9TH NATIONAL REPORT BY SOUTH AFRICA ON THE CONVENTION OF NUCLEAR SAFETY

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The South African National Nuclear Regulator prepared this report on behalf of the Department of Mineral Resources and Energy in consultation with and incorporating contributions from Eskom Holdings SOC Ltd.

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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.

ABBREVIATIONS

AADQ	Annual Authorised Discharge Quantities
AEC	Atomic Energy Corporation
ALARA	As Low As Reasonably Achievable
ALMERA	Analytical Laboratories for the Measurement of Environmental Radioactivity
ANS	American Nuclear Standards
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASN	Nuclear Safety Authority
CAP	Compliance Assurance Plan
CAR	City Amendment Request
CAS	Central Alarm System
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
CRDM	Control Rod Drive Mechanism
CSS	Corporate Support Services
DAC	Derived Air Concentration
DBA	Design Basis Accident
DCT	Disaster Coordination Team
DEC	Design Extension Conditions
DMRE	Department of Mineral Resources and Energy
DOC	Disaster Operations Centre
DoH	Department of Health
ECC	Emergency Control Centre
ECP	External Connection Points
EDF	Électricité de France
EERT	External Events Review Team
EOP	Emergency Operating Procedure
EPA	Executive Personal Assistant
EPD	Electronic Personal Dosimeter
EPR	Emergency Planning And Response
EPREV	Emergency Planning Review

ABBREVIATIONS

EPRIMS	Emergency Preparedness and Response Information Management System
EPSOC	Emergency Planning Steering and Oversight Committee
GSR	General Safety Requirements
HRA	Human Reliability Analysis
IAEA	International Atomic Energy Agency
ICCP	Impressed Current Cathodic Protection
ILRT	Integrated Leak Rate Test
IMS	Integrated Management System
INES	International Nuclear Event Scale
INIR	Integrated Nuclear Infrastructure Review
INPO	Institute of Nuclear Power Operations
INSAG	International Nuclear Safety Advisory Group
IRP	Integrated Resource Plan
IRRS	Integrated Regulatory Review Service
IRS	Incident Reporting System
ISIP	In-Service Inspection Programme
ISO	International Organization for Standardization
ISTP	In-Service Testing Programme
KEG	Koeberg Events Group
KINS	Korea Institute of Nuclear Safety
KIT	Koeberg Integrated Team
KLBM	Koeberg Licensing Basis Manual
KNPS	Koeberg Nuclear Power Station
KORC	Koeberg Operational Review Committee
LTO	Long Term Operation
MDEP	Multinational Design Evaluation Programme
MWe	Megawatt Electrical
NAB	Nuclear Auxiliary Building
NEA	Nuclear Energy Agency
Necsa	South African Nuclear Energy Corporation
NERC	North American Electric Reliability Corporation
NIL	Nuclear Installation Licence
NISL	Nuclear Installation Site Licence
NNR	National Nuclear Regulator
NNSA	National Nuclear Safety Administration
NORM	Naturally Occurring Radioactive Material
NOU	Nuclear Operating Unit

ABBREVIATIONS

NPO	Nuclear Plant Operator
NPP	Nuclear Power Plant
NRC	United States Nuclear Regulatory Commission
NRWDI	National Radioactive Waste Disposal Institute
NSA	Nuclear Safety Assurance
NSSS	Nuclear Steam Supply System
NTN	Nuclear Technology and NORM
NTWP	Nuclear Technology and Waste Projects
NUREG	United States Nuclear Regulatory Commission Regulation
OE	Operating Experience
OHNP	Occupational Health Nursing Practitioner
ONR	Office for Nuclear Regulation
OOG	Outage Operating Group
ORT	Operation At Reduced Temperature
OSART	Operational Safety Review Team
OSGISF	Original Steam Generator Interim Storage Facility
OTG	Operator Training Group
OTS	Operating Technical Specifications
PAIA	Promotion of Access to Information Act
PPE	Personal Protective Equipment
PRIS	Power Reactor Information System
PSA	Probabilistic Safety Assessment
PSHA	Probabilistic Seismic Hazard Analysis
PSIF	Public Safety Information Forum
PTR	Refuelling Water Storage
PWR	Pressurized Water Reactor
PWROG	Pressurized Water Reactor Owners Group
QA	Quality Assurance
QMS	Quality Management System
RERC	Regulatory Emergency Response Centre
RITS	Regulatory Improvement and Technical Services
RPV	Reactor Pressure Vessel
SALTO	Safety Aspects of Long-Term Operation
SAMG	Severe Accident Management Guidelines
SAR	Safety Analysis Report
SCSA	Safety Culture Self-Assessment
SENPEC	Shanghai Electric Nuclear Power Equipment Company

ABBREVIATIONS

SFP	Spent Fuel Pool
SHEQ	Safety Health Environment and Quality
SRA	Safety Reassessment
SSCs	Structures, Systems And Components
SSCWG	Safety and Security Culture Working Group
SSHAC	Senior Seismic Hazard Analysis Committee
SSR	Site Safety Report
SSRP	Safety Standards and Regulatory Practices
STUK	Radiation and Nuclear Safety Authority
TEM	Traffic Evacuation Model
TISF	Transient Interim Storage Facility
TLD	Thermoluminescent Dosimeter
TSC	Technical Support Centre
USA	United States of America
VDNS	Vienna Declaration on Nuclear Safety
WANO	World Association of Nuclear Operators

A. INTRODUCTION

A. INTRODUCTION

South Africa ratified the Convention on Nuclear Safety (CNS) [5.6] 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 defences 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; and
3) Prevent accidents with radiological consequences and mitigate such consequences should they occur.

South Africa has more than 35 years of experience in the safe operation of its two-unit 1 840 Mwe Koeberg Nuclear Power Station (KNPS) and, moreover, has experience in research, development and use of nuclear related technology. As a contracting party (CP) 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 for activities related to nuclear power plants (NPPs). Each CP is obligated to 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 in and contribute to the compilation of the 9th National Report of South Africa, as envisaged by the Convention. Stakeholders included licensees and the executive authority responsible for the National Nuclear Regulator (NNR).

As provided for in the Guidelines regarding National Reports under the CNS, INFCIRC/572/Rev.6 [5.1], the intent of a review process amongst member states 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 sharing knowledge and practices related to emerging issues. In addition, South Africa promotes international cooperation to enhance global nuclear safety through various instruments such as bilateral and multilateral agreements.

In terms of the NNR Act (No. 47 of 1999) [1.1], the NNR is mandated to fulfil national obligations with respect to international legal instruments concerning nuclear safety and to act as the national competent authority in connection with the IAEA's Regulations for the Safe Transport of Radioactive Material. The NNR coordinates and implements South Africa's obligations to the CNS and the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management [5.7].

The national aspirations regarding nuclear energy are embodied in the Nuclear Energy Policy for the Republic of South Africa [2.1], which makes provision for a planned energy mix that includes nuclear energy. The government's vision for nuclear energy shall be guided by a number of principles, including the use of nuclear energy to diversify primary energy sources to ensure security of energy supply, the maximum utilisation of the country's uranium resources, and the contribution to economic growth and job creation. In terms of this policy, 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, ensuring a high priority to nuclear and radiation safety.

The most recent Integrated Resource Plan (IRP) [2.2] was published in October 2019 and aims to balance a number of objectives, namely to ensure security of supply, to minimise the cost of electricity, to minimise negative environmental impact, and to minimise water usage. The 2019 IRP apportions 2 500 MW of energy to nuclear power, and plans should immediately be put in place to accomplish this goal. Planned capacity from nuclear technology must be based on affordability assessments following proper testing of the market on factors such as financing, ownership and project timelines. Given the long lead times for manufacturing of the main components, proactive planning for additional nuclear capacity is a requisite in the timely implementation and construction of new infrastructure.

In accordance with long-term planning, Eskom applied to the NNR in March 2016 for the licensing of two nuclear sites. These are Duynefontyn, an existing site where Koeberg NPP operates in Cape Town, and Thyspunt, a greenfield site in Oyster Bay, near Port Elizabeth (now Gqeberha). The NNR has undertaken the review of the Site Safety Report (SSR) for the Thyspunt site and completed the safety evaluation report in March 2022.

This report provides an update on the South African activities in compliance with the Articles of the CNS. The main issues addressed in this report relate to new safety issues that have emerged since the last Review Meeting, and progress in terms of the challenges and suggestions mentioned in the 7th Review Meeting, including those that have been closed out. The report also focuses on South Africa's experience with regard to the COVID-19 pandemic.

B. SUMMARY

This report presents South Africa's continued efforts to achieve the objectives of the Convention on Nuclear Safety [5.6]. The highlights of the report are summarised below (relevant headings are in italics as per INFCIRC/572/Rev.6 [5.1]):

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

The safety issues highlighted in the President's letter of 23 June 2021 and have been outlined in this National Report as per the guidance provided in the said letter.

Future safety-related activities and programmes planned for the next period until the 10th Review Meeting

The Eskom Koeberg NPP's steam generators are planned to be replaced in 2023. Plans to replace them in 2022 were postponed due to outage scheduling challenges and the need to have the NPP connected to the grid.

The Duynefontyn Site Safety Report (SSR) is being submitted to the NNR in stages as of February 2022. This excludes the detailed seismic study that is the Senior Seismic Hazard Analysis Committee (SSHAC Level 3), which will only be completed after 2024. The seismic study requires the use of quality data, which is currently being obtained by Eskom.

The Long-Term Operation (LTO) safety case of Koeberg Nuclear Power Station will be submitted to the NNR by July 2022.

The Periodic Safety Review started in 2021 and is expected to be concluded by 2022.

Issues and topics as identified and agreed by Contracting Parties at the Organisational Meeting

Pursuant to the organisational meeting of November 2021, given the hiatus created by the cancellation of the 8th Review Meeting, the issues taken from the President's letter of 23 June 2021 have been enumerated in this National Report. The hurdle in particular relates to the Covid-19 safety related issues since the last Review Meeting, the challenges and suggestions from the 7th Review Meeting, and the country's response to the COVID19 pandemic as it pertains to the regulatory body and the licensee respectively. Details regarding the response to the COVID-19 pandemic are presented in Annexure D3.

The questions posed to South Africa in this phase were used as a basis to update the report where necessary. As these questions raise numerous issues, they have been selectively addressed based on their relevance to the Articles of the CNS.

Responses to the results of the previous peer review: suggestions and/or challenges summarised in the Rapporteur's Report

Challenge 1: Multiple projects are being implemented concurrently at the licensee. The NNR requested the licensee to develop a turnaround plan to improve their project management practices, human factors and safety performance. The licensee has provided reporting to indicate that they have prioritised the management of projects and recognise that improvements are needed regarding human and organisational factors. This challenge, however, will require continued attention from the licensee.

Challenge 2: The NNR has been increasing its staff compliment to ensure that sufficient resources are in place. The NNR embarked on a staff sizing exercise by benchmarking with other regulatory bodies whose industries are comparable to those in South Africa. The outcome was a five-year staffing plan (2019–2023) that can be incrementally implemented based on the availability of financial resources.

Challenge 3: The regulatory framework has been enhanced to include principles, safety criteria, and requirements provided for by the most recent IAEA Safety Standards. A required key area was a regulation on long term operation of nuclear installations, which was issued in October 2021. The primary legislation for nuclear safety was issued for public comment in May 2021 after having undergone a thorough review. It is currently being finalised for approval by cabinet after which it will need to be approved by the South African Parliament.

There were no suggestions from the previous Rapporteur's Report for South Africa.

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

The nuclear new build planning was delayed due to the significant amount of time needed to update the IRP 2010-30. The revision led to the IRP 2019, which was eventually published in October 2019, this sets goals and timelines for new nuclear power generation and provides planning for the country's energy mix for both the short and long term.

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

South Africa has benefitted enormously from past international peer review missions, after the Integrated Regulatory Review Service (IRRS) Mission of 2016, each participating stakeholder in South Africa developed an Action Plan to address the observations from the mission. Progress regarding the Action Plans is reported at the biannual Joint Coordination Committee meetings, which involve the relevant entities.

The recommendations and suggestions from the IRRS Mission have been combined with the self-assessment findings and incorporated into an Action Plan. The Action Plan is included in the Divisional Annual Performance Plan of the Regulator and a project management team has been appointed to implement the actions. Quarterly team meetings are conducted to monitor progress and challenges. Eighty percent (80%) of the IRRS and self-assessment actions that were planned for implementation over a two-year period since the 2017/18 financial year have been completed.

Some of the actions specific to the NPP include a process for the acquisition of the necessary regulatory experience, guidance for the different stages of a nuclear installation's lifetime, guidance on the format and content of the related documents for the licensing process, a graded approach in the authorisation procedure for the different stages of a nuclear installation's lifetime, guidance related to long-term shutdown, a procedure to review the periodically updated Safety Analysis Report, and internal guidance for design and operation of nuclear facilities. A draft Decommissioning Policy has been issued for stakeholder comments following the July 2020 Discussion Paper on National Decommissioning Policy for Nuclear Facilities.

The integration of regulatory bodies (i.e. those mandated to provide oversight of nuclear facilities and activities, and those mandated to provide oversight of medical, industrial and research applications) has proved to be a challenge in so far as clarification of roles and responsibilities among parties involved, this has in turn affected the approach to conducting a follow-up IRRS Mission. Based on the progress and impact of the integration process, the Joint Coordination Committee will make a recommendation to the Department of Mineral Resources and Energy regarding the way forward.

The IAEA Safety Aspects of Long-Term Operation (SALTO) peer review took place at the Koeberg Nuclear Power Station between 22 and 31 March 2022. The findings are reported in section 19.3.6.1 of this report. An implementation plan is being put in place in preparation for long term operation (LTO).

Include measures taken to voluntarily make public the reports of international peer review missions

The Minister of the Department of Mineral Resources and Energy of South Africa has granted approval to the IAEA to make the IRRS Mission report available to the international community. Other peer review mission reports that are more focused on internal NNR matters are progressed within the NNR and not necessarily made public.

Peer review mission reports such as pre-SALTO, INIR and Emergency Planning Review (EPREV) reports remain restricted. However, press conferences are held with media houses to make findings available to the public.

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

Operational experience feedback is reported in section 19.7.

Address lessons learned from emergency drills and exercises

Emergency exercises and lessons learned are reported in section 16.1.5.2

Address actions taken to improve transparency and communication with the public

Openness and transparency of regulatory activities are reported in section 8.1.10. Actions are focused on proactive stakeholder engagement, a forum where safety issues are presented to the public and the use of on-line communication, including the use of social media. The legislative mechanism that ensures transparency is the Promotion of Administrative Justice Act [1.11].

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

Respond to any recommendations adopted at the plenary sessions of previous Review Meetings

The 8th Review Meeting of the CNS did not take place due to international concerns related to travel and the prevention of infection during the pandemic. The recommendations from the 7th Review Meeting are retained in this report for the purpose of the peer review process. South Africa previously reported on safety culture, international peer reviews, legal framework and independence of the regulatory body, financial and human resources, knowledge management, supply chain, managing the safety of ageing nuclear facilities and plant life extension, emergency preparedness, and stakeholder consultation and communication. These key issues have been retained in the 9th National Report. However, it must be emphasised that it was necessary to update most of the issues to reflect the current situation.

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 the Convention enters into force for that contracting party is reviewed as soon as possible. When necessary, in the context of this Convention, the contracting party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the 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 report on a significant event.

Section 6.3 has been updated to report on safety upgrading.

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

ARTICLE 6: EXISTING NUCLEAR INSTALLATIONS

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 power plants were found, when assessed, to require any significant corrective actions under Articles 10 through 19 of this Convention. However, safety improvement initiatives have been implemented, and continue to be 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 one International Nuclear Event Scale (INES) Level 1 event.

On 28 October 2021 at approximately 15h00, the Central Alarm System (CAS) ventilation system charcoal filter efficiency test was performed on the CAS ventilation system filter, 6SSM401PI. This in-service test is conducted every 18 months. All pre-system leak checks were performed as required. The filter efficiency test involves the injection of radioactive I-131 into the ventilation system ducting under controlled conditions. The ventilation system was configured and lined up to enable this test to be conducted safely and in a manner that prevented the spread of airborne contamination from the system.

Air samples were taken at various locations during and after the test. Transmission of the air sample media to chemistry was delayed as the shift chemist was busy with priority plant chemistry activities. The analysis results were received at approximately 01h00 on 29 October 2021. Upon review, it was detected that the I-131 activity inside the CAS was measured to be 0.75 DAC. This exceeded the station limit for declaration and establishment of an airborne contamination zone. A follow-up air sample was collected, and elevated airborne radioactivity was detected (0.37 DAC). A decision was made to remove personnel from the CAS and activate the alternative security control room. Affected personnel were identified and sent for whole body counts. The system line-up was modified to allow for faster removal of air to clean up the CAS atmosphere in order to allow access again. The source injection equipment was isolated from the ventilation system to prevent any possible ingress of further activity into the CAS. The incident was rated at INES Level 1 as some personnel were subjected to uptakes in the order of 100 uSv.

Koeberg Nuclear Power Station experienced no safety-related issues or events graded Level 2 or above on the INES.

6.3 Planned programmes and measures for continued safety upgrading

The planned programmes and measures for continued safety upgrading are performed in support of the long-term operation of the KNPS. The details are provided in section 18.1.6.

The plant life extension modifications are addressed in section 18.1.6.4.
The Regulator varied the nuclear installation licence (NIL), NIL-01, and issued variation 19 during the reporting period. The variation includes a condition that requires the operator to perform systematic reviews and reassessments of safety cases every ten years or as directed due to operating experience. Regulations and the associated guidance document have been drafted to support the implementation of the licence condition. As such, the periodic safety reviews must be performed against current standards and reasonably practicable safety improvements are to be implemented within the review period.

Safety improvements, whether through review or actual modifications, are ongoing. The safety improvements required in the short and medium term will focus on the reassessment being performed as part of the steam generator replacement project, the next planned periodic safety review, the process for possible LTO and the management of high-level radioactive waste. These improvements should be justified and based on good engineering practice.

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

The NNR has not identified any event that required the shutdown of the nuclear installations. Furthermore, the operator is pursuing possible long-term operation of the KNPS.

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

The NNR accepts the continued operation of the KNPS based on the following:

ARTICLE 6: EXISTING NUCLEAR INSTALLATIONS

1) The positive outcome of the assessments discussed in Article 14 and Article 18, which demonstrates that KNPS 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), which confirms that KNPS follows the conditions of the licence; and
3) The conclusions of the IAEA, namely the Operational Safety Review Team (OSART) and SALTO missions reported in section 19, and Eskom's commitment to the timeous response to the findings.

However, this conclusion is informed by the following:

1) The effectiveness of the projects planned or being implemented by Eskom;
2) The continued commitment to the availability of both financial and human resources and the effectiveness of Eskom's ongoing recruitment, training and skills-retention programmes; and
3) The continued cooperation by the local authorities in terms of urban developments in the vicinity of KNPS.

At the time of compiling this report there was no compelling reason to prohibit the continued operation of the KNPS.

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 with regard to 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 licences; and

   d) The enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.

Summary of changes

Section 7.1 has been updated to report on the update of the regulatory framework for LTO.

Section 7.2.2 has been updated to reflect changes in regulatory requirements for LTO.

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, 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.

ARTICLE 7: LEGISLATIVE AND REGULATORY FRAMEWORK

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 NonProliferation 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 NNR Act [1.1] and the National Radioactive Waste Disposal Institute Act (No. 53 of 2008) [1.6]. The Department of Mineral Resources and Energy (DMRE) administers these Acts. In addition, the Department of Health (DoH) 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 that is intended to be used for medical, scientific, agricultural, commercial or industrial purposes.

In June 2021, the Minister of the DMRE published the draft National Nuclear Regulator Amendment Bill for public comment. The changes proposed in the Amendment Bill aims to address recommendations from IAEA peer review missions, lessons learned with the implementation of major projects and the operation of existing nuclear installations, amongst others. The DMRE is currently in the process of considering and addressing the comments received on the Amendment Bill.

Further legislation that has relevance to 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) [1.12];
- 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); and
- Dumping at Sea Control Act (No. 73 of 1980).

The South African regulatory body, the NNR, is established by the NNR Act. Its mandate is described under Article 8.1.2. The NNR operates within the following national legislative and regulatory frameworks:

1) The Constitution of the Republic of South Africa, 1996 [1.13];
2) National Nuclear Regulator Act [1.1];
3) Nuclear Energy Act [1.2];
4) Public Finance Management Act (PFMA) (No. 1 of 1999) [1.14] and associated Treasury Regulations;
5) Promotion of Access to Information Act (PAIA) (No. 2 of 2000) [1.7];
6) Promotion of Administrative Justice Act (No. 3 of 2000) [1.11];
7) Regulations on Safety Standards and Regulatory Practices (No. R. 388) [1.8];
8) Regulations on Licensing of Sites for New Nuclear Installations (No. R. 927) [1.9]; and
9) Regulations on the Long-Term Operation of Nuclear Installations (No. R. 266) (LTO Regulations) [1.15].

The NNR enters into cooperative governance agreements to give effect to the principles of cooperative government and intergovernmental relations as contemplated in the regulations in terms of section 6 (3) of the NNR Act and in terms of section 41, chapter 3 of the Constitution of the Republic of South Africa.

The National Radioactive Waste Disposal Institute (NRWDI) was established by the NRWDI Act. 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. The NRWDI is regulated by the NNR. In March 2014, the appointed Board of Directors was inaugurated and the process of appointing the management structures commenced. A steering committee was established to address the transitional arrangements and a roadmap was put in place to ensure a smooth transfer of resources from Necsa to the NRWDI in accordance with section 30 of the NRWDI Act.

The Nuclear Energy Policy for the Republic of South Africa [2.1] was published in 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 by South Africa shall take place for peaceful purposes. 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, focusing 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.

During the reporting period, the Minister of the DMRE promulgated Regulations on the Long-Term Operation of Nuclear Installations. The purpose of these Regulations is to establish the requirements for long term operation of nuclear installations beyond an established time frame defined in the respective nuclear installation licence or current licensing basis. The DMRE also issued a Discussion Paper on National Decommissioning Policy for Nuclear Facilities in July 2020, and recently issued a draft Decommissioning Policy for stakeholder comments. The Decommissioning Policy is being developed in response to a recommendation from the IRRS Mission that was conducted in 2016.

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 Agency [5.2];
2) Convention on the Physical Protection of Nuclear Material and the 2005 Amendment [5.3];
3) Convention on Early Notification 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 [5.8];
8) African Regional Cooperative Agreement for Research, Development and Training Related to Nuclear Science and Technology – Fourth Extension of Agreement [5.9];
9) 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 [5.10]; and
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 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 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, the NNR is mandated to fulfil national obligations with respect to international legal 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 CP obligations to the IAEA CNS and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

7.2.1 National safety requirements and regulations

7.2.1.1 Overview of the secondary legislation for nuclear safety

[Use of IAEA Safety Standards]

The NNR recommends and implements safety standards in the form of regulations and issues guidance documents and position papers to support the implementation of these standards. The safety standards define the scope of regulatory control and elaborate on nuclear and security safety principles, requirements, standards, radiation dose and risk limits, criteria and rules and address all life cycle stages of an NPP.

The development of NNR Safety Standards is governed by Process PROIMS-08 [4.14], Development and Review of Technical Documents. In accordance with Principle 3 of the Vienna Declaration on Nuclear Safety (VDNS), the process dictates that:

1) Literature research must be performed to identify relevant international safety standards, including IAEA Safety Standards; and
2) The development of the document should take into account relevant IAEA Safety Standards.

The NNR has revised and developed a suite of regulations and guidance documents considering IAEA Safety Standards as appropriate. This suite of regulations is still to be promulgated and is currently being revised to be in line with the Amendment Bill as discussed in section 7.1.1 of this report.

Regulations on Safety Standards and Regulatory Practices (SSRP) [1.8] were promulgated on 28 April 2006 and are enforced for all nuclear authorisation holders and applicants for nuclear authorisations in the country. These regulations are based on international safety standards and regulatory practices.

Regulations on the Licensing of Sites for New Nuclear Installations [1.9] were promulgated in 2011.

In terms of section 29 of the NNR Act [1.1] and based on the recommendation of the NNR Board, the Minister of Mineral Resources and Energy published Government notice no. R. 773 on the Categorisation of the Various Nuclear Installations in the Republic, the Level of Financial Security to be Provided by Holders of Nuclear Installation Licences in respect of each Category of Nuclear Installation and the manner in which that Financial Security is to be Provided [1.10] in October 2019. The NNR has reviewed the levels of operator liability to be provided in case of nuclear damage. The revised levels of operator liability, which have been increased above the minimum levels specified in relevant conventions, have been published for comments and are being finalised for publication by the Minister.

Under Government notice no. 33678, the DMRE published draft regulations on the control of developments surrounding the KNPS for public comment in November 2010. 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. A task team was established in 2019 to review and update sections of the draft regulations to mitigate the dispute between national and local authorities (City of Cape Town) on the control and approval of developments within the Koeberg emergency planning zones. The parties agreed to involve legal expertise in the process of finalising the draft regulations.

7.2.1.2 Overview of regulations and guides issued by the regulatory body

In support of these regulations, the NNR currently 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 its position on emerging issues.

