Eskom	**Report**	**Nuclear Engineering**

Title: **KNPS 3rd Periodic Safety Review Global Assessment and Integrated Implementation Plan Report**

Document Identifier:	**331-608**
Alternative Reference Number:	**ERB-988**
Area of Applicability:	**Nuclear Engineering**
Functional Area:	**Nuclear Engineering PSR**
Revision:	**3**
Total Pages:	**34**
Next Review Date:	**Not Applicable**
Disclosure Classification:	**Controlled Disclosure**

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Date: 2023-10-26	Date: 2023-10-26	Date: 2023-10-26	Date: 2023-10-26

Nuclear Additional Classification Information

Business Level:	**3**
Working Document:	**3**
Importance Classification:	**NSA**
NNR Approval:	**Yes**
Safety Committee Approval:	**Yes**
ALARA Review:	**No**
Functional Control Area:	**Nuclear Engineering, PSA**

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Executive Summary

Koeberg Nuclear Power Station (KNPS) conducted its 3rd Periodic Safety Review (PSR) over the period 2019 – 2021 in fulfilment of its 10-yearly regulatory requirement. The objective of the PSR is to ensure a high level of safety throughout the plant's operating life by systematically assessing five subject areas of plant, safety analysis, station performance, and use of operational experience, management and environment. This PSR is also intended to support the KNPS application for Long-Term Operation (LTO).

The PSR scope is subdivided into a review of 14 Safety Factors (SFs) which included aspects relevant to determine suitability for continued operations including LTO period. The SF review requirements assessed the extent to which KNPS comply with national and international codes, standards, and practices. Each SF was evaluated to identify any gaps (deviations), strengths and Proposed Safety Improvements (PSIs) against defined criteria or requirements.

The Global Assessment (GA) considered the cumulative effects of deviations and strengths identified in the SFs. The analyses conducted as part of the GA included, PSR Consolidation of Findings, Defence in Depth (D-i-D) and Fundamental Safety Function (FSF) Analyses, Fundamental Safety Principle (FSP) Analysis, Causal Analysis and Safety Significant Evaluation (SSE) all of which, are covered at a high-level in this report. Detailed information is contained within supporting appendices.

From the SF reviews and the GA process, 113 deviations and 8 Global Issues (GIs) were identified, respectively. Safety improvements were proposed for each of the deviations and GIs. The PSIs were verified, screened, and ranked according to their safety significance. This resulted in a total of 93 safety improvement actions which were included in the Integrated Implementation Plan (IIP) to resolve the deviations and GIs.

A significant portion of safety improvements related to the undertaking of further analytical (studies and analyses) and improvements of programmes, procedures and/or processes, in readiness for LTO. The safety improvements have been confirmed to be reasonably practicable taking into account all other ongoing improvement actions (prior to completion of the PSR process). Eskom regards safety improvements as necessary to ensure that undue risk to the safety, health of the public and the environment is avoided or mitigated and thus aims to implement the improvement actions in a timely manner commensurate with the safety significance of the deviations. The IIP has been approved by Eskom management, and implementation of the actions will be monitored on an ongoing basis.

In addition, this report draws conclusions on the Suitability for Continued Operation (SCO), providing assurance for safe operation over the forthcoming 10 years and into the period of LTO. Inputs for the SCO were derived from the SF reports and the results of the analyses undertaken as part of the GA. The SCO also provides an assessment of the impact of deviations on the Probabilistic Safety Analysis (PSA) and Deterministic Safety Analysis (DSA) as well as Emergency Planning (EP), Emergency Plan Technical Basis (EPTB) and Accident Management. The justifications supporting the SCO of Koeberg is briefly considered in this report, with detailed information provided in Appendix J.

The findings from the PSR, was consolidated to ensure that deviations, strengths, and PSIs are harmonised and thus all interactions, overlaps, and conflicts between the SF Review outcomes are identified, assessed, and resolved. The output of this assessment resulted in the identification of one GI for the inadequate identification, justification, and analysis of Design Extension Conditions (DECs) (GI-001).

The cumulative effects of the SF deviations were comprehensively assessed for their impact on the FSPs, as defined in the IAEA Safety Fundamentals-1 Standard [28]. The analysis identified a notable impact on FSP 3 concerning "Leadership and Management for Safety", resulting in GI-008 which recognises the organisational tolerance for long-standing issues. On the whole, however, the FSP Interface analysis concluded that the Koeberg management system has been well-established and fulfils the safety objectives and requirements as articulated by the FSPs. In addition to the FSP impact analysis, the SF deviations and strengths were also assessed against the levels of D-i-D, FSFs and D-i-D Objective Trees (OTs), the analyses of which, did not identify any significant organisational or operational weaknesses.

The Causal Analysis review identified 15 causes and 26 Contributory Causes (CC) for the SF deviations. The highest number of causes were found to be attributed to the absence of a framework to continuously review international requirements/standards/practices and implement safety improvements, while the remaining causes were distributed around skilled resource constraints, insufficient or inadequate knowledge management, financial constraints (incorrect prioritisation of work), inconsistent demonstration of nuclear safety culture traits and overall inadequate management oversight. These were analysed and grouped into themes which were developed into 6 GIs (GI-002, GI-003, GI-004, GI-005, GI-006, GI-007).

