.4);
5) Requirements for proven technology (18.2.1); and
6) Implementation measures taken by the licence holder (18.3.2).

18.1 Implementation of defence-in-depth

18.1.1 Regulatory requirements on design and construction

[Overview of the contracting party's arrangements and regulatory requirements concerning the design and construction of nuclear installations]

The NNR is mandated by the NNR Act to inter alia exercise regulatory control related to safety over the siting, design, construction, operation, manufacture of components parts, and decontamination, decommissioning and closure of any nuclear installation through the granting of nuclear authorisations.

The requirements of the NNR Act and the principal safety requirements formulated in the SSRP [1.7] form the basis for the stipulation of the regulatory requirements for design and construction of nuclear installations. These principal safety requirements explicitly uphold the principle of defence-in-depth.

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

1) Prevent nuclear accidents;
2) Mitigate the consequences of any such accidents; and
3) Restore sources to safe conditions after any such accident.

In accordance with the safety requirements of the SSRP, the principle of defence-in-depth, as applied in the design, construction and subsequent operation of the nuclear installation, is based on the IAEA INSAG-10 [5.18]. In its broadest context it is upheld by the following requirements of the NNR, such that the licence holder is required to demonstrate compliance with the safety standards indicated above:

1) The licence holder is required to present a safety case for the proposed activity (or change to an existing activity), demonstrating compliance with the stipulated safety standards.
2) For holders of current licenses, design and manufacture can be conducted under the authority of the licence which requires implementation of supplier and procurement processes in accordance with requirements on management of safety. Approval by the NNR is required for modifications as described in other Articles. The NNR conducts reviews and assessments as well as inspections on the design and manufacturing processes.
3) For a new build, the NNR Act dictates that a construction licence is required. A prerequisite for this is that the applicant must be in possession of a site licence as dictated by the Regulations on the Siting of New Nuclear Installations (R.927) [1.8].
4) The applicant for a construction licence must provide:
    a) A project plan, including licensing schedule, vendor and suppliers;
    b) Safety management during construction;
    c) Preliminary Safety Analysis Report;
    d) Site Safety Report;
    e) Topical reports;
    f) Safety classification document;
    g) Quality and safety management documentation;
    h) Preliminary probabilistic safety assessment;

i) Preliminary emergency plan;
j) Nuclear security plan;
k) Arrangements for regulatory control;
l) Commissioning plan; and
m) Decommissioning strategy.

5) The applicant is further required to comply with mandatory hold and/or witness points, beyond which work may not proceed without the approval of the Regulator. These hold and/or witness points, depending on the type of installation and the associated nuclear risk, include:
   a) Site establishment;
   b) Early site activities;
   c) Component manufacturing;
   d) Carrying out of civil works;
   e) Installation of components and equipment; and
   f) Performance of pre-commissioning or functional tests of individual subsystems of components.

The licensing process that was applied at the time of the Koeberg plant design and construction, was that the design of the nuclear installation to be constructed should be based on one that was licensed in the country of origin and that utilised design codes and criteria that were broadly recognised internationally. In addition, the design was required to be subject to a quantitative safety assessment, making use of probabilistic risk assessment techniques, which demonstrate compliance with the quantitative risk criteria laid down by the regulatory body. The design of the nuclear installation to be constructed was assessed to comply with all the safety requirements of the NNR and a nuclear licence was granted for the construction and subsequent operation of the nuclear installation.

18.1.1.1 Modification control process

One of the conditions of the nuclear installation licence, 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 a condition of the nuclear installation licence that a valid and updated safety assessment, which must include a risk assessment, be maintained of the installation.

18.1.1.2 The licence holder's modification process

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

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

18.1.1.3 Requirements for new nuclear installations

As indicated in section 7.2.1.3, the NNR has initiated the process to revise its current suite of regulations and has submitted these revised regulations to the Minister of Energy for promulgation. These regulations have been revised considering the latest international standards and specifies safety objectives for new nuclear installations that must be complied with. Design basis extension conditions must be considered as part of the design basis of new nuclear installations.

In addition to the fundamental safety criteria and objectives of the NNR, the following specific safety objectives for new nuclear installation have been specified:

1) Prevention of accidents shall be the focus by designing for fault tolerance through application of good engineering principles. Fault tolerance is the property of a system to continue operating in the event of failure of one or more components.
2) For all accidents taken into account in the design basis, there shall be no off-site effects and no significant on-site doses for workers as far as reasonably practical.
3) The likelihood of an exposure shall decrease as the potential magnitude thereof increases.
4) Accidents which could lead to early or large releases shall be practically eliminated and have to be considered in the design of the facility.
5) Any off-site releases that could occur shall only require limited off-site emergency response.

The NNR has further developed and issued RG-0019, Interim Guidance on Safety Assessments of Nuclear Facilities, based on the proposed revised regulations as an interim measure to provide guidance to prospective applicants of new nuclear installation licenses. This document provides, amongst others, guidance on compliance with the safety objectives and criteria for new nuclear installations.

18.1.2 Status of application of the defence-in-depth

[Status with regard to the application for all nuclear installations of the defence-in-depth concept, providing for multiple levels of protection of the fuel, the primary pressure boundary and the containment, with account taken of internal and external events and the impact of related sequential, natural external events (e.g. tsunami caused by an earthquake, mud slide caused by heavy rain)]

The safety assessments referred to in Article 14, including the periodic safety reviews and the post-Fukushima assessments, thus far, confirms that Koeberg NPP conforms to its design basis, and that the design basis and operating practices conform to the principle of defence-in-depth, in line with international practice.

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

1) Additional off-site power supplies for grid strengthening;
2) Revision of Operating Technical Specifications and development of shutdown OTS;

3) Moratorium on mid-loop operation with fuel in the reactor;
4) Fast dilution modification;
5) Requirements on risk management;
6) Protection against marine oil spills;
7) Addition of diesel generator power supplies and reactor pump seal supply during station blackout scenarios; and
8) Implementation of an additional (third) cooling loop for the spent fuel pools and backup emergency inventory supply.

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

1) Ensure plant configuration control practices are taken into account in the operational safety assessment.
2) Ensure adequate levels of redundancy of safety trains and support systems.
3) Impose a risk limit on any twelve-month window, including past and planned activities.

Presently Eskom complies with the above requirements through implementation of its OTS (which include the shutdown OTS) 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. Where a degraded condition is identified and a risk assessment and risk balance is performed, on-line repairs are justified (via implementation of preventative mitigation actions) and sanctioned by safety committees.

Another important aspect of ensuring defence-in-depth in the operation of the Koeberg NPP, is the comprehensive independent surveillance and compliance inspection programme (complementary to the Koeberg NPP monitoring programme), implemented by the NNR, to verify compliance with the nuclear installation licence requirements and to identify any potential safety concerns.

As part of the capability assessment performed following the Fukushima event, Eskom evaluated the potential of induced events (one event resulting in another), as well as events affecting both units on the site. In order to mitigate these events, an additional mobile equipment storage facility has been created on an elevated position on site.

Eskom is furthermore expanding the emergency plan capability by the establishment of a new Operational Support Centre from where the recovery teams that will be deployed on site can be coordinated and assisted.

18.1.3 Extent of use of design principles

[Extent of use of design principles, such as passive safety or the fail-safe function, automation, physical and functional separation, redundancy and diversity, for different types and generations of nuclear installations]

The Koeberg NPP is a generation II plant design making use of active and passive engineered safety features, the fail-safe function, automation, physical and functional separation, redundancy and diversity.

Further improvements have been implemented at the nuclear installation on the basis of the plant-specific risk assessment, or on the basis of international experience feedback as described in 18.1.6.

18.1.4 Implementation of design measures for beyond design basis accidents

[Implementation of design measures or changes (plant modifications, backfitting) with the objective of preventing beyond design basis accidents and mitigating their radiological consequences if they were to occur (this applies to the entire nuclear installation including spent fuel pools)]

The application of defence-in-depth, as indicated in IAEA INSAG-10 [5.18] is applied at the Koeberg NPP in which fourth and fifth levels of defence have been implemented following the introduction of emergency operating procedures and Severe Accident Management Guidelines on how to cope with beyond design basis accidents, and with the existence of the emergency plan.

The NNR requires the use of the following well established principles of defence-in-depth (as in IAEA INSAG-10) at Koeberg NPP:

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

Some of the design improvements, associated with protection against beyond design basis events that Eskom has implemented since the original construction of the plant, include:

1) Station blackout diesel generators;
2) External spent fuel pool (SFP) make-up;
3) External connection for containment spray;
4) Safety injection and spray interconnection and booster pump;
5) Qualified spent fuel pool instrumentation;
6) Third SFP cooling train on each unit;
7) Passive autocatalytic hydrogen recombiners in containment;

8) Design extension qualified, solenoid operated pressuriser relief valves;
9) Oil and marine organism mitigation measures;
10) Real time information in Technical Support Centre; and
11) Improved containment sump recirculation strainers.