The following regulatory documents, relevant to nuclear installations, have been issued:

Document No.	Requirements Documents
RD-0013	Requirements on Public Information Document to be Produced by Applicants for New Authorisations
RD-014	Emergency Preparedness and Response Requirements for Nuclear Installations
RD-0016	Requirements for Authorisation Submissions Involving Computer Software and Evaluation Models for Safety Calculations
RD-0018	Basic Licensing Requirements for the Pebble Bed Modular Reactor
RD-0019	Requirements for the Core Design of the Pebble Bed Modular Reactor
RD-0022	Radiation Dose Limitation at Koeberg Nuclear Power Station
RD-0024	Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations
RD-0025	Emergency Communication with the National Nuclear Regulator
RD-0026	Decommissioning of Nuclear Facilities
RD-0034	Quality and Safety Management Requirements for Nuclear Installations

File 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
File Number	**Regulatory Guides**
RG-0006	Guidance on Physical Protection Systems for Nuclear Facilities
RG-0007	Regulatory Guide on Management of Safety
RG-0008	General Transport Guidance
RG-0011	Interim Guidance for the Siting of Nuclear Facilities
RG-0012	Interim Guidance on Construction Management for Nuclear Facilities
RG-0014	Guidance on Implementation of Cyber or Computer Security for Nuclear Facilities
RG-0015	Interim Guidance on the Registration of Nuclear Power Plant Reactor Operators
RG-0016	Guidance on the Verification and Validation of Evaluation and Calculation Models Used in Safety and Design Analyses
RG-0019	Interim Guidance on Safety Assessments of Nuclear Facilities
RG-0020	Interim Guidance on Emergency Preparedness and Response for Nuclear and Radiological Emergencies

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RG-0021	Guidance on the Security during Transport of Nuclear or Radioactive Material
RG-0022	Guidance on Security Incident Reporting for Nuclear Facilities
RG-0023	Interim Guidance on the Conduct and Re-Registration of Nuclear Power Plant Reactor Operators
RG-0027	Ageing Management and Long-Term Operations of Nuclear Power Plants
RG-0028	Periodic Safety Review of Nuclear Power Plants
File Number	**Licensing Guides**
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
File 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 of Pressure Equipment in Nuclear Service
PP-0017	Design and Implementation of Digital Instrumentation and Control for Nuclear Installations

The Regulator also developed and issued the following Technical Assessment Guides to provide further guidance to regulatory staff for the review of related submissions from applicants or authorisation holders:

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Document Number	Technical Assessment Guides
TAG-001	Technical Assessment Guide for the Siting of Nuclear Facilities
TAG-002	Design of Nuclear Facilities
TAG-003	Long Term Operation of Nuclear Power Plants
TAG-004	Operation of Nuclear Facilities

The Regulator varied NIL-01 to Variation 19 in March 2019 in light of international standards and best practices as well as operational experience feedback, and to allow for the possible application for LTO. The reasons for the changes are primarily to:

1) Comply with current regulations on SSRP, specifically the stipulation of the period for periodic safety reviews.
2) Incorporate the latest IAEA Safety Standards Regulations for the Safe Transport of Radioactive Material, SSR-6.
3) Include conditions regarding ageing management.
4) Specify a 40-year operational life for Koeberg that is consistent with the current safety basis.
5) Align the regulatory framework regarding LTO and licence renewal with international practice and recommendations.
6) Expand requirements for decommissioning; and
7) Include requirements for design and manufacturing of components.

The conditions of the nuclear licence for KNPS address the following:

1) General conditions;
2) Nuclear installation description;
3) Demarcation of the site;
4) Scope of activities that may be undertaken;
5) Radiological protection;
6) Environmental protection and effluent management;
7) Radioactive waste management;
8) Emergency planning and preparedness;

9) Medical surveillance and health register;
10) Transport;
11) Safety assessment;
12) Modification to the design of the plant;
13) Design and manufacturing of components;
14) Limits and conditions on operation;
15) Maintenance and in-service inspection;
16) Ageing management and LTO;
17) Decommissioning;
18) Physical security;
19) Dealing with the site;
20) Authorised and qualified persons;
21) Quality and safety management;
22) Documents and records;
23) Organisational changes;
24) Safety committees;
25) Financial security;
26) Inspection programme;
27) Events on the site;
28) Public Safety Information Forum (PSIF); and
29) Display of nuclear licence.

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 Mineral Resources and Energy via the NNR Board. The DMRE 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.

Other regulatory standards are developed and updated as necessary after consultation with the relevant authorisation holders and ratified as appropriate by the NNR Board. The requirements are then incorporated either directly in the nuclear licence or in requirements referenced in the authorisation. The process is documented in PRO-IMS-08, Development and Review of Technical Documents.

The NNR and the Directorate of Radiation Control in the DoH completed self-assessments in the 2011/12 financial year based on the IAEA Self-Assessment Tool. 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 and the Amendment Bill has been published for comment as discussed in section 7.1.1 of this report. The NNR also developed a suite of regulations that is currently being revised to be consistent with the Amendment Bill and will submit the revised regulations to the Minister for promulgation after the Amendment Bill has been published. The draft regulations have been developed to incorporate the regulatory requirements presently referenced in the nuclear authorisations, to address gaps identified during the self-assessment and lessons learned with the licensing of the KNPS and the Pebble Bed Modular Reactor 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.

Following the post-Fukushima review (section 14.1.4.3), the NNR has identified areas for the improvement of regulatory standards and regulatory practices, which have been included in the new regulations. These improvements relate to the:

1) 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 (DEC) as part of the design basis of new nuclear installations (some DEC include additional connection points and robust instrumentation, amongst others).
3) Consideration of simultaneous impacts on multiple facilities on the site.
4) Reliance on off-site services in the short term, which is not permitted; and
5) Testing and inspection of equipment credited in accident management.

7.2.2 System of licensing

7.2.2.1 Overview of the licensing system

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

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

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 inspectors 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

Periodic reviews are required at a frequency acceptable to the NNR (every ten years) as briefly discussed in section 6.3 and described in Article 14. Based on these reviews, corrective actions are identified, and conclusions are drawn on the continued operation of the plant.

Furthermore, the NNR has specified a 40-year operational life in the licence for Koeberg that is consistent with the current safety basis. As such, the operator, Eskom, will have to apply for a licence to operate Koeberg beyond the current licence term. This application must comply with the LTO Regulations and must be supported by a comprehensive safety case, with due consideration of the ageing of structures, systems and components (SSCs). Components identified under design extension conditions are part of the ageing management requirements. The periodic safety review should be used as an input to the safety case to justify LTO. This is to ensure that any required safety improvements will be addressed as part of the preparation for LTO. In this respect, Eskom has commenced with the application process for LTO, which is currently under review by the NNR but is still in a nascent stage. The LTO Regulations were subjected to an IAEA expert mission in May 2016 and were promulgated by the Minister in March 2021.

The safety case must be submitted to the Regulator for review and acceptance 24 months in advance of the time limit specified in the nuclear installation licence. Typically, the application for LTO is made for an additional period of 20 years, however this must be confirmed by the reassessment.

7.2.2.2 Involvement of the public and interested parties

The NNR Act states that the Chief Executive Officer (CEO) must direct 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 to publish a copy of the application in the Government Gazette and two newspapers circulating in the area of every such municipality.

The Act allows any person who may be directly affected by the granting of a nuclear installation or vessel licence 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.

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 in writing with the reasons for the refusal. Or the CEO may grant an application for a nuclear installation or vessel licence subject to such conditions as may be determined.

The NNR Act places the responsibility on the licence holder to establish a PSIF in order to inform the persons living in the municipal area, for which an emergency plan has been established, on nuclear safety and radiation safety matters, as discussed in section 9.4.

The NNR upholds the principles of regular, relevant, open and factually correct communication with stakeholders. Communication and interaction with stakeholders are an ongoing process and are conducted through various channels based on the needs of the target audience.

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 siting, construction, operation, decontamination or decommissioning 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 of the NNR [2.3]. 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 the dose and risk to the public and workers and specifies regulatory requirements. The licensee is also held to various processes, particularly 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 and 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 with 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 SAR for a construction licence (may be combined with 1);
4) SAR 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 review; 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 the relevant manager and, in turn, assigned in accordance with a review matrix to relevant analysts and/or inspectors. The review process is described in an internal process, PROASS-01 [4.13], which addresses, amongst others, responsibilities, authorities and general review and assessment requirements. The outcome of the assessment is consolidated 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 the 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 for the CEO to approve the application.

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 Manager: NPP inspectorate 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 inspections to determine compliance with regulatory requirements and the licensing basis;
2) Investigations and occurrences;
3) Regulatory emergency and nuclear security exercises;
4) Environmental surveillance;
5) Manufacturing oversights; and
6) Follow-up on findings and/or non-compliances.

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 Manager: Inspectorate dedicated to KNPS who 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 and surveillances) described above as well as any other nuclear safety issues are tabled, monitored and followed up.

Inspection findings are graded and classified in accordance with their level of risk.

7.2.4 Enforcement of applicable regulations and terms of licences

7.2.4.1 Power to take legal action

The NNR Act 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. 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 by section 23 to impose any condition in a nuclear installation or vessel licence or certificate of registration which is necessary to ensure the protection of persons, property and the environment against nuclear damage; or provides for the rehabilitation of the site.

7.2.4.3 Experience with legal actions and enforcement measures

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

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

Where necessary, enforcement actions are required and implemented. The NNR issued a directive to Eskom pertaining to non-compliance with Regulator requirements regarding manufacturing practices at SENPEC during the steam generator replacement project.

The NNR also directed the applicant, Eskom, to stop all work on the site of the original steam generator interim storage facility following non-compliance with authorised conditions. Following an investigation and the implementation of corrective actions, the construction licence for the facility was issued. Construction is currently ongoing.

The NNR also monitored the implementation of corrective measures.

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 regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.

Summary of changes

Section 8.1.4 has been updated to report a change in the organisational structure of the NNR.

Section 8.1.5 has been revised to report on the increase in staff numbers.

Section 8.1.7 has been updated to illustrate the trends in financial provision and to respond to the key issue of financial and human resources.

Section 8.1.8 has been updated to provide a statement on the adequacy of resources and to report on the challenge of sufficient human resources.

Section 8.2.3 has been updated to provide more detail on effective separation and to respond to the key issue regarding independence of the regulatory body.

Section 8.2.4 has been updated to reflected name changes of government departments.

Section 8.2.5.3 has been updated to report on the new Multinational Design Evaluation Programme (MDEP) framework.

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 [1.1] to regulate nuclear facilities and 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 matters related to nuclear and radiological safety.

8.1.2 Mandate, mission and tasks

The NNR is mandated by the NNR Act 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 the implementation of a system of compliance inspections and enforcement. Its mandate is further strengthened by section 23 of the 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 in 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.

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; and
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 actions involving radioactive material, to which the NNR Act applies, remain within acceptable safety limits. In practice, this has led the NNR to establish SSRP [1.8], including doses and risk limits, as well as derived operational standards; conduct proactive safety assessments; and determine conditions of authorisation, and obtain 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, additional actions are listed that require other types of authorisations or certificates of exemption.

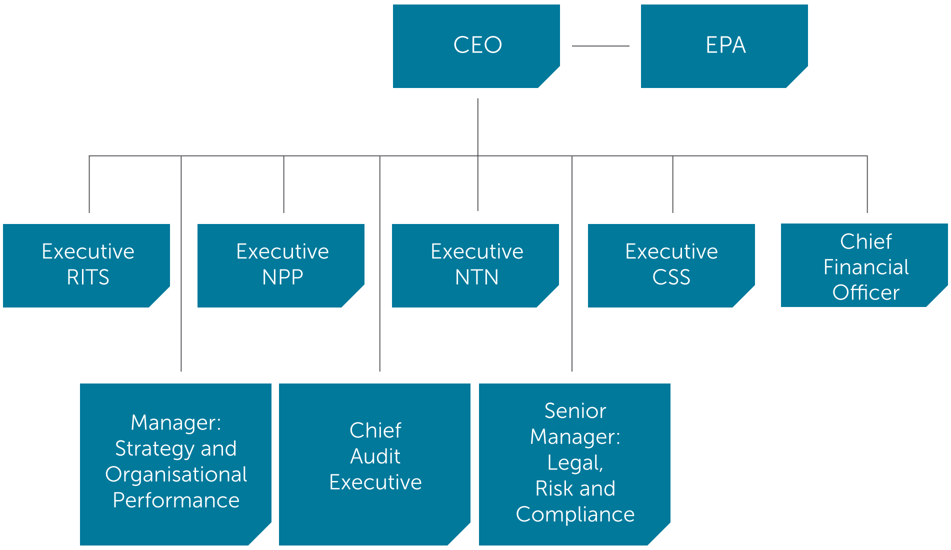
8.1.4 Organisational structure of the regulatory body

The NNR has been established as an independent juristic person by the Parliament of the Republic of South Africa. The NNR is composed of a Board of Directors, a CEO and staff. Its mandate and authority are conferred through sections 5 and 7 of the Act, which set out the objectives and functions of the NNR.

The new structure of the NNR is depicted in Figure 8-1.

ARTICLE 8: REGULATORY BODY

Figure 8-1 NNR Organisational Structure



8.1.4.1 *The Board of Directors*

The executive team of the regulatory body reports to a Board, which is appointed by the Minister of Mineral Resources and Energy. The Board consists of non-executive directors representing key stakeholders of the NNR, including an official from the DMRE, an official from the Department of Forestry, Fisheries and the Environment (DFFE), 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*:

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

8.1.4.2 *The Chief Executive Officer*

The CEO is appointed by the Minister of Mineral Resources and Energy and is also a Director of the Board. The CEO is the accounting officer of NNR 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 [1.14]. 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*

1) Nuclear Power Plant (NPP) division

The Nuclear Power Plant division's mandate is to provide assurance of compliance with conditions of authorisation through a system of compliance inspections, audits and investigations as part of the provision of efficient and effective nuclear regulatory services. This is in accordance with the NNR Act, which requires that a compliance assurance programme be implemented. This division undertakes and implements assurance activities at authorised facilities and enforces compliance. Reviews and assessments are also carried out within the division.

The division effects its mandate by means of a structure that covers projects, inspections and assessments. Major projects that involve plant modifications are licensed through the NPP Projects department.

Compliance assurance activities for all conditions of each licence inform the CAP that is followed by the nuclear power plant. Outages, incidents and applications during the course of the year will trigger inspections, and reviews and assessments by the NPP division. These actions can also result from an observation during a plant walkdown. On occasion, non-compliances require more than just a corrective action, but a thorough investigation.

2) Nuclear Technology and NORM (NTN) division

The NTN division consists of the Naturally Occurring Radioactive Material (NORM) and Nuclear Technology and Waste Projects (NTWP) business units.

ARTICLE 8: REGULATORY BODY

NORM's mandate is to contribute to compliance assurance and to develop and implement standards with regard to regulatory processes, e.g. inspections, authorisations and enforcement. This includes processing new applications, issuing licences, collecting environmental samples, reviewing safety case documentation, and conducting investigations, inspections, reviews and assessments.

NTWP's mandate is to conduct inspections, investigations, and reviews and assessments within the context of the NNR's compliance regime. NTWP is tasked with implementing compliance assurance and enforcement activities for a specific category of facilities in an effort to ensure the protection of persons, property and the environment against nuclear damage. The main facilities that fall under this category are the Pelindaba site (41 licences) and the Vaalputs National Radioactive Waste Repository. Any other matter that deals with nuclear technology, and which is not associated with NPPs and NORM, primarily falls within the NTWP division.

3) Regulatory Improvement and Technical Services (RITS) division

The RITS division consists of the Centre for Nuclear Safety and Security (CNSS); emergency planning and response (EPR); engineering services; regulations, standards and projects; environment and radiation protection; and the laboratory.

The RITS division provides strategic leadership and management in delivering regulatory improvement services to all the technical programmes of the NNR through its cross-cutting and in-depth review and assessment capabilities. The division offers technical expertise in emergency preparedness and response, laboratory services, nuclear safety and security culture, development of regulatory standards and nuclear projects, and the coordination of nuclear security activities.

The division conducts in-depth reviews and assessments in the areas of waste management, environment and radiation protection, transporting radioactive materials and issuing nuclear vessel licences, engineering services, and independent verification by computer codes.

The laboratory unit within RITS provides radioanalytical services for various radionuclides (NORM and artificial radionuclides) from environmental samples such as water, sediments, soil and biological samples for independent verification purposes. This also requires the maintenance and calibration of portable instruments and the coordination of personal and environmental thermoluminescent dosimeters (TLDs) to ensure that the laboratory discharges its analytical services and functions effectively.

The environmental surveillance programme includes the independent verification and radiological environmental analysis of samples collected around NNR regulated facilities such as KNPS, Necsa and the mining and minerals processing facilities.

A key component of this division is the regulatory research and development that is conducted on emerging issues regarding nuclear and radiation safety housed under the CNSS. The CNSS was established to develop capabilities in order to improve regulatory practices related to nuclear safety and security. By developing necessary skills and capacity, the CNSS will attempt to address the anticipated nuclear safety and security needs of the regulatory body as well as those of the nuclear industry at large.

The CNSS collaborates with academic, research and other relevant institutions in order to execute any activities that fall within the mandate of the NNR and to maximise the use of available resources. Its ultimate objective is to enable the NNR to be self-sufficient in fulfilling its own mandate and to develop human capital and build necessary skills and capacity in nuclear safety and security, thereby contributing to the implementation of national strategies and policies, as well as ensuring that the NNR maintains its efficiency and effectiveness.

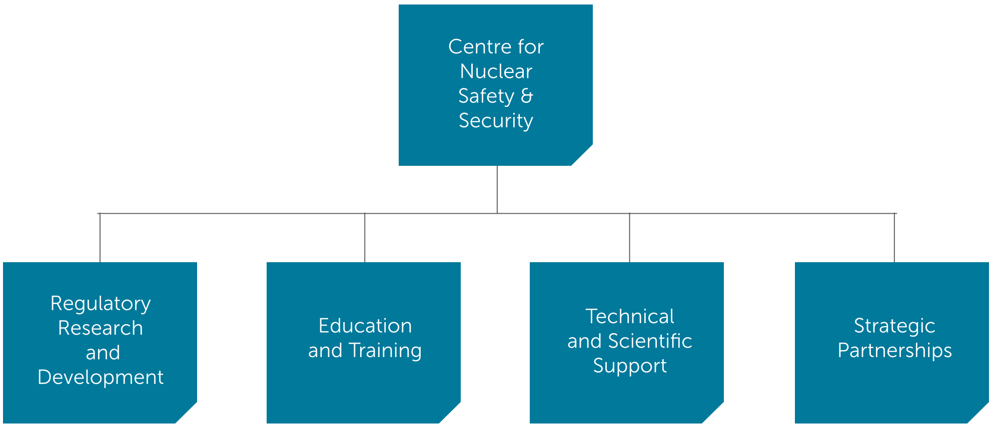
The CNSS executes its mandate through the following four main programmes:

1) Education and Training: Formulates and implements effective education and training programmes with the aim of creating a pipeline of skills, thereby increasing the number of nuclear science and engineering professionals with adequate competencies in radiation protection, nuclear safety and security.
2) Regulatory Research and Development: Facilitates the development and execution of regulatory research and development activities.
3) Technical and Scientific Support: Provides technical and scientific support and/or expert advice or any other service in the fields of nuclear safety and security.
4) Strategic Partnerships: Forms partnerships and collaborations with various local and international partners based on the hub-and-spoke model.

The functional structure of the CNSS is depicted in Figure 8-2.

ARTICLE 8: REGULATORY BODY

Figure 8-2 Functional Structure of the CNSS



4) Non-technical divisions

The non-technical divisions within the NNR consist of the following:

1) Finance;
2) Corporate support services;
3) Strategy, governance and organisational performance;
4) Communications and stakeholder relations; and
5) Legal counsel.

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 and has increased its technical staff complement from 166 to 173. The NNR ensures that staff are remunerated competitively and develops young professionals in their area of expertise. In addition, it is supporting 11 bursary students in various fields of science and engineering at higher learning institutions in South Africa.

The NNR recognises that succession planning is part of the strategic planning for the organisation and will allow it to prepare for operational continuity as and when key employees vacate their positions. The NNR will therefore ensure that documented succession plans are in place to ensure that it has a pool of suitably qualified employees who are prepared to assume critical positions and roles. Succession planning is aimed at contributing to the achievement of the NNR's Equity Plan.

ARTICLE 8: REGULATORY BODY

The NNR is committed to recruiting a high-quality workforce that has the relevant qualifications, knowledge, skills, experience and competencies to deliver on the objectives of the NNR. The NNR believes that all employees have the potential to grow, both in their professional roles and personally, and will therefore strive to provide opportunities for growth and development. All training and development must be aligned with the strategic objectives of the NNR.

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.

NNR staff also actively participate in:

1) Regional training initiatives provided by the Forum of Nuclear Regulatory Bodies in Africa and its international partners; and
2) IAEA Technical Cooperation programmes.

The NNR seeks to create an environment that recognises and supports the values of both nuclear knowledge management and general knowledge management. The NNR strives to foster a culture of knowledge creation, sharing and transferal, and aims to align the three domains of knowledge management, namely people, processes and technology. To give effect to these aspirations, the NNR adopted a Knowledge Management Strategy [4.15], STR-IKM-001, as of June 2017. The objectives of this strategy are to:

- Identify and capture critical knowledge;
- Document and communicate organisational processes;
- Provide for the information and knowledge needs of NNR employees;
- Provide knowledge sharing and transferal platforms between experienced and newly employed graduates;
- Enable knowledge management through information and communications technology;
- Identify the roles and responsibilities of NNR employees in relation to knowledge management practices and processes; and

- Adopt the principles of nuclear knowledge management as well as broader knowledge management.

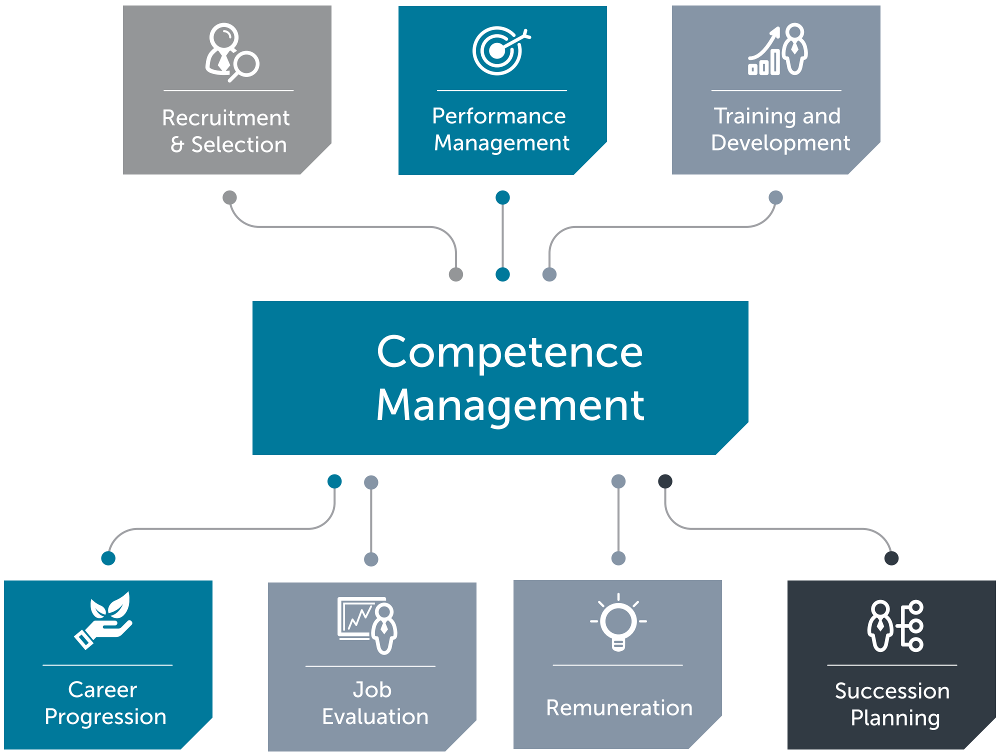
In this regard, line managers take reasonable steps to ensure knowledge retention within their departments through ensuring transferal of knowledge to new employees, succession planning, and the documentation and communication of NNR processes.

The information and communications technology infrastructure is used to provide and maintain electronic platforms and resources for knowledge sharing, transfer and storage.

In order to ensure that regulatory staff possess the necessary qualifications, skills, knowledge, attributes and competence, the NNR approached talent management in an integrated manner. At the core of this approach lies the identification of key competencies for all regulatory staff. Key competencies have been identified using an adapted form of the Methodology for the Systematic Assessment of the Regulatory Competence Needs (SARCoN) for Regulatory Bodies of Nuclear Installations (IAEA-TECDOC-1757).

In applying the SARCoN methodology, the NNR used an integrated approach in the areas of job evaluation, performance management, career progression, etc. The integrated model is depicted in Figure 8-3.

Figure 8-3 An Integrated Model Based on the SARCoN Methodology



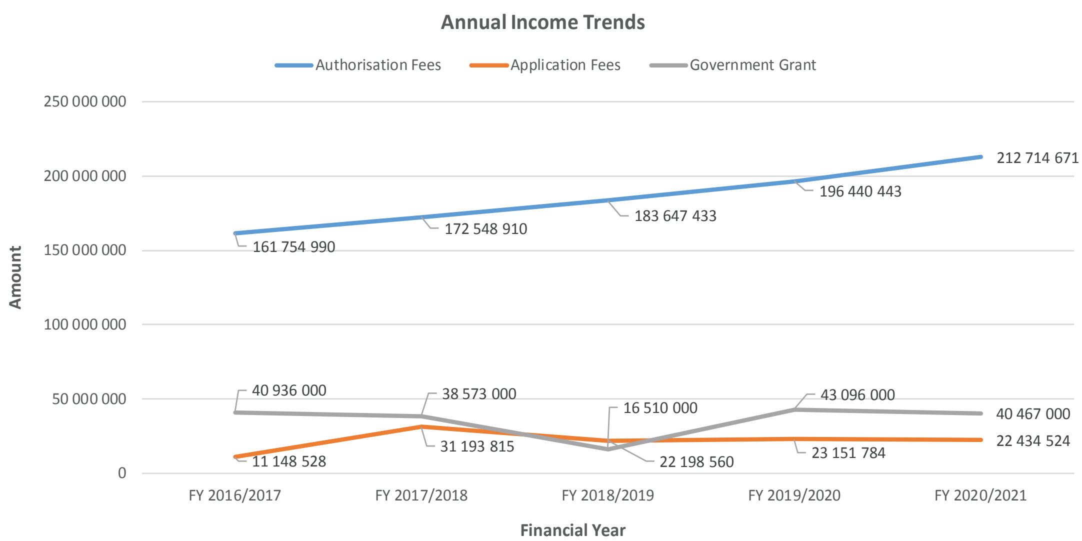
The identified competencies for each role in the organisation will thus inform talent management actions such as recruitment decisions, job evaluation, and the identification of training and development gaps and priorities. When a line manager identifies a staff member that needs to be promoted, the individual is assessed in terms of the level of competency as per the SARCoN model. This assessment is then used as a basis for career progression.