A total of 14 strengths were identified across the SF reviews. These will support Koeberg's track record of continued safe operation and its goals for LTO. The strengths are linked to the multidisciplinary approach applied to independent reviews of design packages, the Anticipated Transients Without Scram (ATWS) accidents which are thoroughly analysed for all possible initiators, a well-structured Safety Analysis Report (SAR), the suite of Koeberg Severe Accident Management Guidelines (SAMGs) that have been enhanced from the generic Westinghouse SAMGs, and an extensive, well-established Operational Experience (OE) programme with EDF, and several other strengths.

In conclusion, the PSR SFs reviews and outcomes are deemed to be comprehensive and provided sufficient data for use in the GA process. The GA process has provided a balanced view of the cumulative effect of the deviations on D-i-D, DSA, FSFs, FSPs, PSA, EP and Ageing Management (AM), and it can be concluded from the GA outcomes that the plant is suitable for continued operations. It also produced the necessary safety improvement actions (contained in the IIP), to maintain risk within acceptable levels, ensure continuous improvement and to support safe operation over the next PSR period and into LTO.

1. Introduction

The Global Assessment (GA) comprises the tasks required to assess the overall safety status of the existing plant and to identify the safety improvements to be implemented to ensure KNPS remains in a safe state for the remainder of its operating period. The GA enables KNPS to objectively justify its decision regarding the plant's suitability for continued operation, inclusive of the period for LTO, and the IIP. The process for conducting the GA consisted of five distinct steps in order of performance, as outlined below:

I. The preparation step in which the GA and IIP methodology [2] are defined and agreed with the National Nuclear Regulator (NNR).

II. The review and assessment of SF outcomes which is achieved by cross-examining the individual SF outcomes, deviations, strengths, and GIs to identify any cumulative effects utilising assessments relating to FSFs, levels of D-i-D, and IAEA FSPs.

III. The verification of safety improvements and compilation of the IIP to provide a schedule for the proposed safety improvements.

IV. The assessment of suitability for continued operation by considering the outputs from II and III.

V. The final step is the compilation of the GA and IIP report which documents all the outcomes of the GA process.

A key part of the GA process is to determine the impact of the risk posed by individually identified deviations from each SF and to therefore, comprehend the cumulative impact on nuclear safety, including the assessment of suitability for continued operations. The detailed reports on the outcomes of each activity in the GA process are attached as Appendices A-J.

2. Objective of the Global Assessment

The objective of the GA is to arrive at a judgement of the Koeberg Operating Units' (KOU) SCO for the next PSR period and into LTO, on the basis of a balanced view of the strengths and deviations, as well as the associated safety improvements. This is achieved by conducting a complex and rigorous analyses of PSR SF results, with due consideration of interfaces and ongoing work activities at the station.

3. References, Definitions, and Abbreviations

3.1 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

3.1.1 Normative

[1] 240-134382460, PSR Basis Document (3rd Periodic Safety Review for Koeberg Power Station), Rev 3, April 2020

[2] 240-163876252, KNPS 3rd PSR Global Assessment and Integrated Implementation Plan Methodology Strategy

[3] 240-161608045, KNPS 3rd Periodic Safety Review Report, Safety Factor 1: Plant Design

[4] 240-161608165, KNPS 3rd Periodic Safety Review Report, Safety Factor 2: Actual Condition of SSCs Important to Safety

[5] 240-161608293, KNPS 3rd Periodic Safety Review Report, Safety Factor 3: Equipment Qualification

[6] 240-161608408, KNPS 3rd Periodic Safety Review Report, Safety Factor 4: Ageing Management

[7] 240-161608463, KNPS 3rd Periodic Safety Review Report, Safety Factor 5: Deterministic Safety Analysis

[8] 240-161608557, KNPS 3rd Periodic Safety Review Report, Safety Factor 6: Probabilistic Safety Assessment

[9] 240-161608617, KNPS 3rd Periodic Safety Review Report, Safety Factor 7: Hazard Analysis

[10] 240-163373725, KNPS 3rd Periodic Safety Review Report, Safety Factor 8 Part 1: Safety Performance

[11] 240-161608663, KNPS 3rd Periodic Safety Review Report, Safety Factor 8 Part 2: Safety Performance (Radiological Protection)

[12] 240-161608733, KNPS 3rd Periodic Safety Review Report, Safety Factor 9: Use of Experience and Research Findings

[13] 240-161608011, KNPS 3rd Periodic Safety Review Report, Safety Factor 10: Organisation, the Management System, and Safety Culture

[14] 240-161608929, KNPS 3rd Periodic Safety Review Report, Safety Factor 11: Procedures

[15] 240-161609178, KNPS 3rd Periodic Safety Review Report, Safety Factor 12: Human Factors

[16] 240-161609577, KNPS 3rd Periodic Safety Review Report, Safety Factor 13: Emergency Planning

[17] 240-161609494, KNPS 3rd Periodic Safety Review Report, Safety Factor 14: Radiological Impact on the Environment

[18] 240-153364501 (KGA-018), Safety Case Preparation (Guide)

[19] 240-156067953 (KGA-029), Safety Justification Preparation

[20] 331-64 (KGA-046), Guideline for Safety Issue Categorisation

[21] KGA-094, Event Investigators Guide

3.1.2 National and International Standards, Codes and Guides used in this Review

[22] NNRA (Act No. 47 of 1999), National Nuclear Regulatory Act, Act No 47 of 1999, on Safety Standards and Regulatory Practices