18.1.5 Implementation of measures to maintain integrity of containment

[*Implementation of particular measures to maintain, where appropriate, the integrity of the physical containment to avoid long-term off-site contamination, in particular actions taken or planned to cope with natural hazards more severe than those considered in the design basis*]

Improvements have been implemented at the nuclear installation on the basis of the plant-specific risk assessment, or on the basis of international experience feedback including those relating to containment safety enhancements.

The modifications implemented in the category of containment safety enhancement (see section 8.1.6) included under the CP1 Alignment Project resulting from the first Koeberg Safety Re-assessment improves the containment of a potential radioactive release to the public. These modifications improve system isolation potential, ventilation systems, measuring of activity and improvements in system leak tightness. The installation of passive autocatalytic recombiners that do not require electrical power supply has been included under this category.

In order to further improve the confidence that the containment will remain protected and intact following a serious event, Eskom has implemented additional plant improvements and extended the procedural guidance to further protect containment. The changes include:
1) The ability to provide containment spray for steam suppression using mobile pumps connected to the outside of the building;
2) Ensuring that the containment spray pump suction lines remain full of water, to prevent cavitation, through the installation of new instrumentation;
3) Upgrading of the environmental qualification of the instrumentation in containment; and
4) The implantation of a complete set of Severe Accident Management Guidelines (SAMG) that include steps to ensure the protection of the containment structure.

18.1.6 Design improvements implemented

[Improvements implemented for designs for nuclear power plants as a result of deterministic and probabilistic safety assessments made since the previous national report; and an overview of the main improvements implemented since the commissioning of the nuclear installations]

Improvements have been implemented at the nuclear installation on the basis of the plant-specific risk assessment, or on the basis of international experience feedback. Examples of improvements are the 79 modifications included in the CP1 Alignment Project resulting from the first Koeberg Safety Re-assessment (refer to Article 14), which can be categorised under the following theme headings:
1) Periodic safety reassessment close-out and General Operating Rules (GOR) alignment issues.

These modifications originated from the close-out report of the safety reassessment performed in 1998 (refer to Article 14), or were identified as improvements to the plant to align the GOR.

2) Containment safety enhancement (discussed in 18.1.5).
3) Equipment qualification.

   This category of modification improves the seismic and/or environmental qualification of equipment identified as essential during an incident or accident, to ensure safe shutdown of the reactor. Included under this category has been the installation of new pressuriser relief valves.
4) Reliability enhancement.

   This category of modification improves the reliability of the plant systems by improving system start-up times, improving the control function of the systems, and by automating critical actions to avoid functional failure in an accident scenario. Included under this category has been the replacement of rod control, turbine control and turbine safety systems with digital technology.
5) Plant operating under accident conditions.

   This category of modification improves the operating condition of the power plant under accident, and in some instances under normal operation, by installation of additional plant–operator interface equipment, installation of a safety parameter display console, installation of equipment to prevent accident conditions from arising, and installation of equipment to prevent human error that may have adverse consequences. Included under this category has been the installation of station blackout diesel generators, located 14 m above the mean sea level, as well as new containment sump strainers
6) Protection against hazards.

   This category of modification includes improvements to protect against high-energy pipe breaks, internal flooding, earthquakes for passive equipment, and against fire.
7) Modifications identified by EDF during their second safety reassessment.

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

18.1.7 Regulatory review and control activities

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

1) All safety-related modifications based on the classification are submitted to the NNR for approval.
2) The NNR requires, based on classification (Safety Related or Critically Safety Related), the licence holder to provide a safety case submission with at least the following elements in support of the proposed modification:
   a) Detailed design;
   b) Safety review;
   c) Risk impact analysis;
   d) Manufacturing, implementation and procurement specifications;
   e) Implementation safety case; and
   f) Functional testing programme.
3) 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 NNR before final approval for implementation of the modification is given.

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

Periodic safety assessments are submitted to the NNR for review. The NNR prepares a review report concluding on the continued operation of the facility. The holder submits a corrective action plan for approval by the Regulator. The NNR monitors implementation of the corrective action plan.

As described above, approval by the NNR is required for modifications or changes to the licence basis.

18.2 Incorporation of proven technologies

18.2.1 Requirements on proven technology

[Contracting party's arrangements and regulatory requirements for the use of technologies proven by experience or qualified by testing or analysis]

The regulatory requirements discussed in Article 7 dictate that:
All structures, systems and components (SSC) important to safety must be designed according to the latest or currently applicable approved standards. If possible, the SSC should be of a design proven in previous equivalent applications, and must be consistent with the plant-reliability goals necessary for safety.

Where new or innovative design or features are used, the results of the investigations on applicability of the codes and standards must be provided to the NNR. It must be demonstrated that the selected codes and standards are fully applicable to the SSC. In any other case, a revised code, standard or specification must be developed and approved.

A test programme must be implemented by the licensee to demonstrate the safe performance of new safety features to predict their performance, to provide sufficient data to validate the analytical codes and to indicate that the effects of systems interactions are acceptable. The test programme must include suitable qualification testing of a prototype simulating the most adverse design conditions.

18.2.2 Measures taken by the licence holders to implement proven technologies

As reported in the previous national reports to the convention, the nuclear installation was built between 1976 and 1984 by a French consortium. Framatome had responsibility for the nuclear island, Alsthom Atlantique for the conventional island, Spie Batignolles for the civil work, and Framateg for overall project coordination.

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

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

Since the commissioning and commercial operation of the nuclear installation, the same principle pertaining to the use of proven technologies has been applied. For example, when a modification is carried out on the plant, the design and its implementation has to comply with the requirements of the SSRP. These state that installations, equipment or a plant requiring a nuclear installation licence, a nuclear vessel licence or a certificate of registration that have an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice. This implies that current international norms and standards, including an acceptable nuclear quality assurance programme, must be utilised [4.5]. 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 [4.6, 4.9].

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.

18.2.3 Qualification of new technologies

[Analysis, testing and experimental methods to qualify new technologies, such as digital instrumentation and control equipment]

This category of modification improves the reliability of the plant systems by improving system start-up times, improving the control function of the systems, and by automating critical actions to avoid functional failure in an accident scenario. Included under this category has been the replacement of rod control, turbine control and turbine safety systems with digital technology.

18.2.4 Regulatory review and control activities

As described above, approval by the NNR is required for modifications or changes to the licence basis.

The NNR conducts assessments and inspections on the design and manufacturing processes as considered necessary.

The regulatory requirements (RD-0034) discussed in Article 7 dictate, amongst others, that: *Where new or innovative design or features are used, the licensee must provide the results of the investigations on applicability of the codes and standards to the NNR. It must be demonstrated that the selected codes and standards are fully applicable to the SSC. In any other case a revised code, standard or specification must be developed and approved.*

Design and development outputs must contain the information necessary for verification and validation to predetermined requirements and/or design criteria. The licensee must ensure that the outputs are reviewed against inputs as part of a design review process to provide objective evidence that the requirements or design criteria have been met.

18.3 Design for reliable, stable and manageable operation

18.3.1 Requirements on human factors and ergonomics

[Overview of the contracting party's arrangements and regulatory requirements for reliable, stable and easily manageable operation, with specific consideration of human factors and the human–machine interface (see also Article 12 of the convention)]

The regulatory requirements (Article 7) dictate that the design of structures, systems and components important to safety, be consistent with the plant-reliability goals necessary for safety. Further, the PSA conducted pursuant to the requirements on risk assessment will reveal human factor issues regarding the design and operating procedures.

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

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

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

18.3.2 Implementation measures taken by the licence holder

Eskom uses the EDF CP1 plants as a deterministic safety reference to ensure alignment with international best practice as discussed in 18.1.6. In this regard Eskom has consistently modified and upgraded the Koeberg NNP by installing relevant modifications.

Additional upgrades currently in progress are discussed below.

18.3.2.1 Steam generator replacement of both units

The steam generator replacement (SGR) project entails the replacement of the six steam generators (three on each reactor unit at Koeberg), scheduled for completion by 2018. The decision to replace the steam generators was informed by the ageing of the current steam generators, and the rapidly decreasing international expertise for similar steam generators. Manufacturing has progressed at various facilities with most of the components being delivered to SENPEC in China for the final assembly of the steam generators.

Interfacing between the NNR and Eskom on the SGR project takes place through special quarterly SGR licensing meetings where outstanding issues are discussed and tracked.

18.3.2.2 Refuelling water storage tank replacement

Each reactor unit at Koeberg NPP has one refueling water storage (PTR) tank, which provides water for cooling the reactors in the event of an accident. Due to their condition, the NNR required the PTR tanks be replaced by outages 121 and 221 in 2015. The PTR tanks are manufactured at Necsa by the PTR Consortium companies. The design reports for the new tanks were submitted by Eskom and are currently under review by the NNR.