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

The capacity of the NNR continues to be supported through both its legislated 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.

Total revenue from the main income streams (authorisation fees, application fees and government grant) increased from R213,8 million in the 2016/17 financial year to R275,6 million in the 2020/21 financial year. This amounts to an average increase of 8,71% over the past five financial years. Authorisation fees continue to account for the biggest portion of the total revenue, at an average of about 76% over the same period. The NNR has, however, been faced with funding challenges over the period. One of the biggest challenges results from the unforeseen closure of mining and mineral processing facilities, liquidations, revocations, reclassifications and decommissioning of facilities. Revenue from application fees remains unpredictable and is dependent on the number of applications received by the NNR. In addition, the government grant has gradually been diminishing. The graph below provides a presentation of the annual income from the three main revenue streams from the 2016/17 to 2020/21 financial years.

Figure 8-4 The Graph of Income Levied Over the Past Five Years



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 projects such as the site licence application review of Thyspunt, and the review of the update to the SSR for the KNPS site.

The NNR Act makes provision for the NNR to levy a licence fee for regulatory work undertaken. The NNR assesses its workload on an annual basis and translates this to a licence fee which is then gazetted for payment by the authorisation holders. The overarching legislation makes provision for licence fees to be paid to the NNR.

8.1.8 Statement of adequacy of resources

The NNR determines the adequacy of resources on an annual basis and levies fees in line with its programme of work. The NNR will require additional resources to cope with upcoming projects such the licensing of the LTO of the KNPS and capacitating the CNSS.

In order to ensure that the NNR has sufficient resources, a capacity evaluation was conducted in the latter half of 2018. From this assessment it was determined that a 19% increase in personnel will be needed for the NPP division. There is general agreement that this increase in staff can be phased in per year based on the support to strategic objectives and financial availability. This intervention has addressed the challenge experienced for insufficient human resources as the NNR now has a plan that can be implemented for additional resources.

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

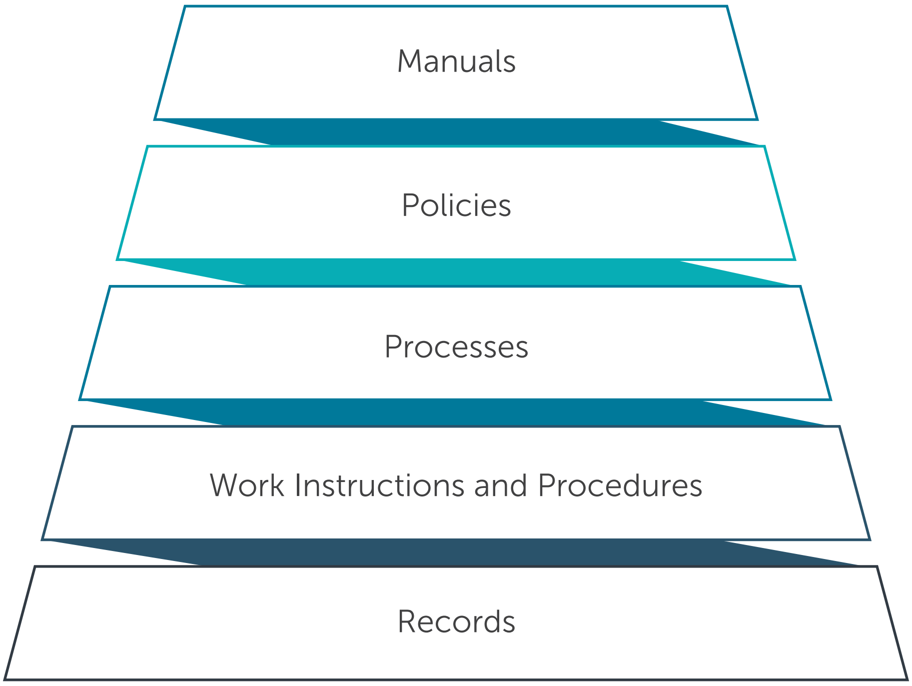
8.1.9 Quality management system (QMS) of the regulatory body

8.1.9.1 Overview of the NNR QMS

As indicated in section 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 QMS, including a comprehensive set of policies and procedures as illustrated in Figure 85.

ARTICLE 8: REGULATORY BODY

Figure 8-5 NNR Document Structure



Previously, the NNR had a management system that was based on ISO 9001:2008, which was partially implemented in 2008. A gap analysis was performed against G-SR-3 and, as a result, in 2015 a new project was undertaken by the organisation to revise the management system and to align it with G-SR-3. With the introduction of GSR Part 2 in June 2016, the NNR had an opportunity to ensure alignment with the new publication before finalising its latest management system manual.

The established integrated management system (IMS) is aligned with the NNR's mandate and the concepts of the IAEA's GSR Part 2. The IMS of the NNR integrates safety, health, environmental, security, quality, human and organisational factors, societal and economic elements in one coherent unit.

The recent highlights for the IMS include the development of an electronic system for the management of the organisation's records, and the revision of the IMS manual to address IRRS recommendations. Furthermore, the NNR's internal team has conducted a first round of process effectiveness audits.

ARTICLE 8: REGULATORY BODY

The NNR hosted the IAEA expert mission on an IMS training course implemented under the SAF9005 project from 15 to 19 January 2018. The IMS manual was revised to include the environmental aspects. A graded approach was approved for implementation in the NNR in January 2019. The graded approach uses the Failure Mode and Effects Analysis methodology to rank the risk associated with processes and generate a rating, which is used to determine the priority assigned to regulatory processes and organisational processes. This is integrated with risk management after which the mitigation of risk is applied.

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. The NNR's graded approach to stakeholder participation ranges from informing to involving, consulting, collaborating and empowering stakeholders on any decision they are affected by. The level of stakeholder involvement is 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 and 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 [1.13] 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 of Administrative Justice Act [1.11] 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.

ARTICLE 8: REGULATORY BODY

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

2) Public Safety Information Forums

In accordance with section 26 (4) of the NNR Act, the holder of a nuclear installation licence must establish a PSIF as prescribed in order to inform the persons living in the 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. The PSIF serves as an effective platform to share information on nuclear safety.

3) Promotion of Access to Information Act

The Promotion of Access to Information Act (PAIA) [1.7] was enacted to give effect to the right of access to information contained in section 32 (2) of the Bill of Rights in 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 periodic information sharing sessions with members of the media and civil society from different regions in South Africa. These sessions are aimed at sharing information on regulatory programmes, topical issues and organisational performance.

5) Website and social media

The NNR website is the primary tool for sharing information with 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. However, due to the prevalence of fake news on social media, the NNR will ensure that its messaging is structured and credible.

6) Communication with the media during a nuclear or radiological emergency

The NNR has developed procedure PRO-ASS-21 [4.16], Communication to the Media during a Nuclear and Radiological Emergency, which will ensure that communication is timely, accurate, consistent and credible.

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; however, it does have contracts with 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. A technical area leader reviews the work of an external Technical Support Organisation, and this input is appraised as part of an assessment. 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 Pressurized Water Reactor (PWR) technology from other regulatory authorities with whom it has entered into bilateral agreements (8.2.5).

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

ARTICLE 8: 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 Mineral Resources and 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 the NNR to produce and submit an annual public report to the Minister of Mineral Resources and 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 Effective separation between the NNR and any other body

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

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. In 1988, a separate regulatory body was established apart from the Atomic Energy Corporation, which was responsible for the promotion and research of the nuclear sciences. From 1999, the independent authority of the NNR is entrenched de jure in the NNR Act, to the extent that powers are conferred on the Minister of Mineral Resources and Energy to appoint the governing, non-executive Board of Directors and the CEO. In carrying out its fiduciary responsibility, the Board of the NNR further ensures the independence of the Regulator. Regulations made by the Board may not be amended by the Minister.

ARTICLE 8: REGULATORY BODY

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 the KNPS, reports to the Minister of Public Enterprises.

The NNR Act 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 states that the Minister of Mineral Resources and Energy must, on the recommendation of the Board, make regulations regarding safety standards and regulatory practices.

Based on the recommendation of the NNR, the executive authority is considering amendments to the founding legislation of the NNR (the NNR Act) in a concerted effort to further strengthen the independence of the Regulator. These amendments will make provision for the Regulator to:

- Have sufficient authority and sufficient competent staffing.
- Have access to sufficient financial resources for the proper and timely discharge of its assigned responsibilities.
- Make independent regulatory judgements and regulatory decisions at all stages in the duration of activities and the lifetime of facilities under operational states and in accidents and incidents until release from regulatory control.
- 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.
- Give independent advice and provide reports to government departments and governmental bodies on matters relating to the safety of activities and facilities; and
- 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 [1.14], as amended. The Board of Directors is the accounting authority in terms of the PFMA. In terms of section 8 (1) and (2) of the NNR Act, the Regulator is governed and controlled 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 DMRE 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 [1.13], 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 ten 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 the respective legislation.

ARTICLE 8: REGULATORY BODY

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

1) Department of Mineral Resources and Energy: Mine Health and Safety Inspectorate;
2) Department of Mineral Resources and Energy: Electricity and Nuclear;
3) Department of Health: Directorate of Radiation Control;
4) Department of Water and Sanitation;
5) Department of Forestry, Fisheries and the Environment;
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 Employment and Labour.

Harmonising the regulation of radioactive sources

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 hazardous substances; and
3) Development of a business model for the regulation of Group III and Group IV hazardous substances.

A memorandum of understanding (MoU) is being discussed between the DoH, DMRE 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

ARTICLE 8: REGULATORY BODY

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 CNS [5.6] and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management [5.7].

To strengthen 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, in order to enhance 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 that 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-mentioned conventions.

8.2.5.1 *Convention on Nuclear Safety*

South Africa ratified the CNS 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 CPs 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 Convention commenced in February 2007. The Convention applies to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications and to military or defence programmes if and when such material is transferred permanently to and managed exclusively within civilian programmes, or when declared as spent fuel or radioactive waste for the purposes of this Convention. In addition, the Convention applies to planned and controlled releases into the environment of liquid or gaseous radioactive material from related nuclear facilities.

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. CPs also have the obligation to take appropriate steps to ensure that disused sealed sources are managed safely.

8.2.5.3 International regulatory forums

Multinational Design Evaluation Programme

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 Nuclear Energy Agency (NEA), which operates within the framework of the Organisation for Economic Cooperation and Development (OECD), and 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 (USA) 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. From 13 January 2022, MDEP was reconstituted under a new framework with the remaining technologies of the VVER and the HPR 1000.

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 from countries such as France (ASN), the USA (NRC), Canada (CNSC), the United Kingdom (ONR), South Korea (KINS), Finland (STUK), China (NNSA), Poland (NAEA) 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 references 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;
2) Nuclear Safety Standards Committee;
3) Radiation Safety Standards Committee;
4) Waste Safety Standards Committee;
5) Transport Safety Standards Committee; and
6) Emergency Preparedness and Response Committee.

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

Sections 9.1 to 9.3 have been changed to include the Nuclear Management Policy of Eskom.

Section 9.4 has been updated to report on the introduction of a communication strategy.

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 SSRP [1.8], "The holder of a nuclear authorisation is responsible for radiation protection and nuclear safety, including compliance with applicable requirements such as the preparation of the required safety assessments, programmes and procedures related to the design, construction, operation and decommissioning of facilities.".

The Eskom Nuclear Management Policy addresses principles to strictly adhere to the requirements of legislation, and the terms and conditions of the relevant nuclear installation licences, permits and authorisations.

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 KNPS in South Africa. Eskom has two nuclear installation licences, namely NIL-01 (Variation 19) for the KNPS and NIL044 (Variation 0) for the Original Steam Generator Interim Storage Facility (OSGISF) located on the Transient Interim Storage Facility (TISF). The licensing requirements applicable to the nuclear licences are addressed in separate licensing basis documents. The Koeberg Licensing Basis Manual (KLBM) [4.10] was developed for the KNPS, and the OSGISF Licensing Basis Manual was developed for the OSGISF.

These documents include all relevant change control processes for modifications, waivers, procedure changes, etc., and serve as a roadmap of the overall safety case for KNPS. This includes:

Eskom policies relating to nuclear safety:

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

The licensing basis documents form an integral part of all the conditions addressed in the KNPS and OSGISF nuclear installation licences. The documents detail 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. These documents define the licensing basis and provide the key mandatory nuclear safety documents that must be complied with to control and demonstrate the nuclear safety of the KNPS and the OSGISF located on the TISF. Provisions are also included to cover the submission of safety cases, reports and communication standards. Interfaces with the NNR and the establishment of a process to ensure that 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 licences are documented and incorporated into an approved process, with independent assurance that the requirements of the nuclear installation licences 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 QMS are further described in section 10.

On the whole, Eskom's performance is satisfactory in respect of discharging its prime responsibility for safety. However, there is room for improvement.

ARTICLE 9: RESPONSIBILITY OF THE LICENCE HOLDER

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, 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 references the use of the KLBM in the conditions of licence.
5) The NNR ensures compliance with the licence through a system of regulatory assessment and compliance assurance activities, 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 [1.1] and the SSRP [1.8], and through a condition of the licence, to make reports and other information available 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 4.10.3 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 licensing basis compliance reports.

The Eskom Nuclear Management Policy addresses principles to operate KNPS, and any future nuclear facility, in alignment with South Africa's Nuclear Energy Policy and in a manner that demonstrates that Eskom has the primary responsibility for safety, thereby maintaining nuclear as a credible clean energy option.

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 [1.1] places responsibilities on the licence holder to establish a PSIF 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 [1.7] also makes provision for the public to request information from the operator or the NNR in the interest of openness and transparency.

The Koeberg PSIF 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.

As the operator, Eskom has also revised its external communication strategy considering the need for improved proactive and transparent communication. The main objective of the external nuclear communication strategy is to gain public support for the ongoing safe operation of KNPS, and nuclear power in general, by:

- Ensuring that community queries and complaints are dealt with timeously and professionally.
- Ensuring transparency by providing the local community around KNPS (and the public) with access to information regarding the safety and operation of Koeberg.
- Providing the public with access to unbiased information regarding the safe use of nuclear power and its benefits to South Africa in general.
- Ensuring that the public has the appropriate information to make informed decisions.
- Minimising the impact of misinformation that is spread by anti-nuclear organisations and individuals.
- Communicating the emergency plan to the residents living within the KNPS emergency planning zone; and
- Maintaining the ability to communicate with the public in a crisis as required by the Koeberg Emergency Plan.

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

Section 10.2.1 has been updated to report on the safety policy developed by the licence holder.

Section 10.2.4 has been updated to report on the Regulatory Management System developed by Eskom.

10.1 Requirements to prioritise safety in design, construction and operation

[Overview of the CP'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 regulatory requirements are provided in the SSRP's [1.8] siting regulations, LTO Regulations and requirements documents (Articles 7 and 13), which address the need for:

1) The priority of safety during the entire life cycle of an NPP;
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 that 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. Through the directive, Eskom 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 (ALARA) 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 Nuclear Generation department of the utility, a policy statement has been drawn up that commits to managing the nuclear installation in line with national regulatory and corporate requirements and complies 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 SSRP [1.8], 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, referred to 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) Series No. 4 and the Assessment of Safety Culture in Organizations Team 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 of Nuclear Power Operations (INPO) TECDOC-1329 and the INPO Principles for a 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/World Association of Nuclear Operators (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 WANO Performance Objectives and Criteria in 2013, which form 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 KNPS nuclear safety culture framework. In this instance, the KNPS adopted the safety culture traits of INPO/WANO as its own nuclear safety culture framework.

ARTICLE 10: PRIORITY TO SAFETY

The Eskom Nuclear Management Policy addresses principles to demonstrate leadership in safety matters at the highest organisational level by implementing and continually improving an integrated management system that combines all the elements of safety, quality, health, the environment, security, and safety culture in a manner that ensures that safety is not compromised by other requirements, and that is applicable to all nuclear activities.

Eskom implements and maintains a safety culture programme to encourage a questioning and learning attitude to radiation protection and nuclear safety and to discourage complacency. A nuclear safety culture survey report is transmitted to the Regulator annually.

Although the main focus of the Nuclear Operating Unit (NOU) safety culture programme is the enhancement of nuclear safety, it is also used to promote good radiological safety, occupational safety, environmental safety and security consciousness by applying the same principles.

10.2.2.2 Safety culture monitoring and feedback

The KNPS implements a systematic process for monitoring safety culture using a graded approach to nuclear safety, including implementing suitable leading and lagging indicators and using suitable qualitative information.

Audits and reviews on the requirements and objectives of this programme are undertaken as part of routine audits, management reviews and self-assessment programmes.

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 to departments and groups and are 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 safety presentations, videos and discussion groups, covering a wide range of nuclear safety matters, including safety culture.

ARTICLE 10: PRIORITY TO SAFETY

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 communications between the NNR and Eskom – 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 on-site psychologist;
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) Human performance factors that are fundamental to training for managers;
14) Human performance training for all KNPS staff and contractors;
15) WANO and EDF leadership support missions; and
16) Screening and evaluation of processes to identify modifications and changes to the plant.

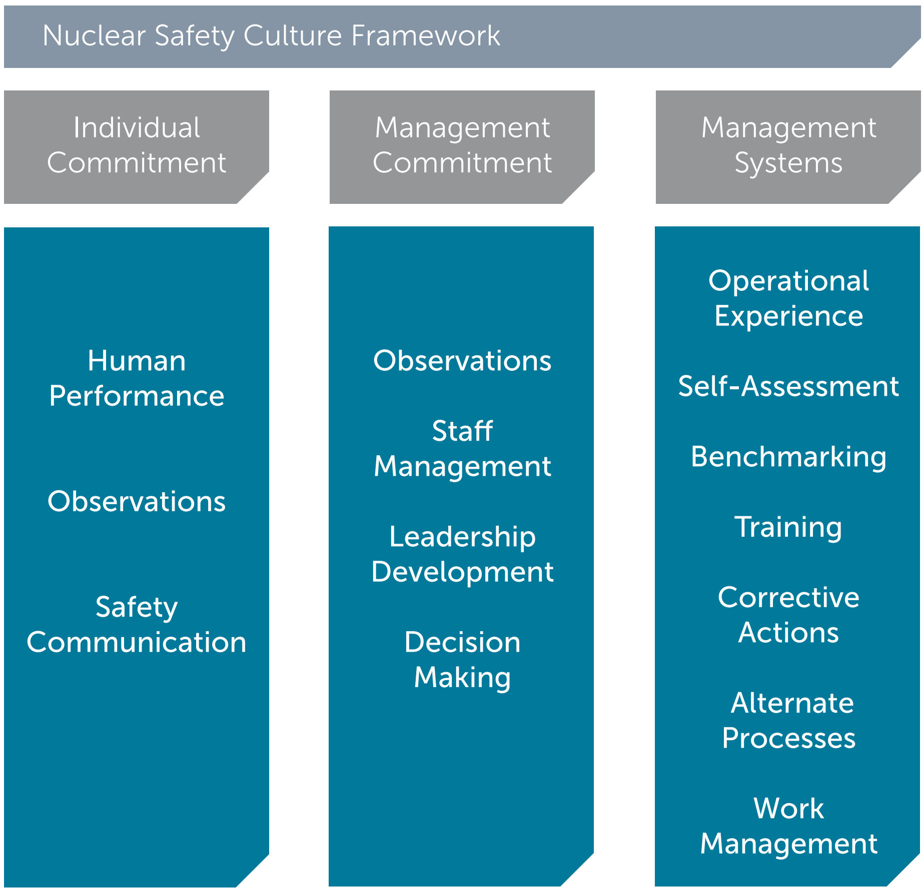
The principle that safety is the overriding priority is clearly stated in nuclear installation directives on the responsibility and accountability for nuclear safety. However, the pressing demands for production and cost savings can influence individuals to tolerate potentially unacceptable conditions.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

South Africa has a diverse national culture. The impact of this national culture is not pronounced. In our opinion, however, a progressive nuclear safety culture would be plant-specific.

ARTICLE 10: PRIORITY TO SAFETY

The nuclear safety management programme outlines the nuclear safety culture framework. The Nuclear Operating Unit gives effect to three categories of safety culture traits through the framework illustrated in Figure 10-1. The three categories are Individual Commitment, Management Commitment and Management Systems.

Figure 10-1 Nuclear Safety Culture Framework



The operator must routinely report to the Regulator on safety culture status and initiative. In 2020, an assessment was performed using the ten traits for a healthy nuclear safety culture.

Based on the feedback from the survey, the following traits were rated as the top three strengths for KNPS:

1) Continuous learning;
2) Personal accountability; and
3) Questioning attitude.

The survey highlighted the following three traits as possible areas for development:

1) Problem identification and resolution;
2) Environment for raising concerns; and
3) Respectful work environment.

10.2.3 Arrangements for safety management

A corporate Nuclear Safety Assurance (NSA) group has been established within Eskom and provides independent safety assurance to the Chief Nuclear Officer. Further details are given in section 12.5.

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.

Eskom's commitment to safety has been demonstrated 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 reviews completed thus far.

10.2.4 Arrangements for safety monitoring and self-assessment

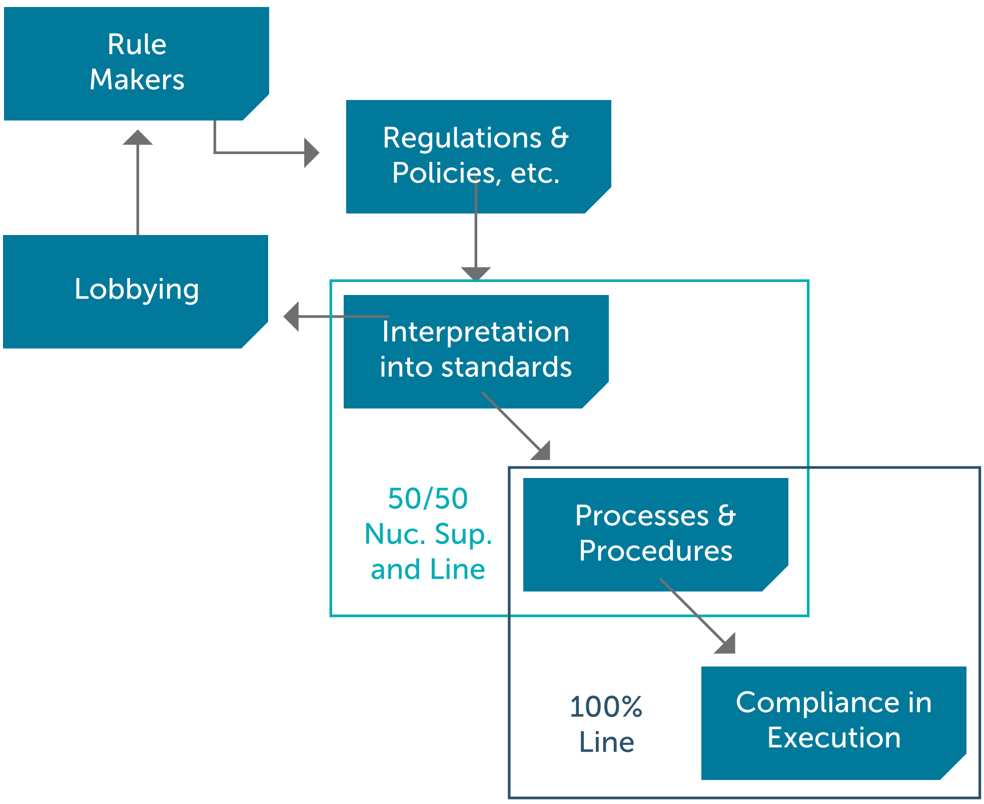
10.2.4.1 The Regulatory Management System

A robust Regulatory Management Programme is fundamental to the sustainability of the KNPS and its reputation as a world-class nuclear organisation. It is a prerequisite for sound corporate governance and an essential element in the overall risk management framework.

Managers have the responsibility to ensure that all activities performed under their control comply with applicable laws. Managers have a duty to monitor regulatory compliance within their area of responsibility, and to ensure that processes and procedures reflect regulatory requirements and that staff receive adequate training and instruction. All staff members have the responsibility to ensure that their activities on behalf of Eskom comply with applicable processes and procedures. The KNPS must also take appropriate steps to ensure that partnering contracting companies comply with the law.

FIGURE 10-2 BELOW DEPICTS THE HIGH-LEVEL PROCESS THAT ENSURES OVERALL COMPLIANCE WITH REGULATIONS AND MAXIMISES THE CHANCE OF FUTURE REGULATORY CHANGES BEING ANTICIPATED AND IMPLEMENTED TIMEOUSLY.

Figure 10-2 Regulatory Management Process



ARTICLE 10: PRIORITY TO SAFETY

Compliance review meetings

A bimonthly meeting will be used to review the following:

- Regulatory breaches;
- Regulatory issues;
- Licensing concerns that that have been raised as PNs (Problem Notification);
- Status of regulatory compliance assessments completed by various regulatory custodians; and
- Regulatory risks that should be raised.

Compliance monitoring

Independent monitoring activities occur at a defined frequency (typically daily and weekly). These activities include:

- The daily Koeberg Events Group (KEG) report (listing of all deviations reported in the last 24 hours, with their initial grading);
- The CAR meeting (Corrective Action Review);
- The weekly safety engineer's report to KORC (plant status control and outstanding deviations reports); and
- The weekly licencing engineer's report to the Regulator (listing of licence basis and regulatory non-compliances).

Planned monitoring activities

One of the licence conditions is the requirement to have a monitoring (inspection) programme in place to ensure compliance with all conditions of the nuclear licence. The quality assurance (QA) monitoring programme is designed to review the processes and procedures contained in the KLBM on a rotational basis every three years.

Ad hoc monitoring activities

Self-assessments are requested by management, when considered appropriate, to review specific activities or functions to ensure that procedural controls are achieving the desired objective and that the documented process is still practical.