[23] NNR RD-0024, Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear Installations

[24] NNR RD-0034, Quality and Safety Management Requirements for Nuclear Installations

[25] NNR RG-0027, Ageing Management and Long-Term Operations of Nuclear Power Plants

[26] NNR RG-0028, Periodic Safety Review of Nuclear Power Plants, Interim Regulatory Guide, Rev. 0, August 2019

[27] NIL-01 (Variation 19): NNR Nuclear Installation Licence

[28] IAEA SF-1, Fundamental Safety Principles: Safety Fundamentals

[29] IAEA SSG - 25, Periodic Safety Review for Nuclear Power Plants

[30] IAEA SSG - 48, Ageing Management and Development of a Programme for Long-Term Operation of Nuclear Power Plants

[31] IAEA INSAG 10, Defence in Depth in Nuclear Safety

[32] IAEA INSAG 12; Basic Safety Principles for Nuclear Power Plants 75-INSAG-3 Rev 1

[33] IAEA SRS-46, Rev 1 (Draft 2 May 2021), Assessment of Defence in Depth for Nuclear Power Plants

[34] IAEA SSG-2, Deterministic Safety Analysis for Nuclear Power Plants

[35] Regulation R388 on Safety Standards and Regulatory Practices (SSRP) (2014), Regulation in terms of Section 36 (read with National Nuclear Regulatory Act No. 47 of 1999)

3.1.3 Informative

[36] 240-153546074, PSR Safety Factor 1 Requirements and Review Methodology: Plant Design

[37] 240-153546120, PSR Safety Factor 2 Requirements and Review Methodology, Actual Condition of SSCs Important to Safety

[38] 240-153546180, PSR Safety Factor 3 Requirements Review Methodology, Equipment Qualification

[39] 240-153546869, PSR Safety Factor 4 Requirements Review Methodology, Ageing Management

[40] 240-153546957, PSR Safety Factor 5 Requirements and Review Methodology, Deterministic Safety Analysis

[41] 240-153557572, PSR Safety Factor 6 Requirements Review Methodology, Probabilistic Safety Assessment

[42] 240-153559553, PSR Safety Factor 7 Requirements Review Methodology, Hazard Analysis

[43] 240-153560282, PSR Safety Factor 8 Requirements Review Methodology, Safety Performance Part 1

[44] 240-153560282, PSR Safety Factor 8 Requirements Review Methodology, Safety Performance Part 2 (RP)

[45] 240-153690416, PSR Safety Factor 9 Requirements, Use of Experience and Research Findings

[46] 240-153690825, PSR Safety Factor 10 Requirements and Review Methodology, Organisation, Management System, and Safety Culture

[47] 240-153695616, PSR Safety Factor 11 Requirements and Review Methodology, Procedures

[48] 240-153695668, PSR Safety Factor 12 Requirements and Review Methodology, Human Factors

[49] 240-153695738, PSR Safety Factor 13 Requirements and Review Methodology, Emergency Planning

[50] 240-153696036, PSR Safety Factor 14 Requirements Review Methodology, Radiological Impact on the Environment

[51] 331-94 (KLA-001), Importance Classification List

[52] 36-1018, Monitoring, Grading and Reporting of Licensing Basis Non-Compliances for the KOU

[53] KAA-688, Corrective Action Process

[54] KAD-025, Processing of Operating Experience

[55] KGG-SAG-5, Control Containment Conditions

[56] KGG-SCG-3, Mitigate CCI Concerns.

3.2 Definitions

Term	Description
Adherence Review	Used where the requirement is to confirm adherence to processes or procedures.
Challenges	Generalised mechanisms, processes, or circumstances (conditions) that may have an impact on the intended performance of safety functions. Challenges are caused by a set of mechanisms having consequences that are similar in nature. (Used in Defence in Depth (D-i-D) assessment)
Complex Review	Used where the review of the requirement needs a programme review or a detailed, often technical, assessment. For example, where a code or standard is adopted to meet the requirement.
Defence in Depth	Defence in Depth is an overall safety philosophy that encompasses all safety activities, including the siting, design, manufacture, construction, commissioning, operating, and decommissioning of nuclear power plants.
Detailed Review	Used where the demonstration that the requirement requires a detailed assessment but deals with a single issue or concept.