18.3.2.3 Planned unit 2 reactor vessel head replacement

Although regular unit 2 head inspections have not revealed any degradation, a project to replace the head is in the initial planning stages.

18.3.3 Regulatory review and control activities

As described above, approval by the NNR is required for modifications or procedure changes as determined by a safety screening and evaluation processes (sections 14.2.4, 19.3.1).

The NNR conducts assessments on proposed modifications and procedure changes to verify compliance to the requirements referred to above.

ARTICLE 19: OPERATION

Each contracting party shall take the appropriate steps to ensure that:

1) The initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme, demonstrating that the installation, as constructed, is consistent with design and safety requirements;
2) 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;
3) Operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;
4) Procedures are established for responding to anticipated operational occurrences and to accidents;
5) Necessary engineering and technical support in all safety-related fields are available throughout the lifetime of a nuclear installation;
6) Incidents significant to safety are reported in a timely manner by the holder of the relevant licence, to the regulatory body;
7) Programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon, and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;
8) 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
9) Conditioning and disposal is taken into consideration for 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.

Summary of changes

Article 19 has been updated to conform to INFCIRC/572 Rev. 5 and includes a new section on procedures for multi-unit sites (19.4.4).

Article 19 has been further updated in terms of:

1) Maintenance and outage staff training (19.2.2);
2) IAEA Pre-SALTO peer review mission (19.3.6.1);
3) Information from the 2014 WANO peer review (19.3.6.3);
4) Structural integrity and containment structures (19.3.6.3)
5) Update of the EOPs based on alignment with the implementation of the new OTS Rev. 7 fallback states (19.4.2);
6) Severe accident management guidelines (19.4.3);
7) Contractor management (19.5.4);
8) Replacement of the Electronic Problem Management System (EPMS) with ActionWay (19.6.2, 19.7.4);
9) Event analysis and trending (19.6.2, 19.7.4); and
10) Procurement of additional dry storage casks (19.8.2).

19.1 Initial authorisation

As stated in section 18, the licensing process that was applied at the time of the Koeberg plant design and construction necessitated that the design of the 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 internationally recognised. This approach applied to the commissioning programme as well, which demonstrated that the installation, as constructed, is consistent with design and safety requirements. On this basis as well as a probabilistic safety assessment a nuclear licence was granted for the operation of the nuclear installation.

As indicated in section 7, in preparation for the envisaged nuclear expansion programme in South Africa, the NNR is presently developing new regulations and guidelines that cover the siting, design, manufacturing, construction, commissioning, operation and decommissioning of nuclear installations. These regulations, are based on IAEA standards and guidelines, as well as those of other countries.

To this end the NNR has recently issued RG-0012 "*Interim Guidance on Construction Management for Nuclear Facilities*". These guidelines and associated revised regulations includes guidelines and requirements on tests and commissioning programmes respectively.

19.2 Operational limits and conditions

19.2.1 Requirements on operational limits and conditions

[Overview of the contracting party's arrangements and regulatory requirements for the definition of safe boundaries of operation and the setting of operational limits and conditions]

The Regulations on Safety Standards and Regulatory Practices [1.7] require that:

1) The operational safety assessment (Safety Analysis Report – SAR for Koeberg) establishes the basis for all the operational safety-related programmes, limitations and design requirements.
2) The OTS includes: operating safety limits as imposed by the design and safety criteria, surveillance requirements to verify that equipment important to safety is operating satisfactorily, parameters that are within the safety limitations, and limitations on the operation in the event that equipment important to safety becomes inoperable or in the event that safety limitations are exceeded.

In order to respect the safety limits dictated by the Safety Analysis Report (SAR), the plant is operated in accordance with the OTS document.

The nuclear licence dictates compliance to the OTS, and that any changes to the OTS are approved by the NNR, prior to implementation.

19.2.2 Implementation of operational limits and conditions

[Implementation of operational limits and conditions, including their documentation, training in them, and their availability to plant personnel engaged in safety-related work]

The current OTS, which were developed specifically for Koeberg NPP, and are similar to the latest OTS of the French EDF NPP's.

The new revision, which was reviewed and approved by the NNR in 2011, is mainly based on deterministic processes and criteria, and derived requirements. This was crosschecked and moderated using various other consistency mechanisms, including extensive use of the power station's PSA models to verify that the deterministically-derived requirements are appropriate in terms of risk.

Training on the OTS is included in the training programme for operation, maintenance and outage staff.

19.2.3 Review and revision of operational limits and conditions as necessary

Changes to the OTS are subject to internal review and assessment by Eskom before submission to the NNR for approval.

19.2.4 Regulatory review and control activities

The Regulator's review of the OTS Rev. 7 took place over four years, resulting in approval in September 2011. Changes to the OTS require regulatory approval, prior to implementation. Compliance to the OTS, operator training, and configuration management of the OTS is covered by the Regulator's compliance inspection programme.

19.3 Procedures for operation, maintenance, inspection and testing

19.3.1 Requirements on procedures for operation, maintenance, inspection and testing

[Overview of the contracting party's arrangements and regulatory requirements on procedures for operation, maintenance, inspection and testing of a nuclear installation]

The Regulations on Safety Standards and Regulatory Practices [1.7] require that:

1) Operations be conducted in accordance with formal procedures, as required by the conditions of licence.
2) An appropriate maintenance and inspection programme be established, to ensure that the reliability and integrity of installations, equipment and plant, which have an impact on radiation and nuclear safety, are commensurate with their safety significance.

As indicated in section 9, the Koeberg Licensing Basis Manual (KLBM) [4.10], which is included in the conditions of the Koeberg nuclear installation licence, 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, including operation, maintenance, inspection and testing. The KLBM includes the necessary processes for configuration control, periodic review, modifications to plant and procedures, and regulatory approval thereof.

The nuclear licence dictates compliance to the KLBM, and, by implication, the process of safety screening and regulatory approval for changes to the operational procedures.

19.3.2 Implementation, review and approval of operational procedures

[Establishment of operational procedures, their implementation, periodic review, modification, approval and documentation]

In line with section 4 of the SSRP, the operational safety-related programmes are based on the prior and operational safety assessments. This ensures that the validity of the safety case is subject to the provisions and undertakings referred to, or assumed, in the safety case that are actually being implemented on an ongoing basis through the operational safety-related programmes.

These cover the following:

1) Compliance with the dose and risk limits;
2) Optimisation of radiation protection and nuclear safety applying the ALARA principle;
3) Safety assessment (prior and operational);
4) Good engineering practices;
5) Safety culture;
6) Accident management and emergency planning, preparedness and response;
7) Defence-in-depth principle during the design and operational phases of the installation;
8) Quality management;
9) Controls and limitations on operation;
10) Maintenance and inspection;
11) Staffing and qualification;
12) Radiation protection;
13) Radioactive waste management;
14) Environmental monitoring and surveillance;
15) Transport of radioactive material;
16) Physical security arrangements;
17) System of records and reports;
18) Monitoring of workers;
19) Decommissioning; and
20) Provisions for accidents, incidents and emergencies.

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

Inspection and testing are performed at Koeberg on structures, systems 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 has been completed to produce a Safety-Related Surveillance Manual (SRSM) that contains the functional testing and surveillance requirements, and includes the associated bases. The SRSM was developed and implemented system by system.

19.3.3 Availability of the procedures to the relevant nuclear installation staff

The KLBM dictates that in accordance with NNR requirements all modes of plant operation shall be controlled by detailed, validated and formally approved operating procedures.

19.3.4 Installation staff involvement in procedure development

[Involvement of relevant nuclear installation staff in the development of procedures]

The requirements on the management of safety [4.5] essentially necessitate that documents related to nuclear safety be prepared, reviewed and verified by technically competent personnel.

19.3.5 Safety management of operational procedures

[Incorporation of operational procedures into the management system of the nuclear installation]

Incorporation of operational procedures into the management system of the nuclear installation is covered by requirements on the management of safety (section 13.1).

19.3.6 Regulatory review and control activities

The nuclear licence dictates compliance to the KLBM, and by implication the implementation of the procedures, training, and development as well as approval for procedures and changes to such procedures.

Compliance to the operating procedures, staff training, and configuration management of the operating procedures is covered by the Regulator's compliance inspection programme.

19.3.6.1 IAEA SALTO (Safety Assessment of Long-Term Operations)

Since 2011, Koeberg NPP has been subject to two IAEA SALTO missions.

The first was conducted in 2011 and related to the In-Service Inspection Programme for Koeberg NPP. The scope specifically related to the adopted risk-informed approach to the selection of inspections. Eskom has subsequently implemented the identified corrective actions.