A comprehensive review is also performed every six months by the Nuclear Licensing Group in conjunction with QA and NSA group, resulting in a report, which is shared with the Regulator.

New/updated legislation

Government gazettes shall be monitored to ensure that draft or new legislation that could impact the Nuclear Operating Unit are timeously identified for inclusion into this monitoring programme.

10.2.4.2 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.

10.2.4.3 Safety engineer function

As reported in previous reports, Eskom (Koeberg) has established five safety engineer posts based on the 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 OTS;
e) Approving the plant work plan after a risk evaluation; and
f) Confirming the compliance with 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 depends on the impact on nuclear safety.

2) Plant outage safety.
   a) Assist and advise during the outage planning phase to ensure compliance with the OTS.
   b) Participate in deterministic risk analyses and propose mitigation methods.
   c) Confirm that the equipment is correctly requalified.
   d) Confirm that the surveillance programme is complied with.
   e) Confirm compliance with nuclear safety requirements during plant state changes or during the outage.
   f) Prepare the outage safety plan.
   g) Confirm compliance with 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 operation, provide advice to the shift manager on operability determinations and 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 (TSC) with expert assistance regarding beyond design basis phenomena and recommend actions.
   f) Participate in the implementation of the Severe Accident Management Guidelines (SAMG).

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 Committee and Koeberg Operational Safety Committee.
   d) Participate in appropriate audits and evaluations.

10.2.5 Independent safety assessments

Independent safety assessments of the design and operation of KNPS are undertaken by the NSA group through a programme of evaluations. Strengths and issues requiring attention 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 organizations concerned with, and facilities and activities that give rise to, radiation risks". The publication further states that leadership in safety matters 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, over and above the requirements for a multilevel concept approach for an IMS, which define 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 [1.1];
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 with 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 comprising inspections, surveillances and audits as well as various forums for interaction with the licence holder.

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 on the achievement of these plans and applies indicators that 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 an IMS that is aligned with international requirements and best practices. The IMS is required to include provisions for promoting and supporting a strong safety and security culture. Consequently, the NNR has developed safety and security culture-related policies and internal guidance documents that are aligned with international safety standards and best practices.

The Safety and Security Culture Working Group (SSCWG) coordinates the initiatives for continual improvement of the safety and security culture within the organisation. As an indication of senior management's committed to foster a strong safety and security culture within the organisation, the following initiatives, amongst others, are undertaken to continuously improve the safety and security culture of the NNR:

1) Adoption of safety and security as one of the NNR's key values in order to instil a culture of safety and security within the organisation, with holders of nuclear authorisations and in the NNR's interactions with all other stakeholders.
2) Inclusion of safety and security culture as one of the key deliverables in the Annual Operational Plans and Risk Registers.
3) Participation of NNR personnel in IAEA Safety Culture Technical Meetings.
4) Biannual safety and security culture awareness sessions for NNR personnel; and
5) IAEA expert mission in November 2019 to review the NNR Safety Culture Self-Assessment (SCSA) results.

10.4.1.1 Safety culture assessment

The NNR conducted an SCSA to:

1) Determine the understanding of safety culture within the NNR;
2) Identify strengths and potential areas that require attention by comparing the observed traits to the IAEA safety culture framework; and
3) Gain insight into organisational behaviour and relationship dynamics that influence safety decisions and performance.

The results of the SCSA were presented to NNR staff. Safety culture awareness sessions are also conducted twice a year through NNR technical seminars.

Initiatives taken to enhance safety culture within the NNR include the following:

1) Participating in the IAEA Technical Meetings;
2) Introducing safety culture themes and sharing them with the business units;

3) Developing SCSA procedures;
4) Training for the SSCWG; and
5) Participating in the November 2019 IAEA review of the SCSA.

The November 2019 expert mission to review the NNR's SCSA results concluded, amongst others, that the NNR recognises the importance of working on safety and security culture, and that senior management plays a key role in the success of safety culture improvement. Comprehensive data gathering was performed, and the team also concluded the following with respect to the SCSA:

- The SCSA introduced elements of a normative lens when gathering data and analysing aspects of the process.
- SCSA results provide a strong basis for developing safety culture improvement actions, as well as broader organisational improvement.
- The SCSA initiated realignment of identified areas for improvement to formulate stronger cultural themes, recommendations and actions.
- The SCSA re-emphasised the importance of making the connection to the safety implications of cultural themes, including clear reference to specific IAEA safety culture framework attributes; and
- The SCSA clarified the distinction between organisational functionality issues, employee satisfaction issues and cultural phenomena.

The team recommended the development of an action plan, which should be used as the basis to set up a formal Safety Culture Continuous Improvement Programme to ensure its long-term sustainability and impact on safety culture.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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

2) Each contracting party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.

Summary of changes

Section 11.1 has been updated to report on the provision of financial resources.

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]

Paragraph 25.2 of NIL-01 (Variation 19) addresses requirements pertaining to the availability of financial resources to safely operate and maintain the KNPS. The KNPS is part of Eskom Holdings SOC Ltd, which is owned by the state. KNPS is not a legal entity on its own and receives its budget and funding from Eskom Holdings. Eskom Holdings is, and remains, a going concern as stated in the audited annual financial statements that are publicly available. Government provides financial support by means of loan guarantees and equity injections to Eskom Holdings. KNPS has always received adequate funding to meet its operational and capital expenditure. The mechanism for demonstrating compliance with paragraph 25.2 of NIL-01 (Variation 19) is under discussion with the regulatory body.

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. 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.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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 at the present, 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 continue operation until 2045. The financial obligation for decommissioning (as well as spent fuel management) has been fully recognised in terms of International Financial Reporting Standards. The financial provision is reflected in the annual financial statements of Eskom Holdings. These financial statements are audited in accordance with South African national legislation.

The amount of decommissioning and spent fuel provision is determined by the present value of the future estimated cash flows. These financial plans are reviewed regularly and adjusted annually, and subject to the South African inflation rate.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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 annual 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, and 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 currently 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 CP'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 for 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; and
7) Compensation for injuries of the Regulator's employees.

In accordance with the provisions of section 29 of the NNR Act, the Minister must, on the recommendation of the Board and in consultation with the Minister of Finance and by notice in the Gazette [1.10], determine:

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, include 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 Mineral Resources and 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 CP'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. RD-0034 [4.5] requires, amongst others, 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 must be implemented to establish technical and behavioural competence requirements.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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

The NNR's licensing standards for reactor operators are fully aligned to 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.

The Eskom Nuclear Management Policy addresses policy requirements on adequate human resources that are appropriately educated and trained and that have been allocated appropriate authority and responsibility in all life cycle phases of the nuclear installation.

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 licences 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; to employ appropriate training methods to ensure that individuals are aware of the relevance and importance of their activities in achieving the safety objectives; and to 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]

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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 or senior reactor operator 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 in normal, abnormal and incident plant operation;
2) Simulator examinations in normal, abnormal and incident conditions;
3) In-plant walk-through examinations; and, for senior reactor operator 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.

In July 2018, KNPS was successful in achieving the third accreditation renewal for its entire operator training programme with the USA-based INPO. KNPS remains the only nuclear power station outside of the USA to achieve this accreditation in 2003. The ongoing assessment and periodic accreditation renewal (2007, 2012 and 2018) provide 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 2024.

This initiative resulted in an overall improvement in 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 practices;
2) Improved operator performance at the plant;
3) A systematic approach to training that caters for the 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.

Furthermore, the operator training at KNPS is independently accredited by the South African Qualifications Authority in accordance with national requirements and standards.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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. Factory acceptance testing has been concluded at the supplier for modifications to the simulator model in preparation for the station's steam generator replacement project.

All initial and requalification training and performance evaluations are performed on these two full scope replica control room simulators situated on-site. The quality of the simulators is 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 non-compliance 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 to formally authorise staff to perform tasks on safety-related plant systems.

There is an increased focus on a multi-skilled workforce, which ensures that the organisation is prepared when employees retire. More experienced staff, closer to retirement age, will usually become contractors or move into training or coaching posts, and their responsibilities will be transferred to younger staff members. Succession planning is done through the talent management process, during which successors, and their developmental areas, are identified. At present, succession planning mainly occurs for higher level staff, but will eventually be rolled out to all levels in the organisation.

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.]

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

Eskom has implemented a systematic approach to training that is addressed in section 11.2.3. Operational experience is gathered and incorporated into training programmes.

11.2.7 Assessment of the licence 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 KNPS 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 an authorisation indicator, 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 as full-time staff.

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 applicable trade skills are assessed.

ARTICLE 11: FINANCIAL AND HUMAN RESOURCES

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 abroad through Eskom's support agreements with companies such as Areva and utilities such as 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 their responsibilities in the emergency plan of the organisation. In their normal functions they receive retraining and qualification through rigorous processes. Training is carried out on drills and shutting down the plant in emergency conditions.

11.2.12 Regulatory review and control activities

As reported in Article 19, 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 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 KNPS 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. In 2016, 100 learners commenced training in the conventional training programme. The training has been completed. 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 have an impact on nuclear safety in the long run, the NNR will continue to monitor staffing and competency levels at KNPS.

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

Section 12.3.1 has been updated to describe the applicable database for tracking operational experience. Other changes are limited to editorial improvements.

12.1 Requirements on human factors and organisational issues

[Overview of the CP'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 (Article 13). RD-0034 [4.5] details the requirements for a process-based IMS for licensees, applicants for a nuclear licence as well as designers and suppliers involved in the design, manufacturing, construction, commissioning, operation, modification and potential decommissioning of a nuclear installation in South Africa under the NNR Act [1.1]. The document addresses:

1) A multilevel-concept approach for an IMS;
2) Quality and safety management requirements to ensure that safety is appropriately taken into account in all activities and decisions; and
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 (Article 13).

ARTICLE 12: HUMAN FACTORS

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 factors 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, DevonWay, containing information regarding problems, events and non-conformances. All such incidents are rated according to the INES. Various root cause analysis methodologies are used and 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. Event codes are used to identify the development of any trends and 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)

HRA methods are applied at KNPS 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 actions conducted post-core damage. The outcomes of the PSA are benchmarked against other international PSA studies. Lessons learned from the Level 2 PSA regarding internal and external events are implemented.

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).

An extra display and mimic have been provided for the spent fuel cooling system.

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, including the application, 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 analysis principle. During training, maintenance personnel have to demonstrate the use of human performance tools. In addition, during operations, the actions that are required to be performed in the control room are regularly rehearsed during training exercises. It is the expectation that the human performance tools will be applied and 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 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. Licensed operators undergo medical examinations and psychological monitoring interviews every six months to identify any personal dispositions that might compromise their performance on shift.

12.4 Self-assessment of managerial and organisational issues

[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 management 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 in order 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 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 NSA group (previously known as the Generation Nuclear Safety and Assurance group), has been operational for approximately 25 years and has positively contributed to the overall enhancement of the licence holder's nuclear safety governance, and 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 nuclear 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 at a Corrective Action Review 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 corrective actions.

All significant operating event reports received from WANO and INPO are formally tracked and generic studies by EDF are processed via Corrective Action Review meetings to formalise a Koeberg position. Event reports from the 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 operational experience feedback 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; and
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 and 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 with regard to 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 review of KNPS, the NNR required that the human factors review incorporates 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 review concluded that the methods and programmes for analysing, preventing, detecting and correcting human errors in the operation and maintenance of KNPS 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 the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

Summary of changes

Updates to Article 13 mainly concern minor editorial changes.

13.1 Requirements on quality assurance programmes

[Overview of the CP's arrangements and regulatory requirements for quality assurance (QA) programmes, quality management systems, or management systems of the licence holders]

One of the principle nuclear safety requirements in section 3.10 of the SSRP [1.8] is that a quality management programme must be established, implemented and maintained in order to ensure compliance with the conditions of the nuclear authorisation. This safety requirement, related to the licence holder's QA responsibilities, was issued as licence requirements in LD-1023 [4.4] and further entrenched in 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 QA programmes presently satisfy both 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 9001:2015, 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 issued in LD-1023 [4.4] and RD-0034 [4.5].

ARTICLE 13: QUALITY ASSURANCE

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 KNPS. This programme is based, as a minimum, on IAEA Safety Code No. 50-C/SG-Q and licensing requirements as per NNR documents LD1023 [4.4] and RD-0034 [4.5]. 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 the 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 QA 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. Based on the review and evaluation by responsible competent engineers, non-conformances for components are dispositioned as follows: use-as-is, repair, rework, or unfit-for-purpose. 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 KNPS 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 OTS;
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 the 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 SSCs, as described in RD-0034 [4.5]. Safety Level 1 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) Inspection findings;
4) Non-compliance reports; and
5) Work orders.

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

1) Observations (based on the judgment as to the adequacy of a particular system requirement);
2) Findings (non-compliance or shortcomings in the implementation of a QA system

requirement); or

3) Licence issue (non-compliance with a condition of the nuclear installation licence requirement).

Inspection 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 refuelling 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, which is responsible for identifying concerns and initiating appropriate corrective actions.

In terms of the requirements of the NNR Act [1.1], the NNR-appointed inspectors are required to be trained and certificated. The training and certification are carried out according to a modular Inspector Training and Qualification 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

Section 14.1.3 has been updated to report on developments regarding the third periodic safety review.

Section 14.1.2.7 has been included.

Section 14.2.3 has received minor updates.

14.1 Assessment of safety

14.1.1 Requirements on safety assessment

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

The NNR Act [1.1] 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 SSRP [1.8]. 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 and sufficient to identify all significant radiation hazards and to evaluate 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.

ARTICLE 14: ASSESSMENT AND VERIFICATION OF SAFETY

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 with the legislated requirements are described in the 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 licence 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 require 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.

These requirements are implemented 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.

ARTICLE 14: ASSESSMENT AND VERIFICATION OF SAFETY

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 PSA and to the deterministic aspects of demonstrating compliance with design and operational requirements.

In terms of section 21 of the Act, the Regulations on Licensing of Sites for New Nuclear Installations [1.9] require that the applicant for a nuclear installation licence for the siting of a nuclear installation must submit an SSR to the Regulator in support of the application.

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 SAR for a construction licence;
4) SAR 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 review; and
9) Safety assessment for decommissioning.

As discussed in Article 6, the NNR has varied NIL-01 and included a specific condition relating to the performance of a safety assessment of the nuclear installation every ten years. To this end, the NNR has also drafted RG-0028 [4.25], Periodic Safety Review of Nuclear Power Plants, on the performance of the periodic safety review.

ARTICLE 14: ASSESSMENT AND VERIFICATION OF SAFETY

Before the operator performs the periodic review, NNR acceptance and/or confirmation should be obtained on the scope and objectives of the periodic safety review, including current national and international standards and codes to be used.

The guidance provided by the NNR in RG-0019 [4.24], Interim Guidance on Safety Assessments of Nuclear Facilities, is aligned with VDNS Principle 1 and specifies the following safety objectives for new NPPs:

1) Prevention of accidents shall be the focus by designing for fault tolerance through the 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 practicable (no off-site effects implies that there should be no off-site radiological impact);
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; and
5) Any off-site releases that could occur shall only require limited off-site emergency response.

RG-0028 further requires the identification of areas where either the licensing basis or current standards and practices are not achieved. A list of proposed safety improvements should be prepared for each negative finding, or, if no safety improvement can be identified that is reasonable and practicable, a justification for this should be provided.

It is therefore expected that the periodic safety review should be performed against current standards, and that reasonably practicable improvement measures are identified and implemented in line with Principle 2 of the VDNS.

Safety assessments of existing nuclear installations are a requirement for nuclear safety. In the case of KNPS, a safety assessment is performed every ten years. The safety assessments are performed in order to identify areas of weakness and areas where improvements can be made in view of technological advancements and operational experience. The assessments also account for plant modifications.

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The NNR has provided guidelines for nuclear licence holders and nuclear licence applicants in the form of LG-1041 [4.8] to facilitate the process of conducting safety assessments and, in the case of the Regulator, the safety assessment review.

The NNR has also developed RG-0027 [4.27], Ageing Management and Long-Term Operations of Nuclear Power Plants, to provide guidance for the LTO of KNPS.

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, an SSR to the Regulator in conformance with the siting regulation [1.9].

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) Design safety assessment of components;
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 SAR and SSR, accompanied by the following:

1) Topical reports;
2) Safety classification document;
3) Quality and safety management documentation;
4) Preliminary 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

With regard to safety assessment aspects for an authorisation to operate a nuclear installation, the applicant is required to provide an 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, thereby addressing any issue giving rise to changes in safety, and shall include the identification of those changes requiring the 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 [1.8].

14.1.2.7 Long-term operation

The operation of a nuclear facility beyond an established time frame defined in the current licensing basis or relevant standards is to be supported by a safety case to demonstrate the continued safe operation of the nuclear facility. In accordance with the SSRP [1.8], the holder of a nuclear installation licence is required to have an appropriate maintenance and inspection programme implemented to ensure that the reliability and integrity of installations, equipment and plant having an impact on radiation and nuclear safety are commensurate with dose limits and risk limits.

To ensure the safe LTO of nuclear facilities, the authorisation holder is to demonstrate that the safety of the nuclear facility will be maintained throughout the proposed period of LTO in accordance with current safety standards as far as reasonably practical; and that sufficient resources and technical support will be available for the intended period of LTO, including cessation of operation and decommissioning, until the termination of the period of responsibility.

14.1.3 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 reviews of the nuclear installation throughout its operational lifetime, at a frequency acceptable to the Regulator, taking into account operating experience and significant new safety information from relevant sources.

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

The periodic safety review 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 review, the holder shall implement reasonably practicable 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 Mineral Resources and 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 practicable safety improvement measures.

14.1.3.2 Koeberg first periodic safety review

The first periodic safety review of KNPS 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's CP1 safety referential was used as a benchmark. The review identified a number of plant improvements that were necessary to bring Koeberg's level of safety to a comparable level to that of the CP1 reference. However, it was recognised that following the next ten-year periodic safety review, a further batch of modifications would need to be implemented in order to maintain a comparable level of safety with the CP1 reference, which in turn was being subjected to ongoing safety upgrades.

Eskom took a strategic decision to aim for a closer alignment to the CP1 hardware referential. Over and above the modifications identified from the periodic safety review, 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 KNPS, and to maximise business and safety benefits of the support contract Eskom has with EDF. The premise was that safety issues affecting KNPS can be resolved in a similar manner to which EDF resolved the same issues for CP1 plants.

Over the following ten years, the so-called CP1 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 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 of plant systems (improve system start-up times and the control function of the systems, and automate critical actions to avoid functional failure in an accident scenario);

5) Enhancement of plant operation under accident conditions (operation under accident conditions, 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 (such as high-energy pipe breaks, internal flooding, earthquakes for passive equipment, and fire); and
7) Modifications identified by EDF during their second periodic safety review (VD-2), including the installation of passive autocatalytic recombiners.

Some 800 modifications and safety improvements implemented on EDF CP1 plants (lot 93 and so-called VD-2 scope of modifications) were reviewed for applicability to KNPS. 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 Koeberg Accident Analysis Manual [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 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 third periodic safety review

In March 2019, the NNR released a draft regulatory guide RG-0028 [4.25], Periodic Safety Review of Nuclear Power Plants, which provides guidance on how to meet the Regulations on SSRP in accordance with the NNR Act.

In line with IAEA practice, RG-0028 requires all nuclear facilities to perform periodic safety reviews. In accordance with the Koeberg nuclear installation licence (NIL-1), a periodic safety review should be performed for the facility every ten years. RG-0028 provides explicit guidance regarding the NNR's expectation on how such a review should be conducted. The periodic safety review should encompass all facilities and SSCs on the site covered by the operating licence (e.g. waste management facilities and on-site simulators), including their operation, as well as the authorisation holder and its staff.

This periodic safety review will be used to support the justification for LTO.

The assessment will review the current status of the plant as well as assess the ability of the plant to meet the requirements and standards for the period of extended operation. As the third safety reassessment (SRA-III) is in support of the justification for LTO, the assessment will look beyond the ten-year period considered in a typical periodic safety review to those areas that are required to support the justification of LTO.

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 and not only according to their type and generation]

14.1.4.1 Koeberg first periodic safety review

Refer to section 14.1.3.2.

14.1.4.2 Koeberg second periodic safety review

Refer to section 14.1.3.3.

14.1.4.3 Review of KNPS following the Fukushima accident

A summary of the post-Fukushima review of KNPS is given below. Further details are provided in Annexure 2.

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

1) Compliance with 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.

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Eskom had previously established an External Events Review Team (EERT) and had begun implementing guidelines issued by INPO and WANO, focusing 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 Review Meeting of the CNS 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 periodic safety review report in December 2011. The scope of the review 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 included prolonged total loss of electrical power and ultimate heat sink. Measures or design features to mitigate these effects were identified. The option to construct an alternative heat sink was considered but not implemented. 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 review did not reveal any major shortcomings in the safety of KNPS 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.

KNPS was one of the first nuclear power plants to implement SAMG, and the NNR is the first regulator to include these in the regulatory process. These guidelines were updated following the Fukushima event and include guidance for spent fuel pool and shutdown accidents. The NNR has consistently enforced conservative emergency planning zones around Koeberg, informed by risk analysis, beyond what has been internationally required. 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 National Report of South Africa [3.1], which was submitted to the IAEA for the 2nd Extraordinary Meeting of the CNS held in August 2012.

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The NNR's 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 periodic safety reviews identified a number of potential improvements to further reduce risk beyond the design requirements.
5) The NNR has identified areas for improvement of the SSRP, which have been included in the revision and update of the regulations. These regulations are currently with the Minister of Mineral Resources and Energy for promulgation.

Improvements to the regulations relate to the:

1) Robustness of the design of nuclear installations 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, which 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 periodic safety review reports covering additional external events and 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, electrical connection points for mobile electrical supply, etc.), and has communicated additional short-term actions to the NNR to be implemented in the near future (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, and mobile diesel generator connection points). Equipment is selected based on its suitability, robustness and fitness for purpose.

In line with progress made internationally, KNPS 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 turntable ladder 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 2024. This work, although related to the Fukushima improvement actions, is in accordance with the application for LTO.

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 exposure pathways such as ingestion, ground shine and inhalation of resuspended radionuclides. 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 and to be consistent with the IAEA International Basic Safety Standards GSR Part 3 [5.15] that specify 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 Nuclear Regulatory Commission (NRC) Alternative Source Terms approach as provided in Regulatory Guide 1.183 [6.5]. This guide uses release durations for accidents when determining the effective dose equivalent at the outer boundary of the low population zone.

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 SSRP, as well as specific requirements in the conditions of licence, including the international benchmark (French CP1 safety referential) and other international practices.

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, and 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 CP's arrangements and regulatory requirements for the verification of safety]

The SSRP [1.8] require the establishment of operational safety-related programmes, limitations and design requirements based on the operational safety assessment. The SSRP further require the establishment of an appropriate maintenance and inspection programme. The maintenance and inspection programme must ensure that the reliability and integrity of installations, equipment and plant are commensurate with the dose and risk limits. RD0034 [4.5] also requires these programmes to be reviewed periodically and updated according to the design specifications and applied codes and standards in order 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 KNPS:

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.

The NNR has issued RG-0014 [4.19], Guidance on Implementation of Cyber or Computer Security for Nuclear Facilities. Eskom is in the process of implementing this guidance and has drafted a cybersecurity standard (240-55410927) to address the growing concerns about attacks on computer systems. The standard also considers requirements defined in the North American Electric Reliability Corporation (NERC) critical infrastructure protection guidelines. The standard is specific to operational technology and outlines the process of identifying and evaluating critical assets, including assessing their vulnerability to cyberattacks, and actions to prevent and mitigate the consequences in the event of an attack.

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 take cognisance of national and international codes and standards, local safety standards and regulatory practices, and operational limits based on installation design requirements.

The feedback of acquired data, attained through a process of engineering evaluations, is fundamental to these programmes 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 SSCs 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 standard, which is approved by the NNR and therefore part of the conditions of the nuclear installation licence. The in-service inspection requirements are primarily derived from the ASME Code, Section XI, Division 1 [6.6] rules as amended for implementation by Title 10, Part 50, Section 50.55a of the United States Code of Federal Regulations [6.7]. Those examinations that are required by ASME Section XI are addressed in the basic scope of the In-Service Inspection Programme Requirements Manual. Examinations identified to be performed, due to criteria outside of ASME Section XI, are addressed in the augmented scope of the In-Service Inspection Programme Requirements Manual. Augmented in-service inspection 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 SSCs 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.

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 Code for Operation and Maintenance is as per limitations and modifications identified in the United States Code of Federal Regulations, Title 10, Part 50, Section 50.55a.

14.2.2.4 Reactor Vessel Surveillance Programme

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 was introduced in order to mitigate the effects of primary water stress corrosion in the steam generator tubing.

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

The last of the spare capsules were inserted in each reactor after 16 operating cycles. Removal of these capsules is planned for 2035 and the results may be used to support the extension of the plant’s operating lifetime beyond 60 years.

Koeberg has acquired a radiation computational capability, which is currently being implemented, to calculate the fast neutron environment within the RPV boundary. This plant-, cycle- and location-specific software tool determines the radiation environment based on Koeberg's unit-specific geometry, material properties and reactor operating history. The system generates location-specific fast neutron flux/fluence data for each of the Koeberg RPVs and its internals, as well as embrittlement data for the extended core beltline.

Studies completed in 2017 concluded that the integrity of both units' RPVs under pressurised thermal shock transients can be demonstrated within the required margins after 40 years of operation. Additional studies completed in 2018 concluded that the integrity of both units' RPVs under pressurised thermal shock transients may be confirmed for extended plant life.

14.2.2.5 Maintenance and testing programme

This programme covers the maintenance of mechanical, electrical, instrumentation and telecommunication hardware and 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. 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 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 reliability-centred maintenance philosophy and principles. As part of this approach, every change in the maintenance basis (maintenance scope or frequency) should 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 probabilistic risk assessment reliability–availability database. Failure analyses will be conducted and corrective actions will be implemented following any functional or potential failures.