Term	Description
Deviation	A negative finding to either the national regulations, the Koeberg Licence or international requirements, or those codes, standards, processes or practices that are adopted to meet any of those requirements.
Deviation Cause	A cause of an event or issue which, if corrected, will reduce the likelihood and/or consequences of future similar events or issues. The objective is to reduce risk to acceptable levels.
Equipment Condition	Used where it is required to verify the condition of equipment, including structures, system and components.
Finding	Information discovered as the result of the periodic safety review. In the context of the PSR it can either indicate a negative finding (gap) with a national or international requirement, or a positive finding (strength) where requirements are exceeded.
Fundamental Safety Functions	The Fundamental Safety Functions (FSF) to be ensured for a nuclear reactor are defined as - Reactivity Control - Heat Removal - Confinement of Radioactivity The FSF are provided by single or combinations of the Safety Functions (NNR Requirements Document (RD)-0034 [24]).
Global Issue	A common higher level, cross-functional, underlying issue that results in multiple deviations, potentially in different Safety Factors.
Grading	The process of identifying the nuclear safety significance of an issue utilising the PSR Basis Document Appendix B process which is in alignment with 331-64 (Koeberg Guide – Administrative (KGA-046) [20]).
Implementable	Within the context of safety improvement, it means that the improvement can be implemented within the timeframe given the safety significance of the deviation. - For improvements that have a high safety significance, the timeframe is within next available opportunity but no longer than 2 years, - For improvements that have a medium grading, the timeframe is within 5 years, For improvements that have a low grading, the timeframe is prior to the next PSR.
Mechanisms	Specific reasons, processes or situations whose consequences might create challenges to the performance of safety functions. (Used in D-i-D assessment).
NNR Requirement	A nuclear safety requirement defined by the National Nuclear Regulatory Body of South Africa that is applicable to the Koeberg Nuclear Power Plant (NPP) as adopted by the PSR Basis document.

Term	Description
Open Licensing Issue	Correspondence between Eskom and the National Nuclear Regulator that needs to be addressed and tracked by the Eskom Koeberg Nuclear Licensing Department.
Practicable	Able to be done or put into practice successfully.
Process Review	Used where the requirement is met through the application of a process, or processes.
Provision	Measures implemented in design and operation such as inherent plant characteristics, safety margins, system design features and operational measures contributing to the performance of the safety functions aimed at preventing completely or partially the mechanisms from occurring.
PSR	A systematic reassessment of the safety of an existing facility (or activity) carried out at regular intervals to deal with the cumulative effects of ageing, modifications, operating experience, technical developments and siting aspects, and aimed at ensuring a high level of safety throughout the service life of the facility (or activity).
PSR Basis Document	Document that defines the scope of the PSR.
Reasonable	Within the context of safety improvement, it means that the effect of improvement is: - Eliminate or significantly reduce the impact of the deviation within the implementable period. - Significantly improve the level of nuclear safety. - Aligns and supports organisational strategic objectives.
Requirement	A nuclear safety requirement defined nationally or internationally that is applicable to the Koeberg NPP.
Requirement Document	A document that lists nuclear safety requirements applicable to Koeberg. These include requirements extracted from the national act, regulations, regulatory and Licence Documents (LDs), the Koeberg licence, the International Atomic Energy Agency (IAEA) General Safety Requirements (GSRs) and Specific Safety Requirements (SSRs), and the Western European Nuclear Regulators Association (WENRA) Safety Reference Levels (SRL) for existing reactors.
Safety Factor	A review area defined in NNR Regulatory Guide (RG)-0028 [26], which is assessed in a periodic safety review (PSR).
Simple Review	Used where a requirement can be confirmed by a relatively simple verification but requires additional confirmation that the requirement is adequately met, and the implementation is effective.
Specialised Review	Used when the review of the requirement has unique aspects specific to the subject matter
Strengths	A positive finding where good practices are either thoroughly applied or current safety requirements are exceeded.

Term	Description
Topical Area	A thematic grouping within a Safety Factor covering particular topic or theme, used to subdivide Safety Factor Reviews.

3.3 Abbreviations

Abbreviation	Description
AADQ	Annual Authorised Discharge Quantity
AC	Apparent Cause
ALARA	As Low As Reasonably Achievable
AM	Ageing Management
AMP	Ageing Management Programme
ATWS	Anticipated Transient Without Scram
ASME	American Society of Mechanical Engineers
CAP	Corrective Action Program
CC	Contributing Cause
CPY	900 MW reactor series type including CP1 and CP2 (translated from French)
DDR	Document/Drawing Change Request
DEC	Design Extension Conditions
D-i-D	Defence in Depth
DSA	Deterministic Safety Analysis
DSE	Design Substantiation Document
DSSR	Duynefontyn Site Safety Report
EDF	Électricité de France
EE-SRA	External Events – Safety Re-Assessment
EOP	Emergency Operating Procedure
EP	Emergency Planning
EPTB	Emergency Plan Technical Basis
EQ	Equipment / Environmental Qualification
FME	Foreign Material Exclusion
FSF	Fundamental Safety Function
FSP	IAEA SF-1 Fundamental Safety Principles
GA	Global Assessment
GI	Global Issue

Abbreviation	Description
IAEA	International Atomic Energy Agency
IIP	Integrated Implementation Plan
INPO	Institute of Nuclear Operations
INSAG	International Nuclear Safety Advisory Group
KGA	Koeberg Guide- Administrative
KNPS	Koeberg Nuclear Power Station
KOU	Koeberg Operating Unit
LD	NNR licence document
LI	Licensing Issue
LOPP	Life of Plant Plan
LTO	Long Term Operation
NIL	Nuclear Installation Licence
NNR	National Nuclear Regulator
NNRA	National Nuclear Regulatory Act
NOU	Nuclear Operating Unit
NPP	Nuclear Power Plant
NSRC	Nuclear Safety Review Committee
OE	Operational Experience
OT	Objective Tree
PAR	Passive Autocatalytic Recombiner
PSA	Probabilistic Safety Assessment / Analysis
PSI	Proposed Safety Improvement
PSR	Periodic Safety Review
QA	Quality Assurance
QRA	Quantitative Risk Assessment
RD	NNR Requirements Document
RG	NNR Regulatory Guide
RGP	Relevant Good Practice
SAMG	Severe Accident Management Guideline
SAR	Safety Analysis Report
SCO	Suitability for Continued Operation
SF	Safety Factor
SFC	Single Failure Criterion
SFP	Spent Fuel Pool