The second was conducted in 2015 and related to the Pre-SALTO mission on safe long term operation. The scope of the mission included the completed, in-progress and planned activities related to long-term operation (LTO), activities involving the ageing management of structures, systems and components important to safety, and revalidation of time-limited ageing analysis.

The identified recommendations and suggestions are currently tracked as part of the IAEA SALTO peer review service.

19.3.6.2 IAEA OSART (Operational Safety Review Team)

At the request of the South African government, an IAEA Operational Safety Review Team (OSART) visited Koeberg NPP from 21 August to 8 September 2011. The purpose of the mission was to review operating practices in the areas of management organisation and administration, operations, maintenance, technical support, radiation protection, operating experience, chemistry and severe accident management. A review of safety culture was also undertaken at the same time.

The OSART report was submitted to the Minister of Energy and shared with the Minister of Public Enterprises, whom Eskom is reporting administratively.

The OSART team concluded that the Koeberg management team was committed to continuously improving the operational safety and reliability of their plant. The team found good areas of performance and also identified a number of proposals for improvements in operational safety.

The main recommendations related to the:
1) Frequency of Eskom organisational changes;
2) Products and services from contractors;
3) Operating Technical Specifications (Rev 6); and
4) Fire protection system.

Special mention was made of the ageing steam generators.

The good areas of performance that were identified, related to the:
1) Corrective Action Programme;
2) External Event Review Team (EERT) and External Events Safety Re-assessment Project, as a quick response to the Fukushima accident; and
3) Severe Accident Management Guidelines.

The OSART team has followed up on the corrective actions, confirming that these have been implemented, except for several minor omissions (such as trending of diesel generator fuel quality and housekeeping in the laboratory).

19.3.6.3 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 NPP in July 2014. 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 NPP.

As a basis for the review, the team used the Performance Objectives and Criteria for WANO peer reviews. These were applied and evaluated in light of the experience of team members and good practices within the industry.

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

The WANO team noted some improvements in selected areas since the previous review. Areas in need of improvement included operations, maintenance and radiation protection requirements, equipment performance and performance monitoring. The utility has developed action plans to address the areas for improvement and to recognise the importance of instilling high levels of worker behaviours to achieve and sustain performance achievement goals.

19.3.6.4 Structural integrity and containment structures

Eskom has responded to concerns raised by the NNR in terms of the condition of the containment structures at Koeberg NPP. During the reporting period Eskom have made progress on the necessary repair work, which mainly involves repair of delaminated concrete on the containment building of Unit 2.

Work on the Unit 2 containment building repairs is ongoing. During outage 221, the repairs in the area above and adjacent to the Unit 2 steam bunkers were completed. Unit 2 underwent the ten-yearly Integrated Leak Rate Test (ILRT) test. The structure showed good linearity and the new repairs behaved well and as expected during the testing, thus passing the test. During Outage 121 the repairs on the steam bunker area were completed. The Unit 1 containment building also underwent an ILRT after the repairs were conducted. The structure and the repairs behaved well and as expected and Unit 1 passed the ILRT test.

Adequate structural capacities/safety margins will need to be demonstrated to ensure safe operation during the long term operational phase. Information has been exchanged between the NNR and Eskom pertaining to concerns raised by the NNR, relating to the condition of the containment structures at Koeberg NPP.

19.4 Procedures for responding to operational occurrences and accidents

19.4.1 Requirements on accident and incident procedures

[Overview of the contracting party’s arrangements and regulatory requirements on procedures for responding to anticipated operational occurrences and accidents]

The SSRP [1.7] requires that, where the prior safety assessment or operational safety assessment (SAR for Koeberg) has identified the reasonable possibility of a nuclear accident, accident prevention and mitigation measures must be established, implemented and maintained. These measures must be based on the principle of defence-in-depth and which address accident management procedures including emergency planning, emergency preparedness and emergency response.

As indicated in section 9, the KLBM, which is included in the conditions of the Koeberg nuclear installation licence, 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, including procedures for responding to anticipated operational occurrences and accidents.

19.4.2 Emergency operating procedures

[Establishment of event-based and/or symptom-based emergency operating procedures]

Eskom is a member of the Pressurised Water Reactor (PWR) Owners Group, and utilises the Westinghouse generic Emergency Operating Procedure (EOP) package, including both Optimum Recovery Procedures and Function Restoration Procedures that have been specifically adapted for Koeberg NPP. The EOP package is maintained current with the latest changes as prescribed by the PWR Owners Group as applicable to Koeberg NPP.

The original suite of Koeberg incident operating procedures was reviewed and revised into the EOP's format. This suite of procedures is currently being adapted to align with the requirements of the Operating Technical Specifications to ensure that, where possible, the fallback state is driven by the incident procedure.

19.4.3 Severe accidents procedures

[Establishment of procedures and guidance to prevent severe accidents or mitigate their consequences]

A comprehensive set of severe accident management guidelines (SAMG) has been written, by Westinghouse, for the licence holder. These were authorised by the NNR for implementation in December 2000. The SAMG have been upgraded to include guidance for severe accidents initiating during shutdown conditions.

The SAMG also includes guidance on actions to respond to a severe accident in the fuel buildings with the following objectives:

1) To prevent melting of the spent fuel;
2) To provide a water cover to scrub fission products released from the spent fuel;
3) To prevent melt through of the spent fuel pool; and
4) To mitigate the fission product releases from the fuel building.

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

19.4.4 Management of accidents at multi-unit sites

[Establishment of procedures and guidance to manage accident situations at multi-unit nuclear installations and/or multi-facility sites]

As reported in Article 16, the Fukushima safety reassessment concluded amongst others that the emergency personnel are considered adequate for one unit failure, but are not considered adequate for emergencies occurring at both units.

Following this, Eskom has established a new functional organisation known as the Operation Support Centre to control and manage plant mitigation activities. This extra support organisation will comprise of an additional 13 positions on standby to ensure effective and timeous response to accident conditions. It is envisaged that the final implementation of this organisation will be completed in 2016. This will assist in ensuring that multiple response teams will be able to be dispatched simultaneously.

Severe accident management training covers multi-unit events. The SAMG are also applicable to both units. Sufficient trained experts in severe accident management exist to manage severe accidents on both units with sufficient procedural guidance from the SAMGs. In support of the experts, the Technical Support Centre has the capability to display and monitor plant data simultaneously for both units.

The OSART Mission in 2011 deemed this sufficient to meet the guidance provided in IAEA Safety Guide, NS-G-2-15 on multi-unit plants.

19.4.5 Regulatory review and control activities

The nuclear licence dictates compliance to the Koeberg Licensing Basis Manual (KLBM) (section 9), and by implication the implementation of the procedures, training, and development as well as approval for procedures and changes to such procedures.

Compliance to the operating procedures, staff training, and configuration management of the operating procedures is covered by the Regulator’s compliance inspection programme.

19.5 Engineering and technical support

19.5.1 Technical support for construction, operation and decommissioning

[General availability of necessary engineering and technical support in all safety-related fields for all nuclear installations, under construction, in operation or under decommissioning]

The requirements on management of safety (section 13.1) include organisational requirements that cover availability of necessary engineering and technical support in all safety-related fields. This applies to all nuclear installations, under construction, in operation or under decommissioning.

19.5.2 Availability of technical support for the holder

[General availability of necessary technical support on the site, and also at the licence holder or utility headquarters, and procedures for making central resources available for nuclear installations]

Eskom 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, Eskom engages the services of consultants. In addition, Eskom has entered into technical cooperation agreements with Électricité de France and other utilities in order to be advantageously positioned, and enjoy adequate support to address the range of competencies required in any given situation.

Looking to the future, Eskom is closely following how Électricité de France decommissions its older nuclear plants. Eskom’s decommissioning strategy, including financial provision is currently based on EDF's, but other international practice is also being monitored.

19.5.3 Dependence on consultants and technical support

Refer to 19.5.2.

19.5.4 Regulatory review and control activities

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

The regulations require that the NNR report on an annual basis on the adequacy of staffing of the nuclear installation. This report is provided in the Regulator's annual report. The NNR in turn requires the holder to conduct an annual assessment on its staffing and competency levels and to report to the NNR accordingly. This process is further covered by the Regulator's compliance assurance programme.

The current situation at Koeberg NPP is that all areas of technical support are well covered.

In response to a concern raised in the previous report by the NNR on overall quality of work (mainly by contractors) at Koeberg NPP, Eskom has implemented a plan of corrective action. The NNR continues to monitor implementation of the corrective actions. According to the inspections there is reasonable improvement in this regard.

19.6 Reporting of incidents significant to safety

19.6.1 Requirements on incident reporting

[Overview of the contracting party's arrangements and regulatory requirements to report incidents significant to safety to the regulatory body]

Section 4.10.3 of the SSRP [1.7] requires that a reporting mechanism be established, implemented and maintained for nuclear incidents, nuclear accidents or any other events that the NNR may specify in the nuclear authorisation.