The requirements of the OTS 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, and 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, and indicates both minor deviations and 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 SSRP 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 demonstrates compliance with the risk limits of the SSRP.

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

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In order to ensure validity and accuracy, a comprehensive comparison was completed between the Koeberg PSA and internationally recognised standards as part of the Koeberg periodic safety review, 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.

Where possible, the Koeberg PSA is used in decision-making where nuclear safety could be impacted. The safety cases for any proposed plant change must include a PSA. OTS changes are also reviewed using PSA insights. Other plant applications that use risk insights 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 Koeberg PSA has been subjected to a number of reviews as part of the confirmation process that, where applicable, 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 EDF's ageing management programme combined with its own existing suite of operational and monitoring programmes for KNPS. 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 SSCs is being managed within existing processes and procedures that include the maintenance programme, the ISIP, plant health system reports, life of plant plans, life cycle management programmes and transient monitoring. The design and licensing knowledge base is maintained in the licensing manual, safety-related programme documents, management system, SAR and all other plant supporting documentation. The NNR requires that all these documents are updated regularly. Eskom also benefits from applied research related to the EDF fleet.

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

1) Eskom is currently in the process of replacing the steam generators of both Koeberg units to sustain the plant lifespan. The current steam generators contain components (tubing) that are susceptible to corrosion. In 2016, Eskom was one of the few nuclear power stations in the world still operating with the older type of steam generator tube material. Eskom has specified the technical criteria of this project for undertaking the associated accident studies in line with the latest international practice. The hot leg elbows for both units will also be replaced.
2) The reactor cavity and spent fuel pit cooling system tanks are susceptible to hairline wall cracks due to stress corrosion cracking. In view of the premature ageing of the tanks, the NNR issued a requirement to Eskom in February 2011 instructing the utility to replace the tanks. Both the Unit 1 and Unit 2 tanks have been replaced.
3) Eskom has embarked on a programme to replace the RPV heads for both reactors at the KNPS. The Unit 1 RPV head was successfully replaced during outage 116 in 2007, following which the Eskom Board commissioned the replacement of the Unit 2 RPV head and control rod drive mechanisms (CRDMs). The Unit 2 RPV head and CRDMs will be replaced during outage 225 in 2022. The Koeberg plant has noted thermal sleeve wear and intends to use the opportunity of the RPV head replacement project to resolve the issues. Several proposals were made by Framatome, which Eskom is still in the process of reviewing. The motivation to replace the RPVs is based on operational experience and ageing management.

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

1) Turbine governing and turbine safety systems (replaced using digital technology);
2) Rod control system;
3) Low pressure turbine retrofit;
4) Station transformer;
5) Generator stator rewind;
6) Unit 1 RPV head; and
7) Unit 2 PTR tank.

The NNR has developed RG-0027 [4.27], Ageing Management and Long-Term Operations of Nuclear Power Plants, to provide guidance for the LTO of KNPS. Safety improvements to the plant are carried out in terms of LD-1012 [4.28], Requirements in Respect of Proposed

Modifications to the KNPS, and are augmented in additional requirements as defined in NIL-01 (Variation 19).

14.2.3.1 Technical assessment and regulatory requirements for plant improvements

Deterministic and probabilistic safety analyses, consistent with the graded approach and covering both operational states and accident conditions, must be carried out for planned plant improvements. A safety assessment shall ensure the reliability and integrity of components during the design and manufacturing stages in order to minimise defects that may give rise to nuclear accidents. Testing and qualification of SSCs shall take place prior to installation.

The frequency of initiating events that may lead to accident conditions shall be taken into account for the following:

1) Loss of vital AC and DC;
2) Loss-of-Coolant Accident;
3) Loss of normal residual heat removal;
4) Loss of ultimate heat sink;
5) Transients;
6) Loss of main feedwater;
7) Malfunctions of SSCs;
8) Steam line breaks; and
9) Pressure vessel failure.

Verification of installation specifications shall ensure that plant improvements are consistent with safe functional requirements. Plant improvements must be made with reference to operational experience feedback and also take into consideration the environmental impact posed by different operational states.

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 committees.

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 programme outlined below.

14.2.5.2 NNR approval process

The nuclear installation licence requires the licence holder to submit 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 assurance 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 programme, which is independently implemented by the NPP inspectorate 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 sections 11.2.3 and 12.6, the licensing of reactor operators 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. 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 for the implementation of appropriate corrective action. Refer to Article 19 for more details.

ARTICLE 15: RADIATION PROTECTION

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

Summary of changes

Section 15.3.1 has been updated to report on additional occupational exposure doses.

Section 15.3.2 has been updated to reflect the additional projected annual public doses and activity discharge levels.

Section 15.3.4 has been updated to report on the updated TLD exposure measurements at the plant site boundary.

15.1 Requirements on radiation protection

[Overview of the CP'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 SSRP [1.8] contain specific requirements for all radiological protection aspects, including compliance with radiation dose limits. The regulations ensure that criteria are in place for all radiation protection oversight and authorisation activities. Section 4.5 of the SSRP 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 must be implemented to ensure that the exposures associated with the authorised action are ALARA. Furthermore, the optimisation of protection must be subject to dose constraints specific to the authorised action, as stated in section 4.5.2. 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 ALARA.

The dose limits prescribed by the NNR for the KNPS are applicable to both members of the public and the occupationally exposed population. These limits are referenced in Annexure 2 of the SSRP, the conditions of the Koeberg nuclear installation licence in the KLBM [4.10], the NNR regulatory requirements document and Eskom's radiation protection standards, which are reviewed and approved by the NNR. 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 specify 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 KNPS, the dose constraint, applicable to the average member of the critical group within the exposed population, is 0.25 mSv per year.

ARTICLE 15: RADIATION PROTECTION

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 KLBM (discussed in Article 9) makes reference to the principles upon which these verification programmes and operational radiation protection programme are based. All of these principles are embodied in the conditions of the nuclear installation licence and the holder's licensing basis manual, as well as the NNR approved radiation protection standards.

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

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

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 [1.8] specifies that the NNR may, for the purposes of controlling radioactive discharges from a single authorised action, determine source-specific annual authorised discharge quantities (AADQ) 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, have been addressed in previous CNS reports. The status quo in this regard is the same, and exposure 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 KNPS. 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 ISIP, implementation of modifications, rework on active components, and component replacements and additional maintenance due to plant ageing.

Over the years, the general reduction in the average annual dose to occupationally exposed workers are mainly due to the integration of dose management in the work management programme and performance management system at KNPS. There should be a further reduction in doses once the new steam generators have been installed. Line groups and departments are successfully managing personnel dose exposure in accordance with weekly, monthly and annual dose targets. The dose targets are set in consultation with line groups and departments and daily dose reviews are performed by the ALARA group at KNPS.

ARTICLE 15: RADIATION PROTECTION

Table 15.3-1 Summary of Koeberg Occupational Exposure Data from 1999 to 2020

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*	0.729
2016	0	394.825	0.167
2017	0	478.943	0.206
2018	0	1612.964*	0.552
2019	0	400.161	0.151
2020	0	569.646	0.260

* Two major outages were conducted in 2015 and 2018.

ARTICLE 15: RADIATION PROTECTION

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 the 4 mSv ALARA target. Table 15.3-1 provides data for the variation this quantity from 1999 to 2020.

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 ensure compliance with the AADQ 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 are 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 OTS.

Operational control over radioactive waste is exercised through the radioactive waste management programme, as required by the SSRP [1.8] and the conditions of the Koeberg nuclear installation licence. In line with the principle of the Radioactive Waste Management Policy and Strategy [2.4], this programme allows for the identification of all sources of waste and the minimisation and optimisation of waste production, collection, handling, treatment, conditioning, quantification, storage and transport.

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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.

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 remains unchanged.

Eskom stores the materials not unconditionally cleared on-site. A portable multichannel analyser instrument is used for measurements to clear volumetric contaminated material from regulatory control. The sensitivity of the instrument is to such a degree that activity concentrations of less than 0.2 Bq/g can be measured, 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 Calculated Annual Public Doses Due to KNPS Operational Discharges from 2002 to 2020

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
2016	0.083	0.399	0.48
2017	0.256	1.023	1.28
2018	0.100	2.507	2.61
2019	0.181	0.448	0.629
2020	0.086	0.938	1.024

The calculated annual dose arising from effluent discharges from the plant during 2003 was 4.9% of the NNR dose limit, compared to less than 1% from 2020. The reason for the decrease in calculated dose in recent years can be attributed to the application of the ALARA principles in effluent management. The values have been corrected for background.

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The variation in the total activity discharged by pathway in each year from 2002 to 2020 is detailed in Table 15.3-3.

Table 15.3-3 Total Activity Discharged from KNPS 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	3.11 E+03	1.96 E+04	2.27 E+04
2016	4.69 E+03	2.99 E+04	3.46 E+04
2017	1.59 E+05	3.33 E+05	4.92 E+05
2018	5.40 E+03	2.51 E+04	3.05 E+04
2019	1.15 E+04	2.72 E+04	3.87 E+04
2020	6.40 E+03	1.45 E+04	2.09 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 because it provides a systematic method for the optimisation of protection and the formalised system of feedback.

The most crucial features of the ALARA programme are as follows:

1) Integration of the ALARA checkpoint into the normal system of operational radiation protection. For all jobs 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 in procedure reviews; some procedures have hold points or warnings before certain steps to include ALARA considerations.
2) Use of a tiered approach to pre-task review based on the anticipated collective dose.
3) 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) 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.

As depicted in Table 15.3-4, the annual calculated 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:

ARTICLE 15: RADIATION PROTECTION

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 refuelling, 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 the 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 with 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 to reduce leaks in the plant.
7) KNPS 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 radiation worker training simulator has been established at the KNPS training centre to fulfil practical training requirements for radiation workers and encompasses 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) 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. The dose estimation tools are readily available to line groups via the intranet dose management website.

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 supplementary to the radiological effluent management programme. The AADQ, 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 that 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 that may form part of the pathways through which the population may be exposed as a result of the 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 KNPS. 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 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.

Results obtained from the environmental surveillance programme indicated the detection of activity in lobster, abalone, and white and black mussels. The radionuclides detected in the past included ^{54}Mn, ^{58}Co, ^{60}Co and ^{110m}Ag.

In terms of direct radiation, Table 15.3-4 indicates representative average measurements of monthly external exposure at the site boundary from 2002 to 2020. The data reflects the total external dose recorded at the site boundary and is used to trend contributions to direct radiation by the nuclear installation. The values have been corrected for background. 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
2005	23.8
2006	23.2
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	22.3
2016	22.0
2017	21.7
2018	20.0
2019	20.2
2020	Not available at time of publication

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 for the nuclear installation to submit periodic reports in an agreed format on all aspects relating to radiation protection, as well as follow-up on the NNR compliance assurance and inspection programme, 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 QA audits. In addition, the regulatory body 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 also performs independent inspections on the Koeberg radiation protection programme.

Other regulatory activities and initiatives include:

1) Establishment of a National Dose Register; Eskom has participated in a Steering Committee and is currently uploading occupational exposure records; and
2) Establishment of a functional and peer reviewed NNR radioanalytical 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 regulatory body.

2) Each contracting party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the states in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

3) Contracting parties which do not have a nuclear installation 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 cover the activities to be carried out in the event of such an emergency.

Summary of changes

Section 16.1.5 has been updated to provide feedback on the status of the emergency exercise carried out the NPP.

16.1 Emergency plans and programmes

16.1.1 Legal and regulatory framework

[Overview of the CP'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, 2002 (Act No. 57 of 2002) [1.4], and as amended in 2015 (Act No. 16 of 2015) [1.5], the DMRE is the national organ of state for the coordination and management of matters related to nuclear disasters at national level.

As a signatory to the international Convention on Early Notification of a Nuclear Accident [5.4], South Africa will notify the IAEA in case of a nuclear accident. Necsa has been designated by the DMRE as the national competent authority to observe this convention and to be the point of contact. Necsa therefore operates a 24-hour Emergency Control Centre (ECC).

ARTICLE 16: EMERGENCY PREPAREDNESS

Proposals have been made to the DMRE to assign the role of national competent authority to the NNR, and the issue is still under consideration.

The NNR Act [1.1] and the SSRP [1.8] specify the requirements on emergency planning to ensure effective preparedness and response to deal with nuclear accidents.

Section 38 of 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:

1) Enter into an agreement with the relevant municipalities and provincial authorities to establish an emergency plan;
2) Cover the cost for the establishment, implementation and management of such an emergency plan insofar as it relates to the relevant nuclear installation; and
3) Submit such emergency plan for approval by the NNR.

The NNR must further ensure that such an emergency plan is effective for the protection of persons should a nuclear accident occur. The emergency plan should include 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 Mineral Resources and 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's emergency controller. In the event of a nuclear accident, the Disaster Management Act requires local authorities to verify and implement off-site protective actions as recommended by the authorisation holder, according to the procedures laid down in the emergency plan. The NNR Act is in the process of being updated; one of the proposed additional responsibilities of the NNR is for the Regulator to, upon request, act as an advisor to emergency response organisations and government organs in case of a nuclear or radiological emergency. This will include verification of protective actions for members of the public as recommended by the operator. The NNR will also undertake communication with the media, conduct press conferences and ensure the quality of information that is disseminated during a radiological emergency.

Requirements on emergency preparedness are documented in RD-014, Emergency Preparedness and Response Requirements for Nuclear Installations [4.7], and 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 [5.16], and the licence holder is required to demonstrate compliance with the requirements of this document. The NNR has developed draft regulations on emergency preparedness and response that will supersede RD-014 and the Regulations on SSRP. These draft regulations are based on GSR Part 7 [5.17], and promulgation is pending the Minister of Mineral Resources and Energy's consultation and approval process.

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

Regulations on Licensing of Sites for New Nuclear Installations [1.9] were promulgated in 2011. These regulations impose requirements with regard to emergency planning zones. The NNR is also reviewing and developing a suite of Regulatory Guides, and has issued RG0020 [4.26], Interim Guidance on Emergency Preparedness and Response for Nuclear and Radiological Emergencies. This guide is based on GSR Part 7 and specifies the regulatory position on selected emergency preparedness and response aspects. In addition, Position Paper PP-0015 [4.22], Emergency Planning Technical Basis for New Nuclear Installations, provides guidance to new applicants on the determination of emergency planning zones, and Regulatory Guide RG0011 [4.17], Interim Guidance for the Siting of Nuclear Facilities, includes emergency preparedness and response considerations.

The Koeberg Safety Analysis Report includes the basis for the emergency planning zones and protective actions, as derived from the approved technical basis. The zones and protective actions are also included in the licensee standards and procedures, as well as the Integrated Koeberg Nuclear Emergency Plan [4.12]. 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

16.1.2.1 Forums

The Emergency Planning Steering and Oversight Committee (EPSOC) was established with the authorities in the vicinity of the KNPS for liaison on emergency preparedness, planning and response. This forum provides direction, steering and oversight relating to the development and implementation of emergency preparedness and response plans for Koeberg. The committee meets on a quarterly basis and is chaired by a representative from the DMRE, which is the organ of state responsible for the 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, as provided for in the Disaster Management Act, the Minister of Cooperative Governance and Traditional Affairs would declare a national state of disaster.

At national level, the DMRE is responsible for the coordination and management of matters related to off-site nuclear disasters. 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 way in which concepts and principles of disaster management are to be applied in its functional area.

In 2014, the IAEA EPREV mission reviewed the national infrastructure for nuclear emergency preparedness and made recommendations based on the country's emergency plan and response programmes. Following the EPREV mission, the DMRE 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. The National Nuclear Disaster Management Plan, which was prepared by the DMRE in 2005 in terms of the Disaster Management Act, is currently under review following the EPREV mission to South Africa.

ARTICLE 16: EMERGENCY PREPAREDNESS

In response to the above, the NNR developed and issued RG-0020 [4.26], Interim Guidance on Emergency Preparedness and Response for Nuclear and Radiological Emergencies, which 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.

RG-0020 was recently reviewed and updated to include the recommendations of the IRRS Mission conducted in 2016. Authorisation holders of nuclear installation licences also reviewed the guide and provided input before it was approved.

The ultimate aim of implementing amendments to the NNR Act, draft regulations and the suite of Regulatory Guides is to establish a regulatory framework that will ensure an integrated National Nuclear Disaster Management Plan, which considers both nuclear and radiological emergencies.

South Africa is a signatory to both the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency [5.5]. Early notification activities are therefore part of the National Nuclear Disaster Management Plan. As mentioned in section 16.1.1, Necsa has been designated as the national competent authority and national warning point. The DMRE is considering the separation of the two functions.

Under the emergency conventions, the IAEA has developed the Emergency Preparedness and Response Information Management System (EPRIMS). It is a web-based tool that enables member states to conduct self-assessments and information sharing on emergency preparedness arrangements. Currently, representatives from both the NNR and the DMRE serve as the South African Country Coordinators for EPRIMS. The South African self-assessment information has been uploaded to EPRIMS. The coordinators are in the process of establishing a national EPRIMS team comprising representatives from all EPR stakeholder organisations. The team will be responsible for coordinating the review and assessment of respective organisational EPR arrangements through the EPRIMS tool.

ARTICLE 16: EMERGENCY PREPAREDNESS

The NNR has completed the process of upgrading its Regulatory Emergency Response Centre (RERC). The RERC 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 recommended to protect people and the environment. The RERC will also provide the NNR with the means to communicate with relevant stakeholders.

The RERC's new infrastructure and capabilities include 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. RERC emergency procedures have been reviewed and updated in line with the upgrade and a resource plan has been developed for the activation of the RERC in case of a nuclear or radiological emergency. Emergency exercises will also be conducted periodically and procedures will be updated using any findings.

The NNR has established a verification laboratory to analyse environmental samples that are collected in line with the compliance assurance programme. The laboratory is capable of analysing various matrices using different techniques such as gamma spectrometry, alpha spectrometry, liquid scintillation counting and gross alpha/beta counting. The NNR laboratory takes part in proficiency tests through the IAEA ALMERA network (Analytical Laboratories for the Measurement of Environmental Radioactivity) in order to monitor and demonstrate its performance and analytical capabilities.

The laboratory has initiated the process of acquiring an accreditation from the South African National Accreditation System for its methods and activities as required by the ISO/IEC 17025 standard. The aim is for the laboratory to be fully accredited in the next three years. Currently the laboratory is working on the Gamma Accreditation process, which is to be completed by the end of 2019. As part of the accreditation process, the laboratory has been participating in the IAEA Worldwide Open Proficiency Tests since the 2015 test on anthropogenic and natural radionuclides in water, biota and soil samples. Most of the submitted results have been acceptable for precision and accuracy (based on the Z-score method) and have been comparable to those of all other participating international counterparts.

16.1.3 Implementation of emergency preparedness measures by the licence holders

16.1.3.1 Classification of emergencies

KNPS has a system in place for the classification of emergency situations based on the severity of the event. Depending on the severity, the actions taken could range from activation of the licence holder's ECC to notification of the local, provincial and national government.

Emergency situations are classified 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 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 (CoCT) is only notified of the event for informative purposes.

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

16.1.3.1.2 Alert

An Alert is 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, and the NNR and all off-site government support organisations are notified.

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 is declared as a result of events that involve the actual or likely failure of the installation's safety functions, which are required for the protection of workers and the public. The potential exists for more significant releases of radioactive material. 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 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

A General Emergency is the highest level of classification and is 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, as well as the implementation of protective actions within affected areas are required. On-site and off-site agencies are activated. The public is notified and, if necessary, the on-site Emergency Control Centre will recommend the implementation of protective measures for members of the public to the local disaster management centre. The on-site emergency organisation is 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 [1.1] 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. The NNR is required 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. Evacuees will go to a mass care centre where accounting of persons will take place. A notice will be published and everyone in the area must provide the requested information. 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.

The NNR Act is in the process of being updated and one of the proposed additional responsibilities of the NNR is for it to act, upon request, as an advisor to emergency response organisations and government organs, other than an authorisation holder in terms of the Act, in the case of a nuclear or radiological emergency. This will include verification of protective actions for members of the public as recommended by the operator. An example of a protective measure is the distribution of iodine profylax. The pre-distribution of iodine profylax is planned.

In addition, the NNR is required to exercise regulatory responsibility by monitoring the response of the parties concerned and requiring corrective action in the event of an inadequate or inappropriate response. In terms of fulfilling its regulatory responsibilities proactively, the NNR also attends a forum for liaison and communication between the parties participating in the 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. This forum meets on a quarterly basis and consists of representatives from the authorisation holder and local authorities.

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 comprise representatives from the three spheres of government, namely local government, provincial government and national government, and form the Disaster Coordination Team (DCT). A procedure has been developed that details the communication, activation and operation of the DCT.

If local authorities require technical advice or support, the DCT could refer them to the NNR. 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.

Following the 2011 Fukushima Daiichi nuclear accident, and the requirements to conduct stress tests, Koeberg was required to establish measures and resources to respond to emergencies that could affect the two units and co-located facilities simultaneously. Modifications have been implemented to make provision for the portable equipment, connection points and communications systems that would be needed for an emergency involving the two units.

16.1.3.2.1 Identification and activation of emergency organisation

The identification of emergency situations that 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 ECC 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 at and activation of the ECC 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.

ARTICLE 16: EMERGENCY PREPAREDNESS

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 ECC. The team consists of an emergency controller and support 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 that will be taken into consideration in determining adequate protective actions.

Upon mustering at the ECC, the on-site emergency 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 CoCT.

A further requirement is the availability of an Alternate ECC, in the event that the on-site ECC becomes untenable owing to the consequences of the accident. An additional requirement regarding alternative disaster management locations has been identified during the EPREV mission. These need to be established in other neighbouring local municipalities from which the CoCT could operate and implement protective actions. Following the EPREV mission, Eskom, the CoCT and Western Cape Disaster Management Centre identified the utilisation of both the West Coast District Municipality and Cape Winelands District Municipality for the coordination of responses in case all the disaster management centres located in the south are affected by a nuclear emergency at the KNPS.

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 government authorities. The off-site emergency organisations involved are from the local, provincial and national government.

Initial notification of an Alert, Site Emergency or General Emergency at the KNPS is communicated to the City of Cape Town DOC from the on-site ECC. The declaration of a General Emergency, as per licence holder procedure KAA811 [4.12], the Integrated Koeberg Nuclear Emergency Plan, implies a threat to the public that 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 DCT is composed of the head of the CoCT Disaster Management Centre and representatives from the provincial government of the Western Cape and the DMRE.

Implementation of protective actions

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

Following the declaration of a General Emergency at KNPS, the DCT recommends the declaration of a national disaster to the National Disaster Management Committee. Before implementing the required protective actions, the DCT reviews the recommended protective actions and their technical basis against protective actions that have been addressed and procedures that have been approved by the NNR. 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 government.

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 NNR has issued guidance on late-phase and recovery aspects to Koeberg. 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 to 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.

These 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, 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 continuous basis as part of the licensee's programme of emergency exercises. Improvements in the late-phase aspects of the plan are also conducted through regulatory emergency exercises.

Review of traffic evacuation model

As part of the Koeberg evacuation plan to monitor population developments around the facility up to the boundary of the urgent protective zone, the CoCT has reviewed the TEM and submitted it to the NNR for approval. The TEM was approved by the NNR in 2015 on condition that it be updated annually to account for infrastructure and population changes. However, the CoCT has requested permission to extend submission dates. The updated TEM was submitted to the NNR in March 2019 and the review was completed.

16.1.3.3 Holder's facilities for emergency preparedness

[Facilities provided by the licence holder for emergency preparedness]

Since completion of the upgrade, the ECC and DOC have been effectively operational.

16.1.3.4 Emergency preparedness measures for multi-unit and external hazard events

A large quantity of externally stored emergency equipment, including emergency diesel generators and high-pressure pumps, was procured and has been integrated into the emergency response procedures. Several plant modifications that allow for external connection points for mobile equipment have already been implemented. An assessment was made of the resilience of the emergency response organisation and it was found that a sufficient number of emergency response organisation members are available to supplement the minimum crew called out for a dual unit event at Koeberg.

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, in order to maximise the 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, a Thematic Working Group has been established to coordinate the needs of all intervening organisations that form part of the Koeberg Emergency Plan. Training representatives of intervening organisations can address specific training needs at Thematic Working Group meetings. Emergency preparedness and response training programmes at KNPS 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 station 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 that are identified are corrected in accordance with an action plan. Internal emergency exercises and drills also include the local authorities and off-site agencies. The NNR normally attends the licensee exercises as an observer, depending on the aspects to be tested.

ARTICLE 16: EMERGENCY PREPAREDNESS

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. Currently no review cycle is prescribed by the NNR, however, in terms of future improvements, the NNR draft regulations will require emergency plans to be reviewed every five years after their promulgation. The NNR also reviews and approves the TEM submitted by the municipal authorities in terms of the requirements indicated in section 16.1.1.

16.1.5.2 Nuclear emergency exercises

As part of emergency preparedness, regulatory 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 specific 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. The NNR conducts such exercises at intervals of 18 months to two years. To supplement the regulatory emergency exercises, Koeberg also conducts yearly internal exercises and drills that include the off-site response organisations.

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

The last NNR emergency exercise at KNPS took place on 12 November 2020. The aim of the emergency exercise was to evaluate the assessment of accident conditions, and notification and communication arrangements between KNPS and the emergency response organisations. Due to the COVID-19 pandemic and the health and safety restrictions imposed by the lockdown regulations in the country, a limited scope exercise was performed in combination with selected surveillance activities. The exercise objectives were limited to simulation and evaluation of the communication arrangements between KNPS and the emergency response organisations. The specific objectives of the exercise were:

1) Identification, notification, activation and communication of on-site and off-site emergency functionaries;
2) Alternate ECC operability and readiness;
3) Status of Fukushima commitments; and
4) Implementation of COVID-19 arrangements at Koeberg, the CoCT and Tygerberg Hospital.

The exercise activity did not involve the activation of the off-site response organisations due to the deployment of resources to deal with the national disaster (COVID-19 pandemic). A limited number of NNR umpires monitored and evaluated the responses of KNPS and the CoCT Disaster Operations Centre during the emergency exercise. Other NNR staff members virtually observed the proceedings of the exercise in the operator's ECC from the RERC.