Abbreviation	Description
SME	Subject Matter Expert
SPI	Screening of Proposed Improvements
SR	Safety Related
SRA	Safety Re-Assessment
SRL	Safety Reference Level
SRS	Safety Report Series
SSC	NPP Structures, Systems, Components
SSE	Safety Significance Evaluation
SSG	Specific Safety Guide
SSR	Site Safety Report
SSRP	Safety Standards and Regulatory Practices
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association

4. Global Assessment Methodology

4.1 Global Assessment Tasks

In alignment with the KNPS 3rd PSR Basis Document [1] and the Global Assessment and Integrated Implementation Plan Methodology Document [2], the GA and IIP process was conducted by applying the following steps:

a) Identification and consolidation of the SF findings, both deviations and strengths

b) Causal analysis of the deviations

c) Analyses of D-i-D and FSFs and aggregate cumulative impact of deviations on these

d) Interface analysis – impact of SF outcomes on FSPs

e) Development and screening of safety improvements to address the deviations

f) Ranking of identified safety improvements and development of an IIP

g) Assessment of the overall suitability of continued safe operation of the plant over the next PSR period and into LTO

h) Preparation of the GA report.

i) Nuclear Safety Review Committee (NSRC) approval of proposed safety improvements and associated timelines

Objectives and the results of each of the above steps are discussed in Section 5 of this report.

4.2 Global Assessment Team

The GA team was an interdisciplinary team, with appropriate expertise in Operating, Design, Nuclear Safety, Ageing Management, Radiation Protection and Management of the plant. Consistent with the requirements in RG-0028 [26], the team comprised of GA experts who were not involved in the SF reviews, Subject Matter Experts (SMEs) as well as independent technical and process reviewers. The GA team structure is shown in Figure 1.

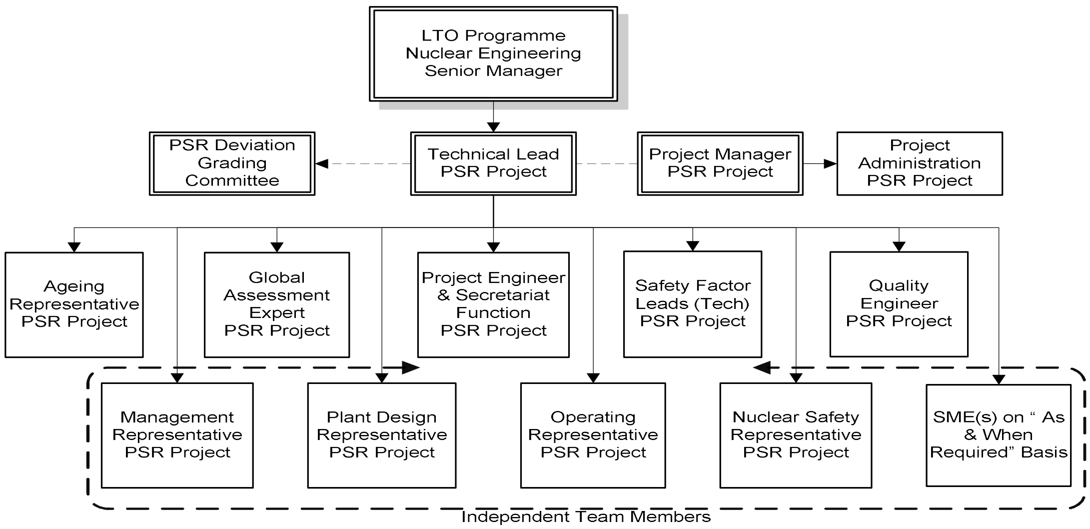

Figure 1: Global Assessment Team

5. Global Assessment Results

The GA tasks discussed below were conducted in accordance with the GA and IIP methodology document [2].

5.1 GA Input Data from PSR SFs Review Findings

During the PSR SF review phase, 1149 separate reviews were conducted across all 14 SFs using consolidated requirements generated from regulatory and international requirements and guidance documents. The assessed requirements in each SF are contained in references [3] to [17].

5.1.1 Deviations

A total number of 113 deviations were generated across 12 SFs, excluding SF-8 (Plant Performance) and SF-9 (Use of Experience from Other Plants and Research Findings), which did not identify any deviations during the assessments. The deviations arising from the PSR SF reviews, and their distribution based on nuclear safety significance are shown in Figure 2. The detailed deviation list, with description and safety significance of each deviation is provided in Table 3 of Appendix A. As depicted in Figure 2, the grading distribution of the 113 deviations is: HIGH = 1; MEDIUM = 13; LOW = 79; and DROP = 20.