The NNR has issued specific requirements on the reporting of incidents including the manner of reporting, timescales, classification, and corrective actions.

Section 6 of the SSRP provides a definition of a nuclear accident and incident and requires that the holder immediately inform the NNR when a nuclear accident or incident occurs, in terms of the current situation and its evolution. The NNR should also be informed of the measures taken to terminate the nuclear accident or incident and to protect workers and the public, and the exposures that have occurred and those expected to occur.

As indicated in section 9, 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, including procedures for reporting incidents significant to safety to the Regulator.

19.6.2 Criteria and procedures for incident reporting

[Overview of the established reporting criteria and reporting procedures for incidents significant to safety and other events such as near misses and accidents]

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

In order to comply with the NNR requirements for reporting of events, Eskom has established an approved procedure. The process is tracked using ActionWay, a condition reporting and management tool and can be summarised as follows:

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

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

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

1) Protection of the fuel;
2) Control of reactivity;
3) Containment of radioactive materials; and
4) 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 ActionWay reports are received by the NNR and the information is screened for statistical evaluation and analysis. This information is used as one of the tools to gauge compliance with the safety requirements, and the conditions of the nuclear installation licence.

Additionally this information is utilised to:
1) Amend the compliance inspection programme to reflect areas of weakness for further attention.
2) Influence the scope of audits to focus on apparent shortcomings.
3) Input plant-related data to the probabilistic risk assessment.
4) Emphasize training and competence in identified areas of operator licensing examinations.
5) Assist in the identification of human factors as root causes during human performance evaluation.
6) Highlight information for media transmittal and explanation of events including INES notification via the IAEA.

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

The nature of the NNR's event reporting requirements for the nuclear installation is such that events are categorised, graded and reported to the NNR in a manner related to their impact on the risk. This means that the reporting of any non-compliance is directly related to its safety significance and is dealt with by the licence holder and the NNR accordingly. At all times, the NNR ensures that non-compliant situations are identified, reported and dealt with in the shortest possible timescale. The criteria for non-compliance are 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. Eskom 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, where any matter of concern can be recorded and sent to the nuclear installation management and the NNR, anonymously if preferred.

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

19.6.3 Statistics of reported incidents significant to safety for the past three years

There have been no safety-related issues or events at Koeberg NPP graded level two or above on the INES scale. Refer to section 6.2.

19.6.4 Documentation and publication of event reports

[Documentation and publication of reported events and incidents by both the licence holders and the regulatory body]

Eskom reports significant nuclear safety events to WANO, and the NNR reports events to the IAEA Incident Reporting System (IRS).

19.6.5 Policy for use of the INES scale

The policy of Eskom and the NNR is to use the INES scale for reporting of nuclear events.

19.6.6 Regulatory review and control activities

The NNR reviews the incident reports submitted in terms of the requirements referred to in section 19.6.1. Depending on the level of severity, the NNR will prepare and submit a report to the media and to the IRS as appropriate.

The NNR compliance inspection programme covers the licence holder's processes for event reporting and corrective action processes.

19.7 Operational experience feedback

19.7.1 Requirements on collection, analysis and sharing of operating experience

[Overview of the contracting party's arrangements and regulatory requirements of the licence holders to collect, analyse and share operating experience]

The regulatory requirements dictate that the management is responsible for ensuring that systems are in place to continuously improve organisational systems and processes. This includes implementing operating experience and lessons learned from internal and external sources, both within and outside the nuclear industry. A systematic in-depth event analysis and corrective action process, which addresses human and organisational factors alongside technical issues, must be established.

As indicated in section 9, 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, including procedures for collecting, analysing and sharing operating experience.

19.7.2 Local and international operating experience feedback

[Overview of programmes of licence holders for the feedback of information on operating experience from their own nuclear installation, from other domestic installations and from installations abroad]

Eskom has an Operating Experience (OE) Group which is responsible for external experience feedback and the total direction and management of the OE system. (Refer to section 12.5.1).

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

Eskom reports significant nuclear safety events to WANO.

19.7.3 Procedures to analyse domestic and international events

The CEO of the licence holder produced a corporate directive, 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.” In order to implement and satisfy this directive, in conjunction with the requirements of the NNR, the licence holder’s management 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 Électricité de France, the Institute of Nuclear Power Operations, the World Association of Nuclear Operators, Framatome Owners Group, the Original Equipment Manufacturer and the United States Nuclear Regulatory Commission. Refer to Figure 19-1 for sources of operating experience information.

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

19.7.4 Feedback from operational events to modifications and training

[Procedures to draw conclusions and to implement any necessary modification to the installation and to personnel training programmes and simulators]

All internal events are entered onto the stations electronic condition reporting system (ActionWay) and receive an appropriate analysis, depending on the grading of the event (refer to section 12.5.1). External events (i.e. events reported by other plants/utilities) are also analysed for relevance to the station. The Corrective Action Review Committee reviews all the event analyses and endorses the recommended corrective actions or makes additional recommendations. These could include modifications to the plant, or to personnel training programmes, or simulators. Implementation of the recommended actions is also tracked on ActionWay.

19.7.5 Sharing experience feedback with other operating organisations

Eskom has a collaboration agreement with EDF and there is a Koeberg Integrated Team (KIT) established at the station composed of Koeberg and EDF staff. Operating experience from EDF and from Koeberg is shared with the respective organisations through the KIT (refer to section 12.5.1). Links to other organisations such as WANO are established through the KIT office.

19.7.6 Use of international information databases on operating experience

Covered by section 19.7.3.

19.7.7 Regulatory review and control of holder programmes

This process is covered by the Regulator's compliance assurance programme (section 7.2.3).

19.7.8 Regulatory body feedback of operational experience

[Programmes of the regulatory body for feedback of operational experience and the use of existing mechanisms to share important experience with international organisations and with other regulatory bodies]

As reported in section 8, the NNR has entered into various international bi-lateral agreements with other nuclear regulatory authorities and these forums are important in terms of operational experience feedback.

The NNR also reports events to the IAEA-IRS for international operational experience feedback. The IRS database is made available to all staff within the NNR and the nuclear installation. The NNR participates in the annual joint IAEA/NEA IRS meeting.

19.8 Management of spent fuel and radioactive waste on the site

19.8.1 Requirements for the on-site handling of spent fuel and radioactive waste

[Overview of the contracting party’s arrangements and regulatory requirements for the on-site handling of spent fuel and radioactive waste]

Regulatory requirements regarding radioactive waste management are given in the SSRP [1.7] in terms of a waste management programme, and the safety of long-term radioactive waste storage, clearance, discharge, and transport.

As indicated in Article 9, 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, including on-site handling of spent fuel and radioactive waste.

The nuclear licence restricts Eskom, in terms of the numbers of fuel elements stored in the spent fuel pools, and in terms of the number and type of spent fuel dry storage casks.

19.8.2 On-site storage of spent fuel

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

1) In a spent fuel pool which has been re-racked from the initial design to increase the physical storage place for spent fuel of both units. The increased storage of spent fuel in the spent fuel pool has necessitated the installation of a third train of spent fuel cooling.
2) In four dry storage casks in which a total of 112 spent fuel assemblies are stored.

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

The investigations will include the following options:

1) Long-term above ground storage on an off-site facility licensed for this purpose;
2) Reprocessing, conditioning and recycling in South Africa or in a foreign country;
3) Deep geological disposal; and
4) Transmutation.

In the interim, used nuclear fuel is, and shall continue to be stored in authorised facilities within the generator’s sites.

Eskom indicated that spent fuel storage capacity at Koeberg will need to be expanded, and has submitted a proposed strategy for spent fuel dry storage that includes the following four phases:

1) Extension of the use of the existing (four) spent dry fuel casks in the Cask Storage Building (CSB) at Koeberg.
2) Acquisition and use of additional casks to be stored in the CSB.
3) Establishment of a Transient Interim Storage Facility (on the Koeberg site).

4) Establishment of a Centralised Interim Storage Facility (off-site).

The NNR has formally accepted the strategy subject to the necessary approvals. Koeberg has initiated the process for the manufacture and procurement of seven additional dry storage casks to create additional storage space in the spent fuel pools to cater for the planned changes in fuel management. This is done while waiting on governments initiatives related to spent fuel management and final options chosen.

19.8.3 Implementation of on-site treatment, conditioning and storage of radioactive waste

The operational radioactive waste management programme implemented at the Koeberg NPP has been extensively covered in section 15.

19.8.4 Waste minimisation

[Activities to keep the amount of waste generated to the minimum practicable for the process concerned, in terms of both activity and volume]

Covered in section 15.