The NNR umpires recorded detailed observations and associated findings during the exercise for all the response locations identified prior to the exercise, and these were captured in the exercise report.

The post-exercise debriefing session involving the umpires was held virtually the day after the exercise, and feedback on initial impressions on the responses, lessons learned and potential areas for improvement were provided.

The NNR validated all the findings by umpires and compiled an exercise report in order to ensure adequate correction of all inadequacies. The NNR concluded that the Integrated Koeberg Nuclear Emergency Plan remains viable for the protection of persons, property and the environment despite some areas of improvement, which have been identified.

Although the Emergency Plan for the power station remains viable, the observation gathered from testing the responses of the local authority, taking into account the CoViD-19 restrictions, was that their processes had not been updated. The lesson from this finding relates to the need to ensure that the local authority prioritises amending emergency processes in response to key changes brought about by an event such as a pandemic. In this regard there is a need for wider coordination from the national authority to ensure controls are aligned at the local level.

ARTICLE 16: EMERGENCY PREPAREDNESS

Following the issuance of the final report, Eskom was required to ensure that appropriate corrective actions are identified and implemented to address the findings in accordance with identified timescales. The Koeberg corrective action plan is being implemented and to date the NNR has closed out a number of findings from the report.

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

Refer to section 14.1.4.3.

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.

In terms of the Convention on Early Notification of a Nuclear Accident, international communities and neighbouring countries would be notified either directly or via the IAEA or by Necsa in its capacity as the national competent authority.

16.2 Information for the public and neighbouring states

16.2.1 Informing the public about emergency planning and emergency situations

[Overview of the CP'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 ECC is activated, further communication is established with the local Disaster Management Centres.

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

1) A 2 400-watt siren systems installed in areas close to the installation;
2) A 100-watt siren units installed on farms or in farming areas situated within 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 affected within at least 15 minutes, throughout 360°. From 5–10 km, notification is required to be affected within 30 minutes, through a 67.5° downwind sector. From 10–16 km, notification is required to be affected within a period of 45 minutes, through a 67.5° downwind sector.

The Public Warning System Upgrade Project has been completed and includes a newer digital communications and telemetry system, and the ongoing addition of new sirens to the south-eastern sector, 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 five locations, namely the Koeberg High Voltage Control Room, the High Voltage Control Room Simplex, the Koeberg ECC, the Alternate ECC and the CoCT Disaster Operations Centre. Full volume siren testing is conducted on an annual basis. The most recent test was conducted in February 2020.

A dedicated Joint Media Centre 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 Joint Media Centre to receive briefings on the status of the emergency, based on data provided by the ECC at Koeberg. Briefings will be provided by the regional nuclear emergency manager assisted by the regional communications officer and technical staff from the Alternate ECC. Press releases will then be sent to the South African Broadcasting Corporation to inform the public at large. KNPS also adopted a social media system to monitor public perception about an emergency. The perceptions will be considered when media statements are developed, and media broadcasts are implemented. Upon the declaration of a nuclear emergency, the licence holder must notify the NNR.

ARTICLE 16: EMERGENCY PREPAREDNESS

In terms of the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, 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 KNPS for liaison on emergency preparedness, planning and response. These forums are summarised below.

Emergency Planning Committee

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

Public Safety Information Forum

As indicated in section 9.4, the NNR Act [1.1] requires that the holder of a nuclear installation licence establish a PSIF to inform persons living in the municipal area where an emergency plan has been established on nuclear safety and radiation safety matters.

The Koeberg PSIF meetings take place on a quarterly basis and constitute a forum where queries of the public are addressed. 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.

Communication with the public about protective actions, using plain and understandable language, is the responsibility of the local authorities. Through the RERC, the NNR has the capability to issue communications to the public by providing updates and reports on safety issues during an emergency. The DMRE is in the process of completing a national communication protocol and a crisis communication plan that will assist decision makers to effectively manage information that is published on social media.

16.2.2 Arrangements to inform competent authorities in neighbouring states

This requirement is not applicable as KNPS 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 appropriate 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 re-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 on their own territory of the nuclear installation.

Summary of changes

Section 17.1 has been updated to provide information on the progress with the SSR for the Thyspunt site. This includes the completion of the public consultation process and preparation of the final safety evaluation report for recommendation and decision by the NNR Board.

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 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.

ARTICLE 17: SITING

17.1.1 Requirements on siting and site evaluation

[Overview of the CP'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 Regulations on Licensing of Sites for New Nuclear Installations [1.9] require the applicant for a nuclear installation licence for the siting of a nuclear facility to submit, in support of the application, an SSR 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 the cumulative impact of the 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:

1) Description of site and environs;
2) Population growth and distribution;
3) Land use;
4) Adjacent sea usage (if applicable);
5) Nearby transportation;
6) Civil and industrial facilities;
7) Meteorology;
8) Oceanography and cooling water supply;
9) Impact of natural hazards;
10) Impact of external man-made hazards;
11) Hydrology;
12) Geology and seismology,
13) Fresh water supply;

14) Site control;
15) Emergency services;
16) Radioactive effluents; and
17) 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 [4.1];
2) RG-0011, Interim Guidance for the Siting of Nuclear Facilities [4.17];
3) PP-0014, Considerations of External Events for New Nuclear Installations [4.21]; and
4) PP-0015, Emergency Planning Technical Basis for New Nuclear Installations [4.22].

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, PSA 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;
7) Site Safety Report;
8) Assessment of loss of off-site power together with the failure of on-site backup systems; and
9) Consideration of loss of ultimate heat sink (i.e. loss of seawater cooling).

ARTICLE 17: SITING

The safety case for a nuclear installation licence to site must:

1) Provide assurance that the nuclear safety criteria (pertaining to dose and risk) given in the SSRP [1.8] 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 has submitted NISL applications for two sites, namely Thyspunt and Duynefontyn. Thyspunt is a new or green field site, whereas Duynefontyn is an existing site, which currently hosts KNPS. Thus, the site licence application for Duynefontyn also includes reanalysing the site upon which KNPS is constructed and operated. The site licence applications are currently being assessed in accordance with the promulgated siting regulations described above. A probabilistic seismic hazard analysis (PSHA) of the Thyspunt site was performed in accordance with NRC Regulatory Guide 1.208 [6.8] using the Senior Seismic Hazard Analysis Committee (SSHAC) Level 3 process described in NUREG-2117 and NUREG-2213. The PSHA for the Duynefontyn site is currently ongoing and is being performed in accordance with the SSHAC Level 2 augmented or enhanced process described in NUREG-2213.

Review of the SSR submitted by Eskom for the Thyspunt site has been finalised. To date, the NNR has completed the following review phases:

1) Phase 1: Review against the NNR Act and general management system requirements, including application format;
2) Phase 2: Review against NNR siting regulations;
3) Phase 3: Review against NNR siting guidelines;

4) Phase 4: Detailed specialist or expert review, i.e. review of specialist topics or discipline-specific topics;
5) Phase 5: Preparation of the draft safety evaluation report;
6) Phase 6: Public consultation; and
7) Phase 7: Preparation of the final safety evaluation report for recommendation and decision by the NNR Board.

During the initial licensing of the KNPS, 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 KNPS comprises two three-loop 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 SSR 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 earthquake and tsunami hazard design bases for KNPS have been established considering local conditions and historical event data.

KNPS 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 or seismic isolation system that provides the capability for the nuclear island to withstand a seismic event of up to 0.3g ground acceleration;
2) The plant can withstand winds of up to 225 km/h; 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 means of physical separation of safety systems, extensive fire detection and mitigation systems and smoke extraction. A fire and rescue team are 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.

The requirements of the NNR are currently stipulated in the Regulations on Licensing of Sites for New Nuclear Installations. The NNR has also recently completed the phase of developing regulatory standards and processes for licensing of sites with the approval of RG-0011 [4.17] and TAG-001 [4.23], Technical Assessment Guide for the Siting of Nuclear Facilities. RG0011 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 CEO.

The NNR reviews the submissions for a site licence to verify compliance with the Regulations on SSRP, 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. The Board directs the CEO 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 [1.12] and the associated regulations.

The Environmental Impact Assessment permit for the Duynefontyn site was issued on 12 October 2017 by the Department of Environmental Affairs. The Duynefontyn site is an existing nuclear site comprising the KNPS. The permit was issued on condition that the NNR issues a nuclear site licence for the Duynefontyn site once its review process has been completed.

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 Regulations on Licensing of Sites for New Nuclear Installations (17.1.1).

The NNR has further stipulated limitations on urban developments in the vicinity of the 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 [1.1], regulations are in the process of being published on the monitoring and control of developments in the vicinity of the KNPS 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 Regulations on Licensing of Sites for New Nuclear Installations (17.1.1) stipulate 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 SSR 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.

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 safety reviews, and post-Fukushima review respectively.

As indicated in section 14.1.3.2 and 14.1.3.3, two periodic safety reviews have been undertaken of the KNPS. As part of these reviews, internal and external hazards were reviewed. For the latter review, the hazards listed in IAEA Safety Guide NS-G-2.10 [5.14] and the internal hazards studied by EDF for their VD-3 project were used. The review included a reassessment 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 review was undertaken as directed by the NNR. The scope of the review 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 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; and
6) Accident management.

The review included safety considerations for operation of multiple units at the same facility site. The findings of the review 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 CP1 safety referential), and other international practices.

The NNR produces a report on the outcome of the periodic safety 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.

ARTICLE 17: SITING

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

17.4.1 International arrangements

Consultation with neighbouring countries was not conducted as part of the review of the site licence application for the Thyspunt site since the only neighbouring country (Lesotho) near that site was deemed too far to be impacted by the application. Similarly, the location of the Duynefontyn site is far 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 of changes

Section 8.1.6 has been updated to report on the design improvements that have been implemented as well as those that are still planned.

18.1 Implementation of defence in depth

18.1.1 Regulatory requirements on design and construction

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

The NNR is mandated by the NNR Act [1.1] to, *inter alia*, exercise regulatory control related to safety over the siting, design, construction, operation, manufacture of components parts, 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 [1.8] 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.

Section 3.9 of the SSRP requires that a multilayer (defence in depth) system of provisions for radiation protection and nuclear safety commensurate with the magnitude and likelihood of the potential exposures involved shall be applied to sources such that a failure at one layer is compensated for or corrected by subsequent layers. 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 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 licences, 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 Licensing of Sites for New Nuclear Installations [1.9].
4) The applicant for a construction licence must provide:
    a) A project plan, including licensing schedule, vendors and suppliers;
    b) Safety management during construction;
    c) Preliminary SAR;
    d) Site Safety Report;
    e) Topical reports;
    f) Safety classification document;
    g) Quality and safety management documentation;
    h) Preliminary PSA;
    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 required 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 of the installation, which must include a risk assessment, be maintained. The requirements for modification are informed by factors such as ageing effects, ensuring the safety function, the maintenance basis, and operational experience.

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 SAR, and the plant General Operating Rules (OTS, maintenance and inspection programme, operating principles, etc.). This detailed safety assessment is summarised in a safety case, which must include a quantitative risk assessment to demonstrate that the installation, with the modification, still complies with the risk criteria of the NNR.

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

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 review, thus far confirm that KNPS 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 OTS to include OTS for shutdown states;
3) Moratorium on mid-loop operation with fuel in the reactor;
4) Fast dilution modification (protection against a reactivity excursion);
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;

8) Implementation of an additional (third) cooling loop for the spent fuel pools (SFPs) and backup emergency inventory supply; and
9) Additional nitrogen supply tank for the auxiliary feedwater system.

The need to implement a system of risk management 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.

Currently, 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 are 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 KNPS is the comprehensive independent surveillance and compliance inspection programme (complementary to the KNPS 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 erected on an elevated position on-site.

Furthermore, Eskom is 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.

ARTICLE 18: DESIGN AND CONSTRUCTION

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 KNPS 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 KNPS in which fourth and fifth levels of defence have been implemented following the introduction of emergency operating procedures (EOPs) and SAMG on how to cope with beyond design basis accidents, and with the existence of the emergency plan.

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 SFP make-up;
3) External connection for containment spray;
4) Safety injection and spray booster pump;
5) Qualified SFP 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 the TSC;
11) Improved containment sump recirculation strainers;
12) Improved leak tightness of the fuel building;
13) Replacement of the radiation monitoring system;
14) Modification of the reactor protection system;
15) Upgrade of the control system for emergency diesel generator sets;
16) Rod control system replacement;
17) Replacement of the pilot-operated relief valves;
18) Priority extraction of the fuel building ventilation; and
19) Upgrade of the fire detection system in the reactor building.

CONSIDERING THE NEED TO ENSURE THAT THE SEISMIC SAFETY ASSESSMENT IS UP TO DATE, ESKOM IS INITIATING AN SSHAC LEVEL 3 ASSESSMENT OF THE KNPS SITE.

18.1.4.1 Requirements for new nuclear installations

The NNR has developed and issued RG-0019 [4.24], Interim Guidance on Safety Assessments of Nuclear Facilities, as an interim measure to provide guidance to prospective applicants of new nuclear installation licences. This document provides, amongst others, guidance on compliance with the safety objectives and criteria for new nuclear installations.

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 18.1.6) included under the CP1 Alignment Project, resulting from the first Koeberg periodic safety review, improve 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.

Eskom has implemented additional plant improvements and extended the procedural guidance to further ensure that the containment will remain protected and intact following a serious event. 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;
4) The implementation of a complete set of SAMG that include steps to ensure the protection of the containment structure;
5) The upgrade of the containment electrical penetrations; and
6) The addition of venting lines to containment spray and safety injection systems.

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 periodic safety review (refer to Article 14). The improvements can be categorised under the following theme headings:

1) Periodic safety review close-out and General Operating Rules alignment issues.
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. The installation of new pressuriser relief valves has been included under this category.

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. The replacement of rod control mechanisms, turbine control and turbine safety systems with digital technology has been included under this category.
5) Plant operating under accident conditions.
6) Protection against hazards. This category of modification includes improvements to provide protection against high-energy pipe breaks, internal flooding, earthquakes for passive equipment, and fire.
7) Modifications identified by EDF during their second periodic safety review. 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.

Table 18.1.6 Quantitative Risk Criteria for the Public and Workers

Public	
Average annual population risk	10^{-8} fatalities per year per site
Maximum annual individual risk	5 x 10^{-6} fatalities per year
Workers	
Average annual risk to workers	10^{-5} fatalities per year per site
Maximum annual individual risk to workers	5 x 10^{-5} fatalities per year per site

18.1.6.1 Ageing management assessment

Ageing management assessment is required for all in-scope safety-related SSCs of the nuclear facility in order to determine the fitness for purpose to meet design functions and capabilities. Therefore, the ageing management assessment starts with defining the scope of the safety related SSCs to be considered. The approach of the assessment includes performing ageing management review, determination of applicable ageing management programmes and time limited ageing analyses. The safety assessment is required to demonstrate that the actual condition of the SSCs will be known throughout the intended period of operation, and to provide confidence that there is and will be adequate processes and programmes in place to manage the effects of ageing throughout the intended period of operation. The ageing management approach considers the current licensing basis General Operating Rules such as the maintenance, in-service inspections and testing, and safety-related surveillance manual requirements. The assessments are undertaken as a project, namely SALTO.

In addition to the ageing management programme, other safety-related programmes are required for safety-related aspects such as supporting the ageing management efforts or ensuring that the operations meet the current licensing basis requirements. The other safety-related programmes that are considered in the programme include:

- Operating Technical Specifications;
- Nuclear security; and
- Water chemistry.

The maintenance and surveillance programmes for the SALTO excluded equipment related to other current licence-binding programmes.

18.1.6.2 Periodic safety review

The third periodic safety review will be performed to support long term operation with the aim of determining the extent to which the current licensing basis remains valid for the intended period of operation, the extent of the facility's conformance to modern codes and standards, and any changes in the design basis of the plant. The assessment will be carried out as a project.

Programmes such as emergency planning and preparedness, the impact of long-term operations on the environment, and the radiation protection and radioactive waste management assessments will be performed as part of the periodic safety review to support long term operation.

18.1.6.3 Duynefontyn specific site characterisation project

The analysis of the site-specific characteristics used for the Koeberg SSR will be revised. The aim of this project is to perform studies using the latest methodologies. The site-specific characteristics are required for assessing the robustness of the facility against internal and external hazards.

18.1.6.4 Plant life extension modifications

The modifications are divided into three categories as follows:

1) Changes required due to the end of the qualified life of the component. There are three modifications that fall into this category, namely pressuriser heater replacement, I&C terminal penetrations and Unit 2 RCP pyrocontrole RTD replacement. These plant modifications are required prior to entry LTO.

2) Changes decided on to effectively manage plant ageing into the intended period of LTO. There are three modifications that fall into this category, namely steam generator replacement, Unit 2 RPV head replacement and impressed current cathodic protection of containment building.

   a) Steam generator replacement project:
   The steam generator replacement project entails the replacement of the six steam generators (three on each reactor unit at Koeberg), which is scheduled for completion by 2023. 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 well at various facilities with most of the components being delivered to Shanghai Electric Nuclear Power Equipment Company (SENPEC) in China for the final assembly of the steam generators. The first set of three steam generators was delivered in 2021. Compliance audits are carried out by the contractor and subcontractors in order to ensure to the process of safety classification.

b) Reactor vessel head replacement project:
Although regular Unit 2 RPV head inspections have not revealed any degradation, a project is in progress to replace the Unit 2 RPV head in 2022.

c) Impressed current cathodic protection of containment building:
Both Unit 1 and Unit 2 containment buildings (1/2 HRX) at the KNPS show signs of corrosion-related concrete damage, which has considerably increased over the last 10 to 15 years. For the most part, the damage is superficial. However, to ensure the building remains structurally sound, the installation of impressed current cathodic protection (ICCP) on both units is advised. The purpose of the system is to protect the steel components (rebar and post-tensioned tendon tubes) from corrosion and ultimately ensure that the containment civil structures remain under post tensioning for the life of the KNPS.

3) Modifications necessary to close the actions to reduce the risks identified in previous safety reassessments or periodic safety reviews. These modifications are not necessarily linked to the end life of the plant but are required to ensure that the plant is in line with industry acceptable practices. The list includes:
- Prioritised actions from the Fukushima response assessment; and
- Any other outstanding actions from the second safety reassessment (SRA II).

18.1.6.5 Spent fuel project

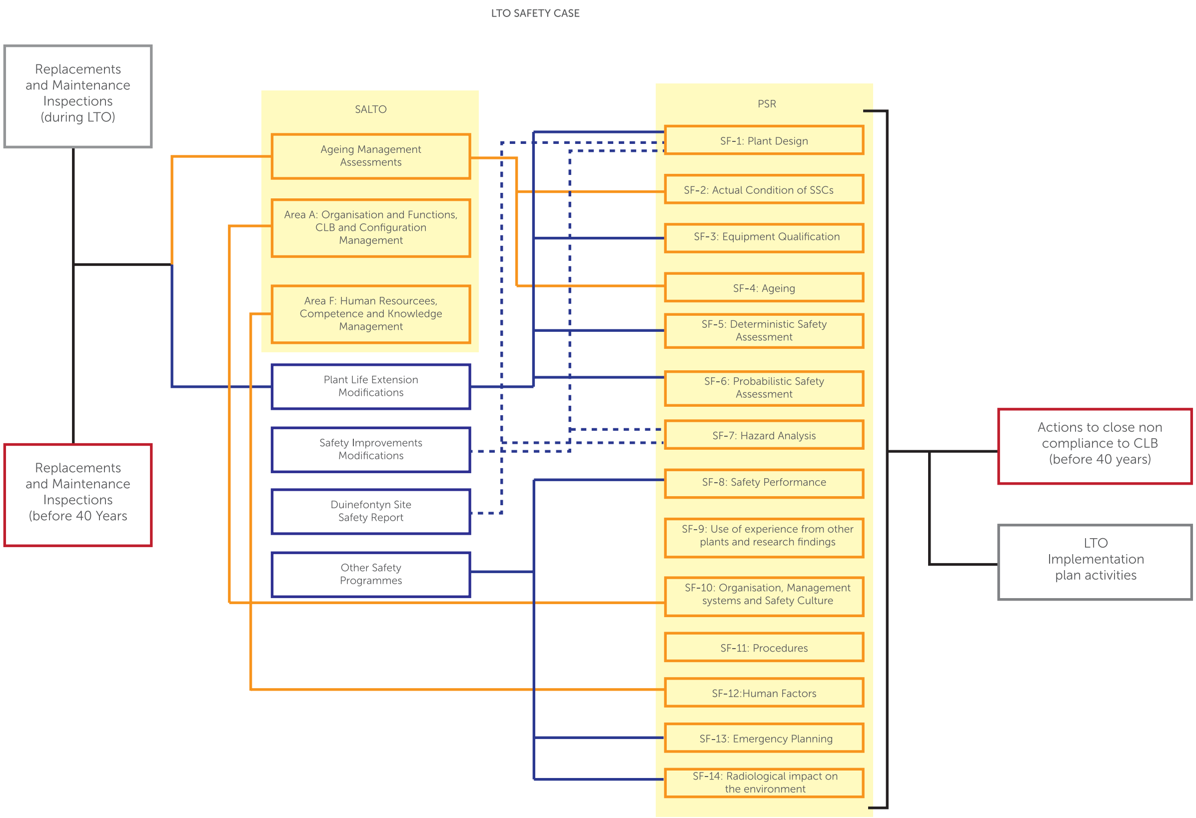
At the end of December 2021, 11 casks were stored in the Cask Storage Building on the Koeberg site (a total of 336 fuel assemblies). Seven empty HI-STAR 100 casks still remain. Unit 2 has 111 empty spaces in the spent fuel pool vs the 56 required for Outage 225 start-up (this is in addition to the 157 spaces reserved for emergency core offload). The next cask loading campaign is scheduled to start in June 2022 (four casks on Unit 1) before Outage 126.

Future spent fuel activities under consideration include the strategy beyond Outage 127, which needs to be ready prior to Outage 227 (February 2025).

18.1.6.6 *Interdependencies of programme scope*

In order to extend the life of Koeberg, there are several interdependent and interrelated activities that require coordination and integrated management, including integrated implementation oversight in order to achieve the deliverable of meeting the regulatory requirements for LTO. The relationship between the activities is depicted in Figure 18-1.

Figure 18-1 LTO Safety Case



18.1.6.7 *Steam generator replacement of both units*

The steam generator replacement project entails the replacement of the six steam generators (three on each reactor unit at Koeberg), which is scheduled for completion by 2023. 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 well at various facilities with most of the components being delivered to SENPEC in China for the final assembly of the steam generators. The first set of three steam generators was delivered in 2021.

Interfacing between the NNR and Eskom on the steam generator replacement project takes place through special workshops and monthly steam generator replacement licensing meetings where outstanding issues are discussed and tracked.

18.1.6.8 Planned Unit 2 reactor vessel head replacement

Although regular Unit 2 RPV head inspections have not revealed any degradation, a project to replace the head is underway. Design and initial manufacturing activities are in progress. The Unit 2 RPV head is scheduled for replacement in 2022.

18.1.6.9 Planned replacement of control rod drive mechanisms

Koeberg has decided to upgrade the CRDMs on Unit 2 as part of the RPV head replacement project. Since the international OE relating to thermal sleeve wear became known during the manufacturing phase, the opportunity was used to incorporate a design change during manufacturing to counter the wear witnessed in PWRs worldwide. The impact of the design change on rod drop times is currently being analysed.

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) Based on the classification (Safety Related or Critically Safety Related), the NNR requires 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.

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 and the NNR monitors the implementation of the corrective action plan.

As described above, approval by the NNR is required for modifications or changes to the licensing basis.

18.2 Incorporation of proven technologies

18.2.1 Requirements on proven technology

[CP's arrangements and regulatory requirements for the use of technologies proven by experience or qualified by testing or analysis]

All SSCs important to safety must be designed according to the latest or currently applicable approved standards. If possible, the SSCs should be of a design proven in previous equivalent applications and must be consistent with the plant-reliability goals necessary for safety. The regulatory framework has been updated to address this requirement.

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 SSCs. In any other case, a revised code, standard or specification must be developed and approved.

ARTICLE 18: DESIGN AND CONSTRUCTION

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 operating 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 Koeberg nuclear installation was built between 1976 and 1984 by a French consortium. The consortium comprised Framatome, responsible for the nuclear island; Alsthom Atlantique, responsible for the conventional island; Spie Batignolles, responsible for the civil work; and Framateg, responsible 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 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 have to comply with the requirements of the SSRP [1.8], which state that installations, equipment or plant requiring a nuclear installation licence, a nuclear vessel licence or a certificate of registration and having an impact on radiation or nuclear safety must be designed, built and operated in accordance with good engineering practice. This implies that current international norms and standards, including an acceptable nuclear QA programme, must be utilised (as per RD0034 [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 QA programme (as per RD-0016 [4.6] and LG-1045 [4.9]).

Independent design verifications are required to be carried out for selected designs on more critical safety-related plant SSCs. 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 automating critical actions to avoid functional failure in an accident scenario. The replacement of rod control, turbine control and turbine safety systems with digital technology has been included under this category.

18.2.4 Regulatory review and control activities

As described above, approval by the NNR is required for modifications or changes to the licensing 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 CP'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 SSCs important to safety complies with quantitative risk criteria 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 the 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 the 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.

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 in 18.1.6.

18.3.3 Regulatory review and control activities

As previously mentioned, approval by the NNR is required for modifications or procedure changes as determined by a safety screening and evaluation processes (sections 14.2.4 and 19.3.1).

The NNR conducts assessments on proposed modifications and procedure changes to verify compliance with 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 is 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; and

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 any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

Summary of changes

Section 19.3.6 has been updated to report on the SALTO mission of March 2022 and the repairs needed for the containment buildings.

ARTICLE 19: OPERATION

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 PSA, 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 currently 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 recently issued RG-0012, Interim Guidance on Construction Management for Nuclear Facilities [4.18]. These guidelines and associated revised regulations include guidelines and requirements on tests and commissioning programmes.