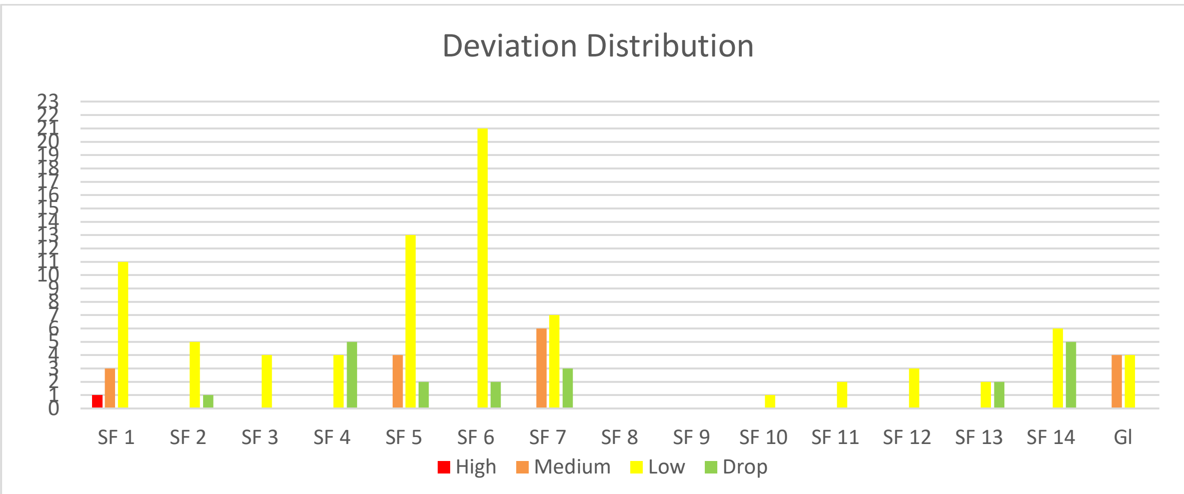

Figure 2: Deviations raised per Safety Factor, including Global Issues (GIs)

The distribution of deviations and associated safety significance per SF is shown in Table 1.

Table 1: Distribution of Deviation Safety Significance per Safety Factor

QRA Ranking	Total	SF-1	SF-2	SF-3	SF-4	SF-5	SF-6	SF-7	SF-10	SF-11	SF-12	SF-13	SF-14
Total	**113**	**15**	**6**	**4**	**9**	**19**	**23**	**16**	**1**	**2**	**3**	**4**	**11**
HIGH	**1**	1	0	0	0	0	0	0	0	0	0	0	0
MEDIUM	**13**	3	0	0	0	4	0	6	0	0	0	0	0
LOW	**79**	11	5	4	4	13	21	7	1	2	3	2	6
DROP	**20**	0	1	0	5	2	2	3	0	0	0	2	5

QRA – Quantitative Risk Assessment

5.1.2 Proposed Safety Improvement Actions

As a result of the 113 deviations, a total of 165 PSI actions (prior to consolidation, verification, screening and ranking) were raised. Detailed descriptions of the PSIs and the corresponding deviations is presented in Table 11 of Appendix A.

5.1.3 Strengths

A total of 14 Strengths (generally in relation to beneficial practices and behaviours observed) were identified, 3 in SF-1, 2 in SF-5, 6 in SF-6 and 3 in SF-9. The list of Strengths is presented in Table 2 below.

Table 2: The list of strengths from the Safety Factor reviews

No.	Strength Identifier	Description
1	1B-24-S1	The concepts of diversity, redundancy, segregation, and functional independence are well embedded at KNPS, which is demonstrated through robust justification within system specific documentation
2	1B-25-S1	The Single Failure Criterion (SFC) is accounted for within the inherent design of the NPP Structures, Systems, Components (SSCs) at KNPS. This information can be found within system specific documentation, including Life of Plant Plans (LOPPs) and Design Substantiation Documents (DSEs)
3	1G-01-S1	The independent reviews of design packages contain a multi-discipline approach. The use of departments and specialists is considered extensive beyond the requirements of Relevant Good Practice (RGP). This has been validated in the modification sample studies
4	5A-01-S3	The ATWS accidents are thoroughly analysed for all possible initiators, which is a strength compared to Belgian CPY
5	5C-01-S1	Well-structured SAR, with up-to-date information and dynamic links (Notwithstanding shortcomings related to Duynefontyn Site Safety Report (DSSR) and DEC)
6	6A-05-S1	The vessel rocketing failure mode was considered as a containment failure mode in the Koeberg Level 2 PSA but is not contained in the EDF Level 2 PSA.
7	6C-11-S1	The existing processes at Koeberg such as the Safety Evaluation Process and the Non-Conformance process are well-established and adequate tools to assess the impact of plant changes on PSA.
8	6C-12-S1	The definition for risk-significant components is formal and is more sensitive than the American Society of Mechanical Engineers (ASME's) definition of risk-significant basic events

No.	Strength Identifier	Description
9	6C-12-S2	The panel discussion review system ensures that qualitative insights also inform risk significant gradings.
10	6C-24-S1	The Koeberg SAMGs have been enhanced from the generic Westinghouse SAMGs. KGG-SCG-3 Mitigate CCI Concerns [56] contains additional guidelines to mitigate a severe challenge to containment due to basemat failure. This guideline does not exist for other NPPs.
11	6C-24-S2	KGG-SAG-5 [55] which discusses the hydrogen PARs that prevent long term build-up of hydrogen in containment are also not contained in the generic Westinghouse SAMGs.
12	9B-01-S1	Koeberg has a well-established OE exchange with EDF and World Association of Nuclear Operators (WANO) / Institute of Nuclear Operations (INPO) and relevant operating experience is continuously being drawn and incorporated for its own operations. The added benefit of Technical Support from EDF in the event of a need to timeously and safely resolve a sudden technical issue on any of the Units is especially beneficial for the continued operation of the Plant and into LTO.
13	9B-04-S1	The licensing basis non-compliance review process, as described in 36-1018 [52] is a good practice.
14	9C-02-S1	The Corrective Action Process (KAA-688 [53]) and Processing of Operating Experience (KAD-025 [54]) is a good practice in line with international (IAEA) best practice.