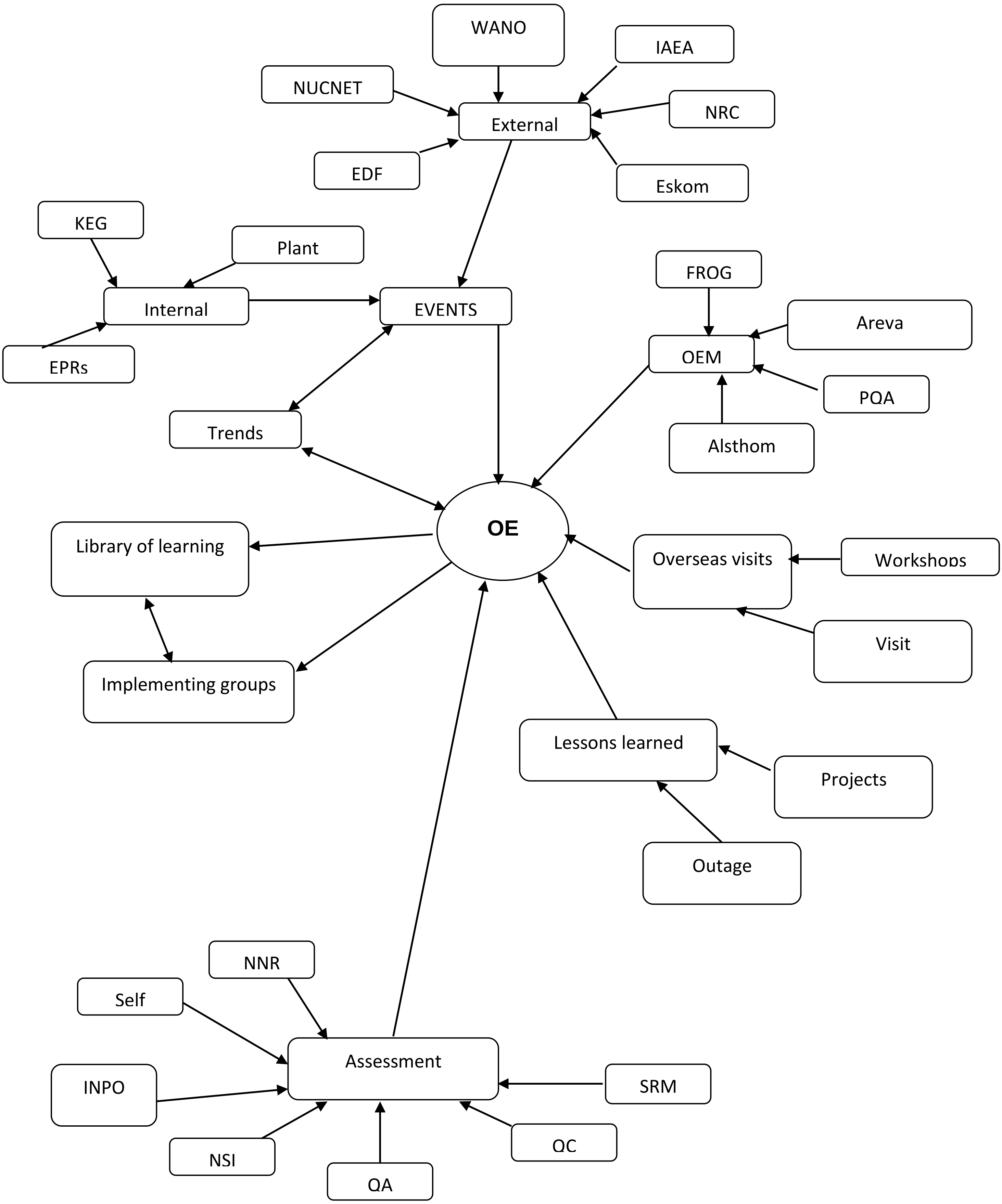
19.8.5 Established procedures for clearance of radioactive waste

Covered in section 15.

19.8.6 Regulatory review and control activities

Covered in Section 15.

Figure 19-1. Koeberg NPP OEF System



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D. ANNEXURES

D.1 Annexure 1: Results of Koeberg External Events Safety Reassessment

In light of the lessons learned from the Fukushima Daiichi nuclear accident in March 2011, Eskom completed a safety re-assessment of Koeberg NPP focussed on external events, both in the design basis and beyond design basis domains, as directed by the NNR. The safety re-assessment evaluated the provisions of the design basis concerning extreme natural phenomena and combinations of external events appropriate for the Koeberg site. The robustness of the facility's design to maintain its safety functions beyond the design basis hazards (which includes the prolonged losses of electrical power and the ultimate heat sink) was also evaluated. In this assessment, potential cliff-edges have been identified where the defence-in-depth will be eroded to the point where small deviations in plant behaviour could give rise to severe plant damage.

The assessment of the availability and reliability of accident management measures specifically considered events that potentially affect both Koeberg units, as well as the spent fuel storage facility. The adequacy of emergency management and response provisions was also assessed.

The re-assessment concluded that the Koeberg NPP is adequately designed, maintained and operated to withstand all the external events that were considered in the original design basis. Nothing has been found to warrant curtailing operation or to question the integrated design margins inherent in the current facility.

The assessment identified hardware modifications, additional procedural guidance and training and additional manpower and equipment that can extend the robustness of the facility to cope with extreme external events. These will increase plant safety margins, provide more flexibility and diversity for accident management and in some cases remove or extend identified cliff-edges. The provision of portable equipment has been considered as an alternative where plant hardware modifications are not feasible or cost beneficial. The portable equipment such as fire pumps, salvage pumps and diesel tankers have already been procured.

The station is currently designed to cope with a loss of off-site power for up to two days and for a station blackout of eight hours. Recognising that a severe external event may challenge the timely augmentation of off-site support and services, additional reserves of diesel fuel and associated equipment are being procured in order to extend this coping time.

Provided the potable water reservoirs remain intact, the station has adequate water supplies to supply make-up water for periods in excess of 20 days, using mobile water pumps. The complete loss of the ultimate heat sink (sea) will not result in fuel damage, but damage to the infrastructure will occur to the extent that the plant will be rendered unusable for future power generation.

The station is built on a terrace that provides an adequate margin against a design basis tsunami-induced flood. A flood higher than the design basis, which comes over the terrace, will render significant safety systems inoperable. In terms of flooding, this represents a cliff-edge. Further increasing the safety margins against flooding will require modifications to certain equipment and making some rooms housing essential equipment watertight.

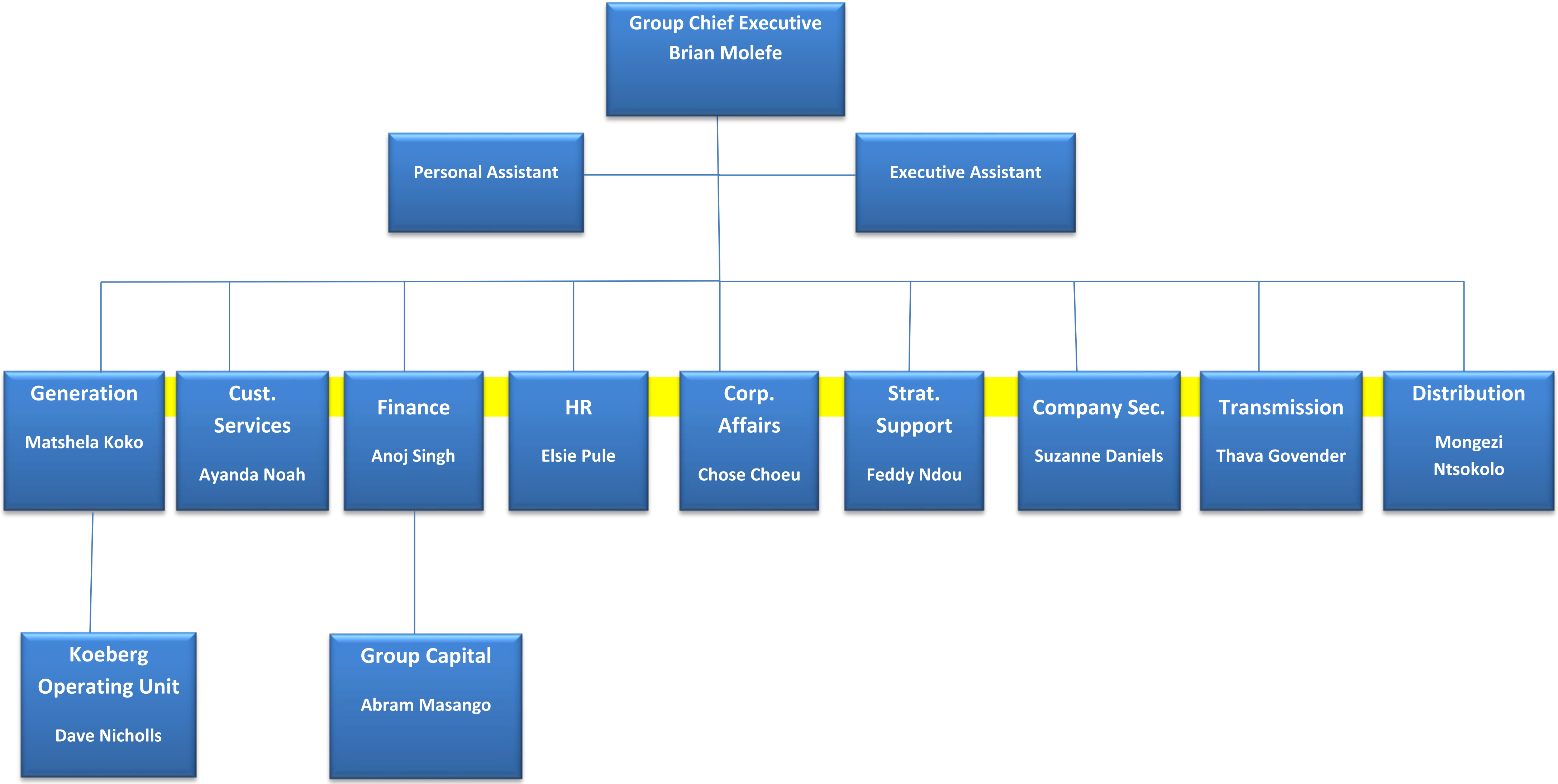
The plant’s design is robust against a seismic event with significant margin on most safety-related equipment. The fire protection systems for non-safety related plant equipment are not seismically designed and no reliance can be placed on these systems, and alternative measures are required. Most administration buildings and storage facilities are not seismically qualified. Collapse of these buildings following a seismic event could complicate the station’s response to such an event and may impede accessibility to vital recovery equipment and spares. The emergency control centre and Technical Support Centre are not equipped to adequately respond to a major earthquake. Improving this situation will require additional modifications.