19.2 Operational limits and conditions

19.2.1 Requirements on operational limits and conditions

[Overview of the CP's arrangements and regulatory requirements for the definition of safe boundaries of operation and the setting of operational limits and conditions]

The Regulations on SSRP [1.8] require that:

1) The operational safety assessment (SAR for Koeberg) establishes the basis for all the operational safety-related programmes, limitations and design requirements; and
2) The OTS include operating safety limitations as imposed by the design or by the safety criteria, surveillance requirements to verify that equipment important to safety is operating satisfactorily or that parameters 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.

ARTICLE 19: OPERATION

In order to respect the safety limits dictated by the SAR, the plant is operated in accordance with the OTS document.

The nuclear licence dictates compliance with 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, their documentation, training in them, and their availability to plant personnel engaged in safety-related work]

The current OTS were developed specifically for KNPS and are similar to the latest OTS of EDF NPPs.

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 with the OTS, operator training and configuration management of the OTS are covered by the Regulator's compliance inspection programme.

ARTICLE 19: OPERATION

19.3 Procedures for operation, maintenance, inspection and testing

19.3.1 Requirements on procedures for operation, maintenance, inspection and testing

[Overview of the CP's arrangements and regulatory requirements on procedures for operation, maintenance, inspection and testing of a nuclear installation]

The Regulations on SSRP [1.8] require that:

1) Operations be conducted in accordance with formal procedures, as required by the conditions of licence; and
2) An appropriate maintenance and inspection programme be established to ensure that the reliability and integrity of installations, equipment and plant having an impact on radiation and nuclear safety are commensurate with their safety significance.

As indicated in section 9, the 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 the plant and procedures, and regulatory approval thereof.

The nuclear licence dictates compliance with the KLBM and, by implication, the process of safety screening and regulatory approval for changes to the operational procedures.

19.3.1.1 Replacement parts, obsolescence and nuclear certification for manufacturing

KNPS considers obsolescence and non-availability of parts at both a system and component level. When a system engineer identifies that it will become difficult to continue to support a system due to system ageing or large-scale obsolescence, the system is considered for replacement. This is done through the Nuclear Technical Plan and modification process.

On a component level, KNPS performs equivalencies to accept (or identify) replacement parts or components for items that are no longer available. A large percentage of these are performed on replacement parts proposed by the original plant constructors (Framatome) with whom Eskom still maintains spare parts contracts. In some cases, Eskom identifies alternative suppliers that are qualified to supply to the nuclear industry, or occasionally performs its own qualification of certain commercial grade items. KNPS also maintains an obsolescence programme to identify important parts at risk of becoming obsolete in order to deal with such instances without impacting operations.

KNPS has experienced some challenges regarding suppliers with nuclear certifications. There are generally extra costs and timelines involved with qualifying and overseeing these suppliers according to the requirements of the NNR (RD-0034 [4.5] and PP-0012 [4.20]), as well as longer lead times for the manufacture of qualified parts. The fact that the original plant manufacturing codes have been superseded by modern equivalents also occasionally requires a reconciliation between the modern manufacturing and design codes used by the original or alternate suppliers (often RCC-M, RCC-E and ASME) and the plant design base (the original French regulations used during design and construction). This is typically handled through the equivalency process.

19.3.2 Implementation, review and approval of operational procedures

[Establishing 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 set out in a p and implemented accordingly.

Inspection and testing are performed at Koeberg on SSCs 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 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 currently distributed amongst a number of programmes.

The Safety-Related Surveillance Manual that contains the associated bases, functional testing and surveillance requirements 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]

ARTICLE 19: OPERATION

The requirements on the management of safety, RD-0034, essentially necessitate those 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 with the KLBM and, by implication, the implementation of procedures, training and development as well as approval for procedures and changes to such procedures.

Compliance with 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

Since 2011, KNPS has been subject to two IAEA SALTO missions.

The first was conducted in 2011 and related to the ISIP for KNPS. 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 LTO, activities involving the ageing management of SSCs 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. A follow-up IAEA pre-SALTO peer review was conducted in September 2019.

Furthermore, another IAEA SALTO peer review mission took place at KNPS in March 2022. An IAEA team of nuclear professionals from eight countries reviewed the safety aspects of Koeberg's LTO to extend the life of the power station by 20 years, including preparedness, organisation and programmes for safe operation.

The team also provided recommendations and suggestions to further enhance the preparations for LTO safety, including that Eskom should:

1) Comprehensively review and implement all plant programmes relevant for LTO;
2) Complete the revalidation of qualification of cables in the containment for the long-term operation period; and
3) Ensure full functionality of the containment structure monitoring system.

The findings will form part of an implementation plan to be completed for LTO preparedness.

19.3.6.2 IAEA Operational Safety Review Team

At the request of the South African government, an IAEA OSART visited KNPS 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 Mineral Resources and Energy and shared with the Minister of Public Enterprises, whom Eskom reports to administratively.

The OSART team concluded that the Koeberg management team was committed to continuously improving the operational safety and reliability of the 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 related to the:

1) Corrective Action Programme;
2) EERT and External Events Safety Reassessment 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 WANO team, comprising experienced nuclear professionals from four WANO regions, conducted a peer review at the KNPS in February 2017. 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 KNPS.

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 chemistry, maintenance and fire protection requirements, equipment and organisational programme implementation. The utility has developed action plans to address these areas and to recognise the importance of instilling a high level of employee behaviour 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 KNPS. During the reporting period Eskom has made progress on the necessary repair work, which mainly involves repair of delaminated concrete on the containment building of Unit 2.

Repair work on the Unit 2 containment building 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 Integrated Leak Rate Test (ILRT), which is conducted every ten years. The structure showed good linearity and the new repairs behaved well and as expected during the testing, and therefore passed 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 Unit 1 passed the test as expected.

Both Unit 1 and Unit 2 containment buildings show significant corrosion-related concrete damage, which has considerably increased over the last 10 to 15 years. For the most part, the damage is superficial. However, to ensure that the building remains structurally sound, the installation of impressed current cathodic protection (ICCP) on both units is advised for the LTO of KNPS. The solution of ICCP was derived through research conducted by the University of Cape Town and an international expert panel. The purpose of the system is to protect the steel components (rebar and post-tensioned tendon tubes) from corrosion and ultimately ensure that the containment civil structures remain under post tensioning for the LTO of the KNPS.

Eskom has contracted the services of an international supplier who specialises in nuclear engineering to ensure a sound ICCP design that does not affect the integrity of the third barrier (containment). The supplier has partnered with a design firm with vast experience in the design of cathodic protection systems as well as computer modelling of impressed current.

The ICCP project budget was approved in 2019 and funding was obtained in March 2020 for the design and implementation of the ICCP. The project has progressed to the initial phases of ICCP design and will be completed prior to 2024.

19.4 Procedures for responding to operational occurrences and accidents

19.4.1 Requirements on accident and incident procedures

[Overview of the CP's arrangements and regulatory requirements on procedures for responding to anticipated operational occurrences and accidents]

Section 3.8 of the SSRP [1.8] requires that where the prior safety assessment or operational safety assessment (SAR for Koeberg) has identified the reasonable possibility of a nuclear accident, accident prevention and mitigation measures based on the principle of defence in depth and which address accident management procedures, including emergency planning, emergency preparedness and emergency response, must be established, implemented and maintained.

As indicated in section 9, the 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 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 Pressurized Water Reactor Owners Group (PWROG) and utilises the Westinghouse generic EOP package, including both Optimum Recovery Procedures and Function Restoration Procedures that have been specifically adapted for KNPS. The EOP package is kept up to date with the latest changes applicable to KNPS as prescribed by the PWROG.

The original suite of Koeberg incident operating procedures was reviewed and revised into the EOP's format.

19.4.3 Severe accidents procedures

[Establishment of procedures and guidance to prevent severe accidents or mitigate their consequences]

Westinghouse wrote a comprehensive set of SAMG 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 include guidance on response actions in the case of a severe accident in the fuel building. These actions have 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 SFPs; and
4) To mitigate fission product releases from the fuel building.

Measures for emergency planning, emergency preparedness and emergency response are 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]

Measures have been put in place to manage a multi-unit accident. These measures include connection points, portable equipment and ensuring the availability of sufficient staff in the case of an emergency involving more than one unit.

Eskom had established a new functional organisation known as the Operation Support Centre to control and manage plant mitigation activities. This has assisted 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. There is a sufficient number of trained experts in severe accident management to manage severe accidents on both units with adequate procedural guidance from the SAMG. In support of the experts, the TSC has the capability to display and monitor plant data simultaneously for both units.

The OSART Mission in 2011 deemed these measures sufficient to meet the guidance provided in IAEA Safety Guide NS-G-2.15 on multi-unit plants. However, Koeberg has fallen behind with the implementation of its initiatives to fully address the gaps in its external event assessments.

19.4.5 Regulatory review and control activities

The nuclear licence dictates compliance with the KLBM (section 9) and, by implication, the implementation of procedures, training and development as well as approval for procedures and changes to such procedures.

Compliance with 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 the 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 EDF 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 EDF 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 NNR 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 KNPS is that all areas of technical support are well covered.

Eskom has implemented a plan of corrective action in response to a concern raised in the previous report by the NNR on the overall quality of work (mainly by contractors) at KNPS. The NNR continues to monitor the 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 CP's arrangements and regulatory requirements to report incidents significant to safety to the regulatory body]

Section 4.10.3 of the SSRP [1.8] requires that a reporting mechanism must be established, implemented and maintained for nuclear incidents and nuclear accidents or any other events that the NNR may specify in the nuclear authorisation.

ARTICLE 19: OPERATION

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 a nuclear incident. The holder of a nuclear authorisation must immediately inform the NNR when a nuclear accident occurs, or an incident has arisen or is expected to occur or arise and shall provide such information as may be required. This includes the current situation and its evolution, measures taken to terminate the nuclear accident and/or incident to protect workers and members of the public, and the exposures that have occurred and those expected to be incurred.

As indicated in section 9, the KLBM [4.10] 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, QA finding, quality control deficiency or occupational safety event that 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 events, Eskom has established an approved procedure. The process is tracked using DevonWay, 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, which includes the IAEA INES rating of the event 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 DevonWay;
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; and
9) Printing a summary of the event and archiving for records and trending.

The DevonWay 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 the indication of areas requiring further investigation and/or immediate attention to prevent recurrence.

Analysis of events has to cover 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 DevonWay 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 on the probabilistic risk assessment;
4) Emphasise 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; and
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 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 required 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 Notification of Concerns system where any matter of concern can be recorded and sent anonymously, if preferred, to the nuclear installation management and the NNR.

ARTICLE 19: OPERATION

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 KNPS graded Level 2 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 IRS.

19.6.5 Policy for use of the INES scale

The policy of both Eskom and the NNR is to use the INES scale for reporting 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 CP's arrangements and regulatory requirements on the licence holders to collect and analyse and share operating experience]

The regulatory requirements dictate that 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 [4.10] 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 OE Group that is responsible for external experience feedback and the total direction and management of the OE system (refer to section 12.5.1).

According to a condition of the nuclear installation licence, the licence holder reports events that are significant to safety to the NNR in a regulatory document that contains commensurate reporting timescales, which are relative to the safety significance of the events.

Eskom reports significant nuclear safety events to WANO where these are considered to have an important impact on nuclear safety.

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 the resulting corrective actions to completion. They also proactively guide the user to utilise national and international lessons learned to improve nuclear safety in an effective manner, and they apply to the review of industry technical information originating from external sources such as EDF, INPO, WANO, Framatome owners group, original equipment manufacturer and the NRC. Refer to Figure 19-1 for sources of operating experience information.

Eskom has a group, known as the Koeberg Events Group, 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 into the station's electronic condition reporting system (DevonWay) and receive an appropriate analysis, depending on the grading of the event. 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, personnel training programmes or simulators. Implementation of the recommended actions is also tracked on DevonWay.

19.7.5 Sharing experience feedback with other operating organisations

Eskom has a collaboration agreement with EDF and a Koeberg Integrated Team (KIT) composed of Koeberg and EDF staff is established at the station. Operating experience from EDF and 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

This is 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 bilateral agreements with other nuclear regulatory authorities. 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 CP's arrangements and regulatory requirements for the on-site handling of spent fuel and radioactive waste]

The SSRP [1.8] provide regulatory requirements regarding radioactive waste management 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 [4.10] 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 number of fuel elements stored in the SFPs, 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 an SFP, which has been re-racked from the initial design to increase the physical storage place for the spent fuel of both units. The increased storage of spent fuel in the SFP has necessitated the installation of a third train of spent fuel cooling.
2) In four CASTOR dry storage casks in which a total of 112 spent fuel assemblies are stored.
3) In seven HI-STAR dry storage casks in which a total of 224 spent fuel assemblies are stored.

As indicated in the Radioactive Waste Management Policy and Strategy [2.4], 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 time frames 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 the 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 fuel dry casks in the Cask Storage Building at Koeberg;
2) Acquisition and use of additional casks to be stored in the Cask Storage Building;
3) Establishment of a Transient Interim Storage Facility (on the Koeberg site); and
4) Establishment of a Centralised Interim Storage Facility (off-site).

This strategy has been presented to the Regulator and licensing submissions are ongoing. Koeberg has initiated the process for the manufacture and procurement of 14 additional dry storage casks to create additional storage space in the SFPs to cater for the planned changes in fuel management. This is being conducted while awaiting the government's initiatives related to spent fuel management.

19.8.3 Implementation of on-site treatment, conditioning and storage of radioactive waste

The operational radioactive waste management programme implemented at the KNPS is 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]

This is covered in section 15.

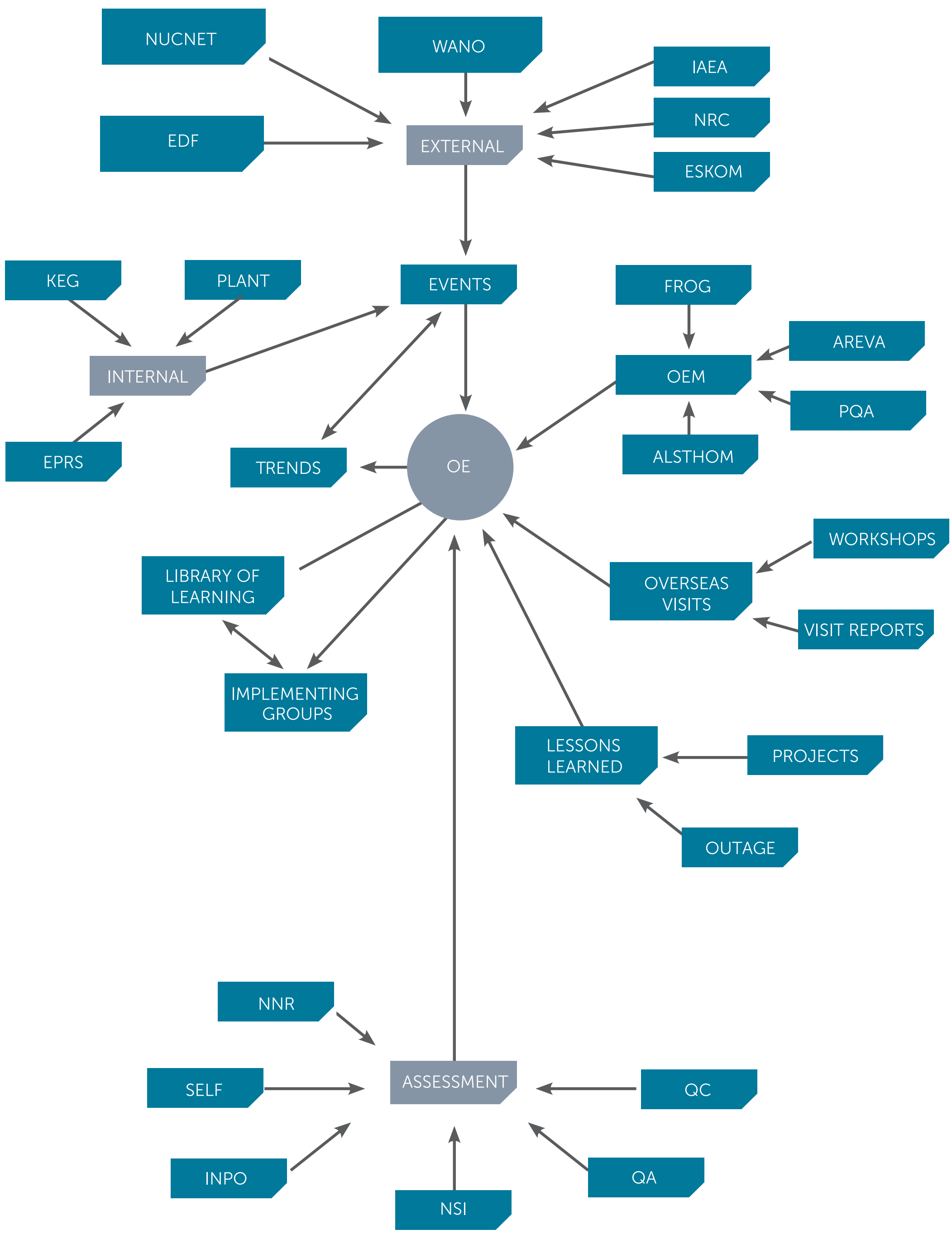
19.8.5 Established procedures for clearance of radioactive waste

This is covered in section 15.

19.8.6 Regulatory review and control activities

This is covered in section 15.

Figure 19-1 Koeberg Nuclear Power Station OE Feedback System



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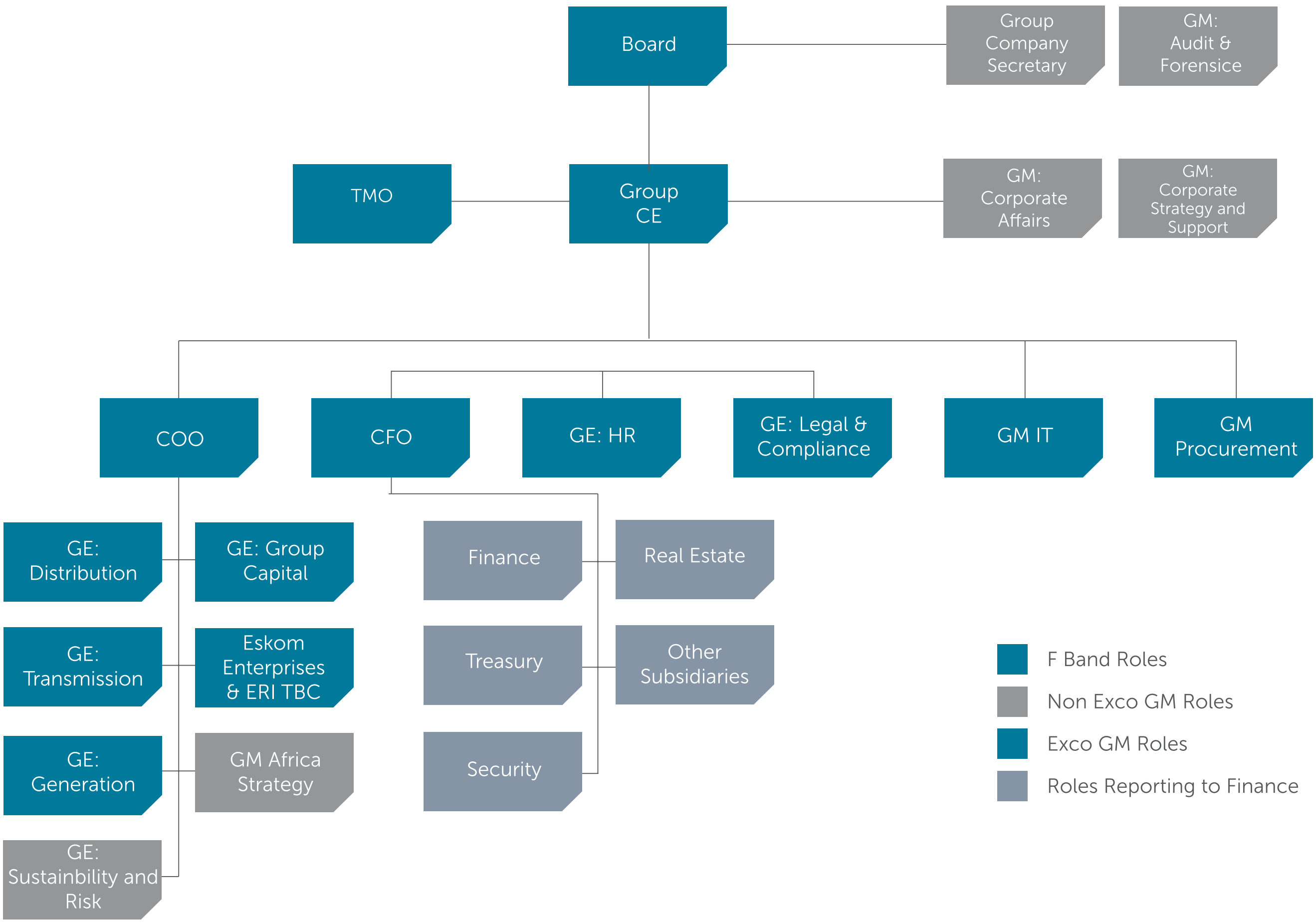
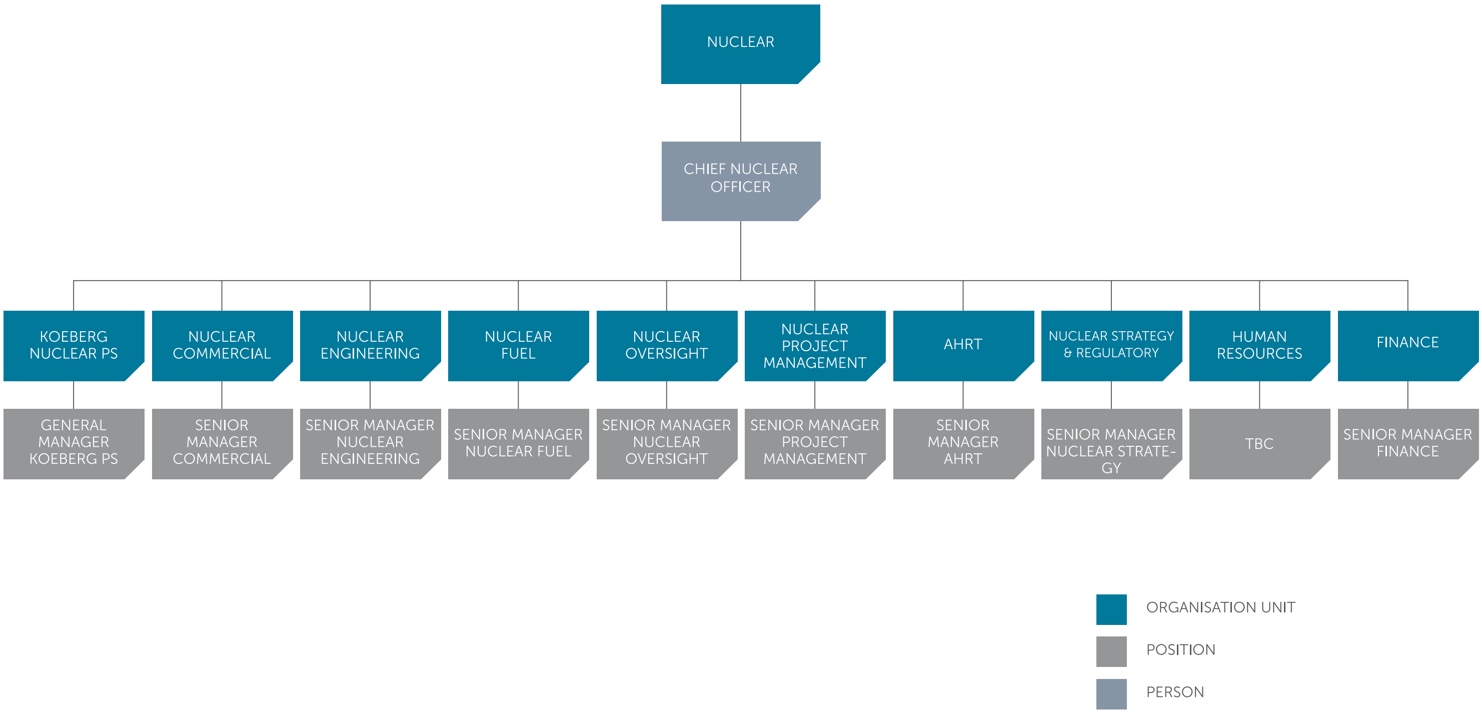
ANNEXURES

D.1 Eskom Organisational Structure



Nuclear Operational Unit Structure



D.2 Post-Fukushima Actions

External Events

No changes to the Koeberg licensing basis have been identified as a result of the periodic safety reviews. Although no peer review has been conducted, benchmarking has been performed against international bodies with regard to the periodic safety reviews.

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;
- Cyberattack; 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, loss of ultimate heat sink, credible combinations of events (including earthquake and tsunami, and severe storm and induced events), and review of the EOPs and SAMG. For all these, hazards of varying magnitudes were analysed, safety margins were evaluated and cliff-edges were identified.

The periodic safety review 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 periodic safety review will be designed to be robust against external events beyond the design basis of KNPS. 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 solution concept.

Two projects are planned to provide for a hardened water supply strategy, namely hardened water supply and hardened water external connection points (ECP). 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 ECP to allow for the connection of mobile emergency diesel-powered generators to supply essential power to the train A and train B emergency switchboards. There will be two electrical ECP per unit leading into the Unit 1 and Unit 2 electrical building with permanently installed cables that run from the electrical ECP to the 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 beyond design basis 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 beyond design basis 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 beyond design basis external event. In order to manage transients related to beyond design basis 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 beyond design basis 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 beyond design basis external event.

During a station blackout, this new hardened system must be able to indicate the:

1) Core temperature;
2) Water levels inside the steam generators;
3) Pressure inside the steam generators;
4) Pressure inside the containment; and
5) Water levels inside the SFPs, 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 EOPs, namely the function restoration procedures and the incident operating procedures, direct the user to seek advice from the 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 EOPs, function restoration procedures, and incident operating procedures when the control room operators are procedurally directed to consult the TSC.