5.1.4 Safety Factor Conclusions

The conclusions drawn in the SF reports were used to inform the GA. Since this PSR supports the LTO licence application, it was imperative that a statement of confidence of operations beyond the originally planned lifetime of the station, be provided as part of the individual SF review conclusions. The outcomes of each individual SF review and its impact on the stations SCO, is presented comprehensively in Appendix J and summarised in Section 5.11 of this report.

5.2 Consolidation of PSR Findings Outcomes

The objective of the consolidation process is to ensure that deviations, strengths, and PSIs are harmonised and thus all interactions, overlaps, and conflicts between the SF Review outcomes are identified, assessed, and resolved. Additionally, the harmonised SF Review outcomes were validated against current open Licensing Issues (LI) tracked by KNPS. This was done to ensure that no conflicts exist between the PSR and organisation's current regulatory commitments. Open LIs were screened to determine which deviations are linked to them and whether there exists a reference letter (refer to Table 6 of Appendix A). The relevance of the LIs to the PSR deviations is shown in Table 7 of Appendix A.

The results of the consolidation process are summarised as follows:

- The interactions, overlaps, conflicts, and amplification effects between 113 deviations yielded a total of 58 interactions and 6 overlaps. While amplification effects were noted in many of the interactions, no regrading of deviations was proposed. The outcomes of this assessment are presented in Table 5 of Appendix A
- 24 deviations were found to interact with open LIs, and no conflicts or regrading was proposed because of the interactions identified.
- 3 PSI actions derived from the SF reviews were duplicated as indicated in Table 11 of Appendix A.
- 14 strengths developed during the SF reviews were evaluated against deviations, and only one interaction between a deviation and a strength was identified and resolved.
- The SF review findings were examined for trends and interactions that resulted in one GI, (GI-001), relating to the inadequate identification, justification, and analysis of DEC events (graded as MEDIUM).
- GIs identified through consolidation and other GA analyses were also reviewed in this task to ensure that new actions derived from GA analyses are harmonised with the SF review findings. 6 GIs (GI-002, GI-003, GI-004, GI-005, GI-006, GI-007) were identified through Causal Analysis, whilst 2 GIs, GI-001 and 008, were identified through the consolidation of deviations, and FSP interface analysis, respectively. All GIs are harmonised with the SF review findings.

For the detailed assessment conducted and results of the 'Consolidation of PSR Findings' task, refer to Appendix A: Consolidation of PSR Findings.

5.3 Interface Analysis of SF Review Findings considering the Fundamental Safety Principles

5.3.1 Links between Safety Factors

The boundaries and interfaces between SFs were addressed in the following four main phases of the PSR.

1. An initial view of the SF interfaces was provided during the development of the SF consolidated requirements and review methodology documents. Any potential overlaps were evaluated to ensure that the requirement is captured in the most appropriate SF.
2. Interfaces between the SFs was identified during the production of the SFs, as more information became available.
3. During the GA phase, an integrated picture was developed through collaborative working amongst the GA team. This facilitated a holistic assessment of the deviations and thus, the development of the GIs following extensive analyses.
4. Consolidation of the PSR findings (as discussed in Section 5.2) and the Causal Analyses (covered in Section 5.5) identified interactions/interfaces that were not found via the aforementioned 3 phases.

5.3.2 Interface Analysis of SF Review Findings considering the Fundamental Safety Principles

The FSP interface analysis determines whether the scope of the SF reviews is consistent with the FSPs documented in IAEA Safety Standards Series No. SF-1 [28]. FSP 2 is excluded on account of relating to the role of government and is therefore beyond the scope of this PSR. No deviations or strengths (across all safety factors) impacted the analyses in FSP 4 and FSP 7. These FSPs were adequately addressed, and the requirements were met. The individual and cumulative impact of the deviations and strengths on the FSPs are analysed under this assessment method. The results of the assessments findings against individual FSPs are summarised:

A. FSP 1: Responsibility for safety

The prime responsibility for safety must rest with the person or organisation responsible for facilities and activities that give rise to radiation risks.

- Some design related deviations are longstanding and relate to the delayed implementation of operational experience (e.g., potential blockage of RIS needle valves (1C-13-D1) and the hydrogen hazard analysis (1B-20-D1)).
- Design bases information and configuration management deviations (e.g., SAR updates on external hazards, Document/Drawing Change Request (DDR) backlog and SAR updates on ageing and LTO) need to be addressed.

B. FSP 3: Leadership and Management for Safety

Effective leadership and management for safety must be established and sustained in organisations concerned with, and facilities and activities that give rise to, radiation risks.