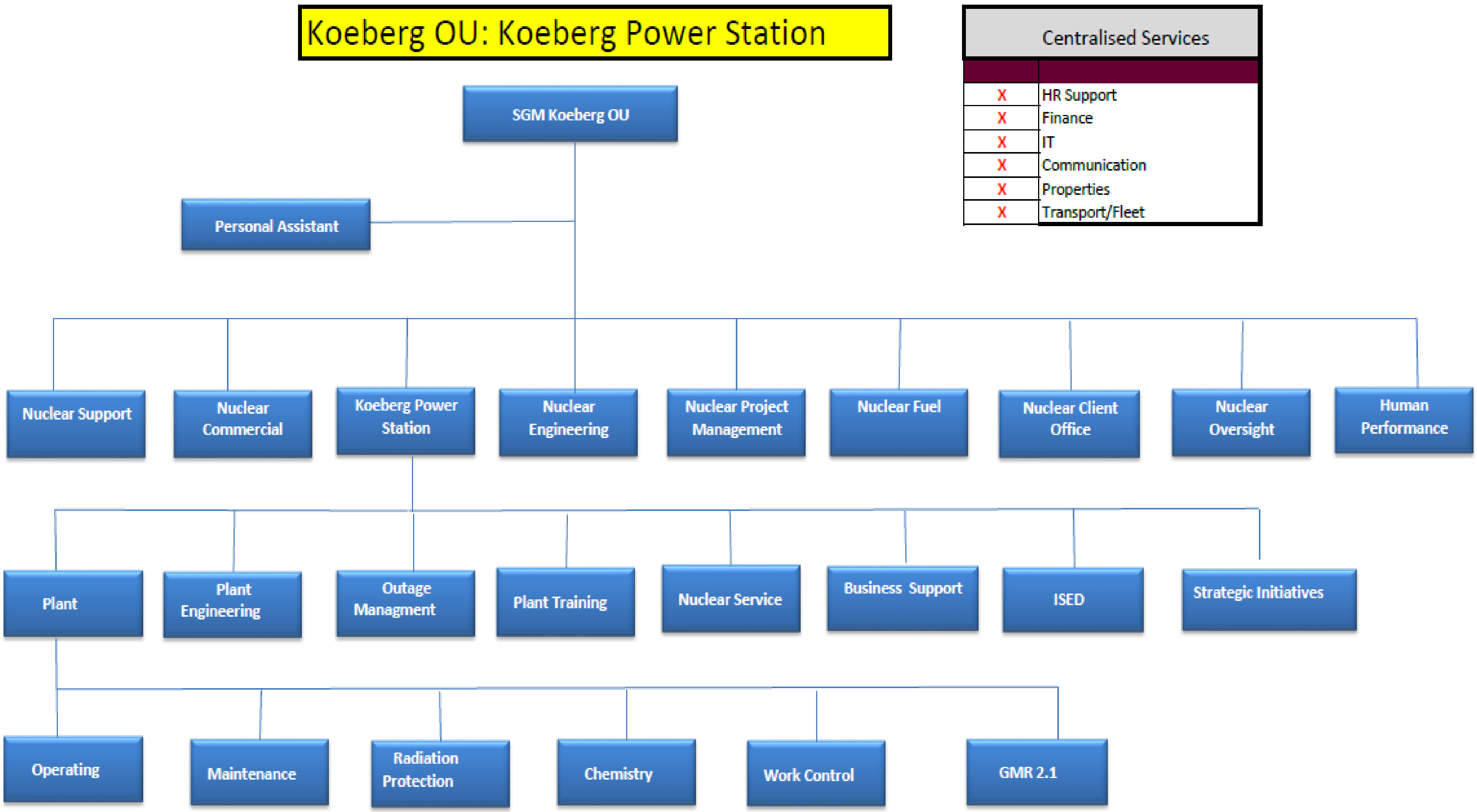
The planned installation of flanged connections in existing cooling systems is a reasonable, but effective means of utilising alternative sources of cooling water, and increases the flexibility and diversity of accident management. Similarly, the planned installation of terminal panels and junction boxes with electrical cross-connection cabling is an effective means of facilitating the supply of alternative electrical power from other areas of the plant and from off-site sources.

The current emergency plan would be challenged if faced with an accident of the severity experienced at Fukushima Daiichi. Some equipment used in the plan does not have the suitable capability to withstand certain external hazards.

Equipment is stored and temporary buildings are erected on the Koeberg site in a manner that could complicate the station’s response to a severe external event, for example by blocking access routes, generating missiles, etc. General design basis weaknesses have been identified for protection against wind-borne and tornado-borne missiles and dealing with large chemical spills.

D.2 Annexure 2: Eskom Organisational Structure




Koeberg OU: Koeberg Power Station
Centralised Services
X HR Support
X Finance
X IT
X Communication
X Properties
X Transport/Fleet
SGM Koeberg OU
Personal Assistant
Nuclear Support
Nuclear Commercial
Koeberg Power Station
Nuclear Engineering
Nuclear Project Management
Nuclear Fuel
Nuclear Client Office
Nuclear Oversight
Human Performance
Plant
Plant Engineering
Outage Managment
Plant Training
Nuclear Service
Business Support
ISED
Strategic Initiatives
Operating
Maintenance
Radiation Protection
Chemistry
Work Control
GMR 2.1

Restricted

D.3 Annexure 3: Post-Fukushima Actions

External Events

No changes to the Koeberg Licensing Basis have been identified as a result of the safety reassessments. Although no peer review has been conducted, benchmarking has been performed against international bodies with regard to the safety reassessments.

The beyond design basis scenarios addressed in the safety assessment are:

- Seismic;
- Tsunami;
- Flooding;
- Hail;
- Lightning;
- High wind;
- Tornado;
- Jellyfish;
- Oil spill;
- Fire;
- Explosions (on and off-site);
- Chemical spill;
- Aircraft crash;
- Cyber-attack; and
- Solar flares.

Other assessments conducted include assessment of the emergency plan, the steam line break in the turbine hall, loss of off-site power supply, loss of all AC power and loss of ultimate heat sink, credible combinations of events (including earthquake and tsunami, and severe storm and induced events), as well as review of the emergency operating procedures and severe accident management guidelines. For all these, hazards of varying magnitudes were analysed, safety margins were evaluated and cliff-edges were identified.

The safety reassessments resulted in many proposed actions to further improve plant robustness, and strategies have been developed to further enhance safety. Plant modifications resulting from proposals from the safety reassessment will be designed to be robust against external events beyond the design basis of Koeberg NPP. The objective of these modifications is to provide additional layers of defence-in-depth that are even more robust against external events than the existing plant design. The term 'hardened' is used to describe this additional robustness in design.

All the plant modifications described below are being designed to be operational after a beyond-design-basis external event.