A post-Fukushima update of the Pressurized Water Reactor Owners Group (PWROG) generic SAMG, on which the Koeberg-specific SAMG are based, was released in 2013 (LTR-RAM-I-13-004). This followed the 2012 revision of the Electric Power Research Institute severe accident management guidance technical basis report (TR-1025295), which forms the technical basis of the PWROG generic SAMG. The Koeberg SAMG were reviewed against the newly released PWROG generic SAMG and updated, and related background documents are in progress. The purpose of these updates is to keep the Koeberg SAMG aligned with international best practices. The current updates are in addition to an earlier 2012 update of the Koeberg-specific SAMG that followed 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;
- SFP level; and
- Reactor primary system pressure.

ANNEXURES

Status of implementation

Project Title	Description	Status and Schedule
Acquisition of Mobile and Portable Emergency Equipment	Several reports emphasised the benefit in the immediate availability of certain portable/mobile equipment when dealing with the safe shutdown of a plant following a beyond design basis extreme external event. Eskom has already acquired most of the equipment and is in the process of acquiring additional equipment to aid with the recovery of the plant after an extreme external event.	90% complete
Develop Accident Procedures	During the periodic safety review, a number of potential vulnerabilities in the Koeberg suite of procedures were revealed. In order for all the mitigating and recovery plans to be successfully deployed and implemented, some new procedures need to be developed while existing procedures need to be refined. The Phase A procedures subproject will implement EOPs for shutdown plant states as well as guidelines on the use of EOPs to assist the TSC team.	Execution Phase: In Progress
Hardened Water External Connection Points	In order to inject water into the steam generators and the primary system, external connection points with their associated piping are required to take suction via mobile equipment from external sources such as the hardened water storage tank and the refuelling water storage tank. This modification will furthermore include the procurement of suitable mobile high-pressure pumps required for injecting water into the steam generators and the primary system.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives
Hardened Storage Building	Portable and mobile equipment designated for use during abnormal conditions must be available and operable at short notice, and for this reason it needs to be stored in an environment that will (i) preserve its condition, and (ii) protect it against the same external events against which the plant has to be protected. A portion of Bulk Stores will be reserved and equipped for the storage of portable and mobile equipment while a new hardened storage building is being constructed.	Execution Phase: In Progress

Project Title	Description	Status and Schedule
Hardened Electrical External Connection Points	During loss of off-site power and station blackout conditions, the installed electrical infrastructure may be rendered inoperable. The infrastructure to supply power from portable generators to certain switchboards will be established by means of strategically located hardened external connection points.	Execution Phase: Completed
Installation of Hardened Instrumentation	Should all power supplies be lost, the batteries powering the indication systems will eventually become depleted. It is essential that the operators stay informed about certain plant parameters in order to control the flow to and pressure in some of the critical systems, installed equipment and mobile equipment. This project facilitates the installation of a hardened indication system to enable effective control of essential safety systems when the existing infrastructure becomes unavailable due to extreme external conditions.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives
Hardened Water Supply	Core cooling and SFP make-up require a guaranteed and uninterrupted water supply at all times and under all conditions. This project facilitates the construction of additional water storage facilities to be available when the normal supply network is compromised by an extreme external event.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives
Filtered Containment Venting	This modification will provide a permanently installed containment venting system that will allow for the containment building to be depressurised to the atmosphere during an event whereby the normal containment pressure-reducing equipment has been rendered unavailable or inoperable. It will furthermore allow steam to be vented from the containment during a loss of cooling in shutdown conditions.	Concept Phase: In Progress Execution Phase has been prioritised as part of the LTO initiatives

Project Title	Description	Status and Schedule
Install Primary Pump Shutdown Seals	In order for effective utilisation of mobile equipment and the planned hardened systems to be installed, it is essential that the primary system inventory be preserved. Installing safe shutdown seals on the primary coolant pumps will prevent leakage of primary coolant through the pump seals, thereby securing the primary system inventory.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives
Hardened On- and Off-Site Communi-cation	The Koeberg communication systems for on-site and off-site communication have not been designed to withstand extreme external events. In order to support the plant following an extreme external event, these systems need to be upgraded. The vulnerabilities of the communication systems will be addressed to optimise the ability of plant personnel to communicate locally with on- and off-site staff, and with international support organisations.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives
Enhance Diesel Fuel Management	In order for all installed and mobile diesel-powered equipment to operate for an extended period, it is important that availability of sufficient diesel fuel be assured. If off-site power is lost, diesel fuel will be required to ensure the extended operation of diesel-powered equipment.	Development Phase: Completed Execution Phase: In Progress
Increase PTR Siphon Breaker Capacity	Should the discharge line from the SFP cooling system suffer a structural failure, the water from the SFP could be siphoned out of the pool. In order to prevent this from happening, the plant has been equipped with siphon breakers. However, initial analysis indicates that these breakers are not sized adequately for larger break sizes. Additional siphon breakers, or modification of the current siphon breakers, are therefore required.	Development Phase: Completed Execution Phase has been prioritised as part of the LTO initiatives

Mobile and portable emergency equipment acquired

Item	Function	Quantity
Diesel storage tank	• Long-term on-site fuel supply for mobile equipment • Long-term fuel supply for SBO back-up • Supplementary fuel for EDGs	2
Diesel transport tanker (10 000 l)	• On-site fuel transfer capability for long-term EDG operation • On-site fuel transfer capability for mobile equipment	1
Diesel transport tanker (40 000 l)	• On-site fuel transfer capability for long-term EDG operation • On-site fuel transfer capability for mobile equipment	2
Truck	• On-site fuel transfer capability • Portable equipment movement	2
Fire tender with turntable ladder	• Firefighting at elevated levels • Access to elevated levels	1
Low-flow pump	• SFP make-up • ASG tank make-up • RCP make-up (SD; head off) • Shutdown RCP injection	5
High-flow pump	• Firefighting; charging of firefighting system supply header during ELAP • Charging fire header from the sea • Back-up containment spray during ELAP • Seismic vault flooding in severe accident	1
High-pressure pump	• Steam generator injection • RCP injection (SD/RRA) Note: To be purchased	3

Mobile and portable emergency equipment acquired

Item	Function	Quantity
Portable fan	• Cooling ASG pump room • Cooling MCR, CEMPs, and other locations	5
Salvage pump	• Drain flooded areas of plant • Flood mitigation due to pipe burst, tsunami and any water and debris evacuation	4
Floating pump	• Supply suction water to pumping equipment from shallow source	2
Satellite phone	• Off-site communication during ELAP • On-site communication between MCR and ECC during ELAP	10
Handset, radio-communication	• On-site mobile communication	-
Multimeter	• Provide critical indication when batteries are lost, e.g. RIC thermo-couples, steam generator levels, steam generator pressure	10
Torch	• Provide illumination during ELAP	-
Floodlight	• Provide illumination to large areas during ELAP	8
Evacuation chair	• Evacuation of immobilised personnel	-
Gas monitor	• Ascertain the presence of a variety of harmful gases to en-sure safe personnel access	5
Oxygen monitor	• Ascertain the presence of sufficient oxygen for personnel entry	10
Thermal imaging camera	• Ascertain the presence of trapped personnel in areas with poor or no visibility • Ascertain the presence of hot equipment in areas with poor or no visibility	2

Mobile and portable emergency equipment acquired

Item	Function	Quantity
SCBA tank, compressor	• Facilitate personnel access to low-oxygen and toxic areas	82
Hazmat suit	• Facilitate personnel access to toxic areas	120
Generator; diesel-driven	• Supply essential switchboards • Directly supply ASG pump motors and back-up to ECC	10
Transformer; portable	• Supply essential switchboards • Directly supply ASG pump motors and back-up to ECC	2
Debris removal vehicle	• Clear debris from tsunami, earthquake or tornado to provide access to emergency and recovery personnel and vehicles	2

D.3 Provisions made by Contracting Party in response to COVID-19

NNR

On 15 March 2020, the South African government declared a national state of disaster in terms of the Disaster Management Act, 2002 (Act No. 57 of 2002). This was followed by a nationwide lockdown as of midnight on 26 March 2020. As an essential service, the NNR could continue operations and staff were allowed to work from home during the lockdown period. However, some activities, such as some site inspections, were suspended during the lockdown.

On 29 April 2020, government issued the following regulations and directive:

- Regulations Issued in Terms of Section 27 (2) of the Disaster Management Act, 2002 (Act No. 57 of 2002); and
- COVID-19 Occupational Health and Safety Measures in Workplaces COVID19 (C19 OHS), 2020.

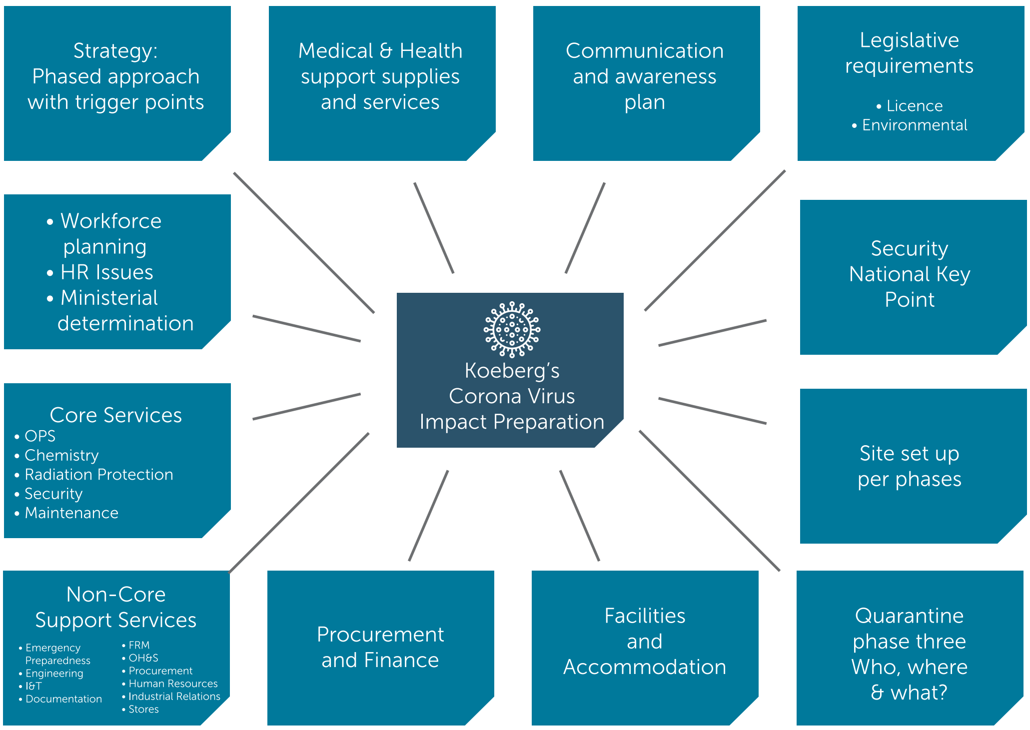
Key inspections were performed remotely where needed and critical inspections were conducted in keeping with COVID-19 protocols. The NNR continued with its licensing and compliance functions using electronic means. Furthermore, meetings with the licensee and international meetings were conducted by means of electronic platforms.

On 1 May 2020, the NNR decided to implement a phased return to offices and a resumption of suspended activities, including inspections. Employees would be permitted to travel to and from work, and to perform work at NNR offices and off-site facilities. However, employees who were able to work from home would continue to do so. Measures that were implemented included the following: strict health protocols and social distancing rules, a phased return to work to allow for measures to make the workplace COVID-ready, and the return to work to be effected in a manner that avoids and reduces the risk of infection.

ANNEXURES

Koeberg Nuclear Power Station

The initial strategy was to develop a plan and to implement the plan in phases. A cross-functional team was established to assess the risk and to implement appropriate mitigations. The focus areas are indicated in the figure below.



KNPS was proactive; it started with planning and preparations as soon as awareness regarding COVID-19 in South Africa was communicated. The appointment of the COVID-19 Recovery Manager and the implementation of the phased approach in response to the COVID-19 impact was in place before lockdown decisions were made at a national level. As such, by the time the national lockdown was announced in South Africa, the station already had a COVID-19 strategy in place. An accelerated plan replaced the phased plan to address the rapid spread of COVID-19 infections. As a precaution, and to safeguard employees, the Koeberg Nature Reserve was closed to members of the public.

At the start of the pandemic a platform was set up with the NNR to provide them with regular feedback and to give assurance that Koeberg continued to meet its licensing requirements regarding minimum staff levels and emergency response organisation preparedness, and that Eskom and support organisations could still fulfil their assigned roles despite the pandemic.

These sessions were very useful to further share operating experience from other utilities and ensure complete alignment with each other. The meetings were also attended by senior executives from both organisations.

The process to purchase COVID-19-related personal protective equipment (PPE) was prioritised, and procurement of PPE such as surgical masks and hand sanitisers were initiated by means of the Emergency Procurement Process. The procurement team expedited PPE delivery despite the limited availability of hand sanitisers. This allowed the station to immediately implement COVID-19 mitigation protocols in the workplace and ensured that the refuelling outage commenced as scheduled.

To ensure compliance with the relevant safety standards, all sanitisers received at Koeberg were sampled by the Chemistry group and analysed for alcohol content. Masks and other COVID-19-related PPE were reviewed before the order was placed by the Koeberg Safety group. Sanitisers were stored in the Chemistry fire lockers, and additional fire lockers were procured for the warehouse to store sanitisers. The procurement team also negotiated with suppliers for partial purchase order deliveries of sanitisers to the Koeberg Site Stores to ensure space availability inside the fire lockers.

Employees at Koeberg were issued with four three-ply cloth masks. Disposable surgical and FFP2 masks were standardised as the masks of choice to be worn at Koeberg. The team also purchased thermal scanning cameras for the different sites. The cameras were set up at the access points to sites or buildings and security personnel were trained to maintain and operate the equipment at the various buildings or site access points.

Due to the COVID-19 pandemic, and following guidance from the World Health Organization, National Institute for Communicable Diseases, Ministry of Health and Eskom Corporate, Koeberg developed an Excel tool/model to assist management in assessing each individual employee's COVID-19 risk profile. The model took into account the employee's COVID-19 level of awareness, work being performed, working environment, dominant mode of transmission based on working environment, employee medical condition (health and age) and the baseline COVID-19 risk mitigations implemented at Koeberg.

The model required the participation of the Departmental/Group Manager, SHEQ Representative, risk assessor, employee, Head of Group, Head of Department and Medical Centre. Based on the employee's medical history (health, comorbidities and age), the Medical Centre determined the employee's vulnerability category. All medical information was treated as confidential, and the assessor only received the final categorisation from the Medical Centre. As part of the model, all employees were made aware of the risk associated with COVID-19, and the treatment and mitigations.

The model was developed to carry out personalised risk assessment for all employees in order to address the risk to personnel health and safety and nuclear safety (see table below). The model had three COVID-19 risk profiles as outcomes of the assessment, i.e. low risk, medium risk and high risk.

Low risk	Medium risk	High risk
• Individual to report for work on-site • Ensure compliance with mitigations in place	• Individual may report for work on-site • Implement additional controls to reduce risk to an acceptable level • Special PPE • Implement specific administrative measures • Restriction of certain duties considered high-risk tasks/ activities • Adaptation of duties and shifts	• Individuals to work from home • Provide tools for remote working • Consider special leave • Consider redeployment or alternative placement options

This model assisted the station to continue its operations without any impact on nuclear safety due to staff shortages caused by COVID-19 infections. The station recorded a modest number of work-related COVID-19 infections (less than 0.6%).

Koeberg traditionally relies on a number of international and local contractors to perform its outage activities safely and reliably. The last two outages were executed during times of significant restrictions and international lockdown limitations, which affected the ability of the station to mobilise skilled resources. To curtail fears amongst contractors and suppliers, Koeberg communicated the protocols and measures that were implemented at the site.

When suppliers were unable to book flights, Eskom took over the administration of all flights booked and paid for by the power utility. Furthermore, when international travel restrictions affected the issuing of work permits, Koeberg engaged the Department of Home Affairs, Department of International Relations and Cooperation, and Department of Public Enterprises for support. Koeberg took extra measures to ensure that the required international and local contractors were able to travel and support the Koeberg outages.

Medical support

Koeberg is privileged to have a fully equipped medical team on-site with a full-time resident medical practitioner. The medical team's services were extensively utilised to guide the Nuclear Operating Unit COVID-19 team regarding the ever-changing requirements as the station continuously improved its understanding of the virus.

Medical surveillance

- With the support of the corporate office, a medical surveillance programme was developed for Koeberg. Initially, as the station was going into an outage during the peak of the pandemic, mass testing was conducted for all on-site personnel and all initial entry personnel.
- Random testing was conducted based on peaks in the number of COVID-19 positive personnel and the nature of work that may compromise infection control measures in certain groups within the station.
- Currently, all initial entry personnel are being tested for COVID-19 at the site Fitness for Duty Centre.

Clinical management

- Isolation rooms were developed on-site for the clinical stabilisation of employees who fell ill at work with clinical features that were consistent with COVID-19 infection.

Workforce empowerment

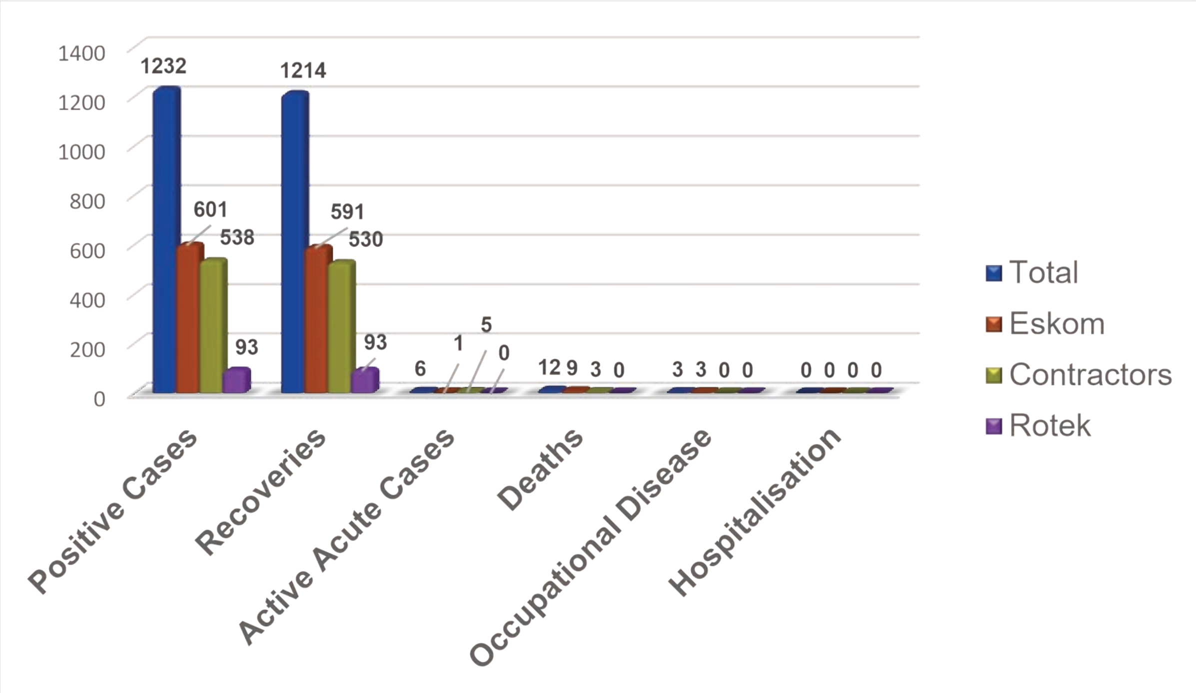
- A number of presentations were made at engagement sessions to share available medical information and the management of cases from both clinical and Human Resources perspectives. The sessions were conducted at various levels, i.e. Heads of Departments/ Heads of Groups and the workforce at large, and through virtual work team sessions for individual groups, especially where there was a spike in the number of COVID-19 positive personnel.
- Information was shared via the COVID-19 publication to provide updated information about COVID-19 within the station.

Support system

- Site Medical Centre occupational health practitioners followed up with employees who tested positive for COVID-19 with the aim of advising employees about the natural progression of the medical condition, what to look out for, clinical care and self-care, protecting one's colleagues and loved ones, and the Human Resources process to follow in relation to COVID-19.
- Based on the follow-up consultation, some employees were advised to seek further medical attention.
- Referral to Employee Assistance Programme services assisted in alleviating the anxiety associated with COVID-19.
- Support to the families of deceased employees during the pandemic included the following:
  - Virtual funerals/memorial services; and
  - Supportive psychotherapy.
- A tracking form was developed to assist managers and employees in tracking close contacts, thus upholding an infection-free workplace as far as reasonably possible. This also assisted with ensuring that the deep cleaning of areas where employees that had tested positive for COVID-19 was done timeously.
- All cleaning staff were trained by the site doctor regarding cleaning and the chemicals to be used.

Koeberg COVID-19 cases as at 21 February 2022

Station management collected and analysed data to successfully set up and direct the organisation.



Total COVID-19 statistics over a two-year window

A total of 1 232 COVID-19 cases were reported, of which 1 214 have returned to work. Koeberg has managed to keep the on-site infections down to only three cases. Twelve employees passed away (nine were Eskom personnel and three were contractor personnel).

Koeberg vaccination programme

- Through extensive work by the Medical Centre staff, in collaboration with the Centre of Excellence at Eskom Corporate, Koeberg was accredited as a COVID-19 vaccination site.
- The site afforded employees, contractors and their families the opportunity to be vaccinated in a safe and controlled environment.
- Koeberg has led Eskom in achieving herd immunity.
- The Eskom OHNPs were trained in COVID-19 vaccination and clinical management.

Operating shift resources

The normal shift structure and cycle exposes a large number of the operating staff (and increases the frequency of contact). Operating Management has been engaging with staff and the unions and will continue to do so to ensure that more suitable solutions are found and sustained. The objective is an alternative shift cycle that reduces contacts and the number of staff working, and increases the number of standby staff. The rationale for selecting such a cycle is based on the following:

- The operating crews on duty shall be reduced to one Shift Manager, two Senior Shift Supervisors, five Reactor Operators, four Non-Licence Operators and six Fire Team Members at all times.
- The Duty Shift Manager shall deal with additional staff requirements on a case-by-case basis.
- Operating staff shall be divided into three categories, namely category A, B and C.
- Category A staff shall be required on-site to manage the safe operation of the plant, and deal with planned and emergent work.
- Category B staff shall not be required on-site and can work from home.
- Category C staff shall be required to remain at home and shall be called upon to safely operate the plant should category A staff not be able to meet the minimum staffing requirements due to COVID-19 infections. (Category C staff is mainly the active SROs and ROs in OTG, OPS Support and OOG).
- The Duty Shift Manager shall maintain an updated staff register of all available staff on standby. This register shall also contain those identified as Category A, B or C. The register shall be kept updated with the date any operator is unable to report for duty due illness, etc.
- The staffing register shall be monitored by Operating Management on an ongoing basis to determine if there is any adverse trend.
- If the manning of the shifts is foreseen to be potentially challenged, the Operating Manager shall be informed. The Operating Manager in consultation with senior management and the COVID-19 task team shall determine the appropriate actions.

Optimum operating shift cycle

After much deliberation and extensive consultation with staff, labour representation and site management, it was decided to implement a temporary shift roster during the lockdown period.

- The shift roster is structured to ensure an 18-day self-isolation period (start of spares week until end of training week).
- During this period, the shift that is in self-isolation must be available to join the rest of the Category C staff if required to take over the day-to-day running of the station.
- It is vital that both Category C staff and the shift that is in 18-day isolation remain in isolation as far as reasonably achievable.

- Category A staff are expected to work shifts and maintain their social distance, including hygiene practises, when on duty. This will ensure that the impact on the rest of the crew is minimised if an individual tests positive.
- Whilst Category A is on duty, they will need to self-cover on NDOs and/or 12 hours in the event of vacancies due to various reasons.

Control room and 19m conduct and access to the plan

- Access to the 19m level and control room was restricted and only the duty operating crew and essential staff were permitted. All security access to the 19m level was revoked except for operating staff and essential staff. Should an individual require access for an emergent critical issue, the Duty Operating Shift Manager shall determine if access is essential and inform security.
- The operating shift and essential staff reporting for duty shall have a separate entrance and exit at security. They will be screened before entering the plant. If an operator does not screen within the acceptable criteria, the Shift Manager shall be informed to make alternative arrangements and the station process shall be followed.
- High levels of hygiene shall be maintained at all times on the 19m level and the control room as per medical staff directives and the Operating Brief.
- Facemasks shall be worn as per Eskom guidelines.
- Before shift handovers, the retiring crew shall confirm that the area is shipshape and that items are disposed of or sanitised. All staff shall wipe down their own workstations (table, keyboard, mouse, telephone, NPO keys and O_2 monitor). The 19m level shall remain sanitised at all times by the operating staff.
- All personnel (maintenance and operating) shall sanitise their hands when entering the 19m level or the control room.
- Crews shall limit control room access as far as possible (e.g. the Shift Chemist to perform rounds via INSQL or call the control room).
- NAB NPOs shall hand over the shift in the NAB. They shall not be allowed access to the 19m level. Crew briefings shall be conducted telephonically.
- Control room eating restrictions shall be temporarily lifted. Workstations shall be adequately cleaned after eating.
- Control room floors shall be cleaned daily with disinfectant and door handles shall be wiped down with disinfectant.
- Control room staff shall make their own food/drinks. The practice of one person making coffee for the crew shall no longer be allowed.

- No phones may be shared. Phones must be disinfected regularly.
- The amount of documentation on the 19m level shall be minimised. Where documentation is required, good hygiene practices shall apply. Logs shall not be printed. The review of logs for shift handover shall be done electronically.
- Social distancing (1.5 m apart) shall be maintained between operators, especially during shift handovers, team meetings and pre-job briefs.

Prepared by:

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