Solution concept: Portable equipment

In the assessment of the lessons learned from the accident at Fukushima Daiichi, one of the most important and internationally prevalent concepts developed is that of using portable equipment to provide additional, flexible, and diverse methods to restore and maintain critical safety functions such as fuel cooling, emergency power, and containment integrity using a defence-in-depth approach.

Eskom is in the process of developing strategies to allow for portable equipment to be used for the provision of water and electricity to the plant to provide critical safety functions under beyond-design-basis conditions. Although the active parts of the systems can be portable, for example, the diesel-powered pumps and generators, permanently installed infrastructure is also required.

This solution concept is also commonly referred to as ‘plug-and-play’. Eskom has developed strategies for water and electrical supply and identified modifications to implement the portable equipment solutions concept.

Two projects are planned to provide for a hardened water supply strategy, namely, Hardened Water Supply and Hardened Water External Connection Points (ECPs). This is in order to provide an on-site hardened water reservoir and a hardened water distribution system to provide water for accident mitigation.

A modification is under development to install hardened electrical External Connection Points to allow for the connection of mobile emergency diesel-powered generators to supply essential power to the train A (LHA) and train B (LHB) emergency switchboards. There will be two electrical ECPs per unit leading into the unit 1 and unit 2 electrical building with permanently installed cables that run from the electrical ECPs to the LHA and LHB boards.

In order to support the strategies under development that allow for portable equipment to be used for the provision of water and electricity to the plant to provide critical safety functions under beyond-design-basis conditions, a storage building is required to house the portable emergency equipment. This equipment will be required to mitigate the effects of BDB external events. The storage building must therefore protect the equipment from the normal highly corrosive coastal environment, from the weather, and from the effects of BDB external events. One of the buildings on site has already been modified to house some of the newly procured equipment, including a new fire tender.

Solution concept: Hardened instrumentation system

The nuclear power plant design includes various systems that require instrument-based monitoring and control of parameters important to nuclear safety. The existing instrumentation systems are designed to function under design basis accident conditions and have not been designed to function during and after a BDB external event. In order to manage transients related to BDB external events, it is required to introduce hardened independent monitoring of certain critical parameters. This project is to provide an alternative hardened source of critical plant parameter information during a BDB event to enable a plant operator to make operational decisions to prevent or mitigate fuel damage and/or to minimise radiological releases.

The primary purpose of the new hardened instrumentation system is to ensure that it will be possible to monitor all critical parameters during a station blackout that may have been caused by a BDB external event.

During a station blackout, this new hardened system must be able to indicate 1) core temperature, 2) the water levels inside the steam generators, 3) the pressure inside the steam generators, 4) the pressure inside the containment, and 5) the water levels inside the spent fuel pool including under boiling conditions.

Procedure enhancement

Project number 12001 (External Event Response Procedures Project) is underway to further improve the robustness of Koeberg's suite of incident and accident response procedures.

A new shutdown accident procedure for station blackout whilst the plant is in shutdown modes is to be developed. In addition to this, the existing shutdown accident procedures KWB-I-RRA-2 (Loss of Core Cooling at Shutdown) and KWB-I-RRA-3 (Loss of Inventory in RRA Conditions) are to be updated.

Numerous steps in the Koeberg emergency operating procedures, the function restoration procedures, and the incident operating procedures direct the user to seek advice from the Technical Support Centre (TSC) when under potentially difficult, complex, and time-stressed situations. Currently, there is no documented guidance available to the TSC personnel on how to assess and respond to such requests. A support manual for the TSC is to be developed in order to provide predetermined, standardised guidance to the TSC staff on how to respond when the control room operating procedures instruct the user to obtain assistance from the TSC. The purpose of the TSC support manual is to provide structured information to the TSC staff for performing technical evaluations and making recommendations during implementation of the emergency operating procedures, function restoration procedures, and the incident operating procedures when the control room operators are procedurally directed to consult the TSC.

A post-Fukushima update of the Pressurised Water Reactor Owners Group (PWROG) generic SAMGs, on which the Koeberg-specific SAMGs are based, was released in 2013 (LTR-RAM-I-13-004). This followed on from a revision in 2012 of the EPRI severe accident management guidance technical basis report (TR-1025295), which forms the technical basis of the PWROG generic SAMGs. The Koeberg SAMGs were reviewed against the newly released PWROG generic SAMGs and updated to the Koeberg-specific SAMGs and related background documents are in progress. The purpose of these updates is to keep the Koeberg SAMGs aligned with international best practices. The current updates are in addition to an earlier 2012 update of the Koeberg-specific SAMGs that followed from an internal Eskom post-Fukushima review.

Local action sheets are to be developed in order for critical indications to be read when their normal power supply is lost. The proposed indications are:

- Core temperature;
- Steam generator wide-range level;
- Steam generator pressure;
- Containment pressure;
- Spent fuel pool level; and
- Reactor Primary System pressure.

Status of implementation

1. Hardened Water Supply Project

The feasibility study for the options associated with this project has been completed. The technical requirements specification has been completed and the execution release approval is scheduled for July 2016. The beginning of the implementation phase is proposed for April 2017.

2. Hardened Water External Connection Points Project

The technical requirements specification has been completed. The execution release approval is at 80% and the implementation of this project is scheduled for June 2017.

3. Hardened Electrical External Connection Points Project

The technical requirements specification has been completed and the design is completed and awaiting the NNR approval which is expected in June 2016. Implementation is scheduled for outages 122 and 222 which are scheduled to start in September 2016 and March 2017 respectively.

4. Hardened Storage Building Project

This feasibility study has been completed. Compilation of the technical requirements specification was started in March 2016. Implementation is planned to commence in September 2017.

Due to the delay in implementation of the project, an interim storage facility has been made available for the Portable Emergency Equipment (PEE) that has been delivered to the site to date. An additional facility will be sourced for identified PEE that is due for delivery.

5. Portable Emergency Equipment

Table 1 below shows the list of PEE already delivered to site and a few that will soon be delivered. All the PEE is currently stored in interim storage facilities. Procedures to use the PEE are in place and relevant personnel have been trained on the use of the PEE. The PEE has been included in periodic emergency exercises.

Table 1: Status of procured items

Item description	Status	Planned delivery date
Portable pump hoses	Procured and available on site	Not applicable
Ventilation fans	Procured and available on site	Not applicable
Satellite phones	Procured and available on site	Not applicable

Item description	Status	Planned delivery date
Multimeters	Procured and available on site	Not applicable
Floating pumps	Procured and available on site	Not applicable
Salvage pumps	Procured and available on site	Not applicable
Torches	Procured and available on site	Not applicable
Compressor for SCBA tanks	Procured and available on site	Not applicable
Hazmat suits	Procured and available on site	Not applicable
Gas monitors	Procured and available on site	Not applicable
Oxygen monitors	Procured and available on site	Not applicable
Evac-chair	Procured and available on site	Not applicable
Thermal imaging cameras	Procured and available on site	Not applicable
Fire truck	Procured and available on site	Not applicable
Mobile emergency diesel generators	Tender invitation being drafted	To be determined
Diesel storage tanks	Procured and available on site	Not applicable
Trailer-mounted low-flow pumps	Procured and available on site	Not applicable
Diesel tankers	Contract awarded	June 2016
Trucks to haul the diesel tankers	Contract awarded	June 2016
Trailer-mounted high-flow pump	Contract awarded	July 2016
Compact loader (small vehicle for the removal of debris)	Tender invitation being drafted	To be determined

6. Hardened Instrumentation Project

The feasibility study and functional requirements specification have been completed for this project. Implementation is planned for outages 125 and 225, which are scheduled to start in March and September 2021 respectively.

7. External Event Response Procedures Project

Execution release approval for this project has been granted. The plan is to submit the procedures to the NNR to gain approval by 2017. Implementation will take place in July 2017.

8. Review and Update of Severe Accident Management Guidelines

An assessment was conducted on the SAMGs in August 2011 to establish the current preparedness of existing accident mitigation and emergency plan strategies, using lessons learned from the Fukushima accident as well as OE from other utilities. The assessment led to updates to the SAMGs and related procedures, as well as corrective maintenance on line-ups and equipment required for severe accident mitigation.

The SAMGs were later also updated to include usage of the mobile diesel water pumps procured as a response to the Fukushima incident. The pumps can be used to make up the auxiliary feedwater tank, direct injection into the steam generators and spent fuel pool make-up.

9. Review and Update of Emergency Response Procedures

Emergency response procedure for responding to incidences during transportation of spent fuel was updated to include a response to events affecting stored spent fuel (in dry casks). The procedure outlining the standby organisation of Koeberg NPP was updated by using lessons learned from Fukushima, and now provides guidance in ensuring that the needs of family members of the Emergency Response Organisation are taken care of while members are busy with the emergency.