- A culture of tolerating longstanding known deficiencies is apparent (See GI-008 identified in §4.5 of Appendix A)
- Limited instances of inadequate management system procedure implementation which need renewed management focus.

- Some improvements in the Ageing Management Program (AMP) are needed.
- There are deficiencies related to DSA quality and PSA scope and quality.
- Complementary Deterministic Safety Analysis and DEC improvements are outstanding.
- There are challenges related to the implementation of some programmes related to obsolescence, codes and standards and the effluent management programme.

C. FSP 5: Optimisation of Protection

Protection must be optimised to provide the highest level of safety that can reasonably be achieved

- Improvement related to the optimisation of the Annual Authorised Discharge Quantity (AADQs) linked to effluent discharges is necessary.
- Procedural requirements linked to the environmental and effluent monitoring programmes needs to be enhanced.
- Optimisation of the effluents discharged is needed by reviewing the adequacy and the plant design and testing and the response thereof, in particular related to the treatment of liquid effluent and use of iodine for charcoal filter testing.
- Re-assessment of the emergency plan technical basis is required.

D. FSP 6: Limitation of Risk to Individuals

Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.

- Eskom needs to ensure that all principal nuclides have a discharge limit and radionuclides are compared to discharge limits in a timeous manner for continuous releases.

E. FSP 8: Prevention of accidents

All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.

- There are isolated cases (e.g. Hydrogen explosion, siphoning of Spent Fuel Pool (SFP), Foreign Material Exclusion (FME) control and CF5 contactors on LLx 380V AC boards) where the risk of occurrences needs to be addressed.
- There are several instances where the understanding and information relating to DEC needs to be improved and where implementation of actions to manage DEC requires timely leadership attention (e.g., Equipment / Environmental Qualification (EQ) programme, priority modifications to mitigate external events, ownership and maintenance of portable equipment).
- Some improvements in accident management procedures are needed.

F. FSP 9: Emergency preparedness and response

Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.

- Improvements relating to arrangements in responding to simultaneous both-unit incidents and accidents are required.
- Input parameters for radiological analyses are evolving and need to be updated periodically.

G. FSP 10: Protective actions to reduce existing or unregulated radiation risks

Protective actions to reduce existing or unregulated radiation risks must be justified and optimised.

- Lack of effective groundwater boreholes to promptly detect and characterise contamination however requires attention.

The FSPs have been adequately assessed without any identified shortcomings identified in the SF reviews. The outcome from this analysis concluded that all the FSP requirements are met. However, there are areas that need to be addressed. Some deviations were proposed to be considered for re-grading, based on their cumulative effect on the relevant FSP. GI-008 linked to FSP 3 was raised, which relates to the tolerance for long-standing issues and graded MEDIUM.

The evaluation concluded that the Koeberg management system has been well-established and fulfils the safety objectives and requirements as articulated by the FSPs and established by the regulatory body. Timely resolution of the underlying causes for the GI-008 and the PSR deviations will ensure continued safe operation, well into LTO.

The detailed assessment and results of FSP Interface Analysis is documented in Appendix B: Interface Analysis (Fundamental Safety Principles). See also Attachment 1 of Appendix B for detailed information.

5.4 Defence in Depth and Fundamental Safety Functions Impact Analysis

The objective of the Safety Analysis - Defence in Depth (D-i-D) and Fundamental Safety Functions (FSF) Impact assessment was to determine and document the adequacy, acceptability, and robustness of the D-i-D levels at KNPS. The five levels of D-i-D are defined in International Nuclear Safety Advisory Group (INSAG)-10 [31] and a description of the levels in addition to the relevant provisions contained in IAEA Safety Report Series (SRS)-46 (Rev.1) [33] can be found in Attachment 2 of Appendix C.

Safety analysis of D-i-D in the GA focussed on determining the impact of individual and collective challenges presented by SF deviations on the five levels of D-i-D and the three FSFs (controlling the power, cooling the fuel and confining the radioactive material), to evaluate and demonstrate the adequacy of the existing arrangements at KNPS. IAEA SRS-46 (Rev.1) [33] provides a set of OTs which allows for the assessment of the severity of deficiencies in the D-i-D levels and FSFs under consideration. The impact review process consisted of four main parts:

- Identification of the impacted level(s) of D-i-D for each individual SF deviation

- Identification of the impacted FSFs for each individual SF deviation.
- Evaluating the individual SF deviations on the overall impact on D-i-D based on OTs
- Evaluation of the impact of strengths and deviations on the associated OTs, recognising that there is potential to mitigate some of the impact of the deviation(s) by the identified strengths.

The outcomes of this assessment were used to confirm the safety significance of the deviations and to ensure correct grading and prioritisation. The results of the distribution of SF deviations with regards to impact on the relevant levels(s) of D-i-D and FSFs are presented in Tables 2 and Table 5 respectively, of Appendix C.

Based on the deductions made from the impact analysis of SF deviations on D-i-D Levels no new GIs were identified. The GA team recommended preliminary consideration be given to prioritising the improvements which address the most affected level(s) of D-i-D, that are, Levels 4A (DEC without Core Melt/Emergency Operating Procedures (EOPs) used) and 4B (DEC with Core Melt/Severe Accident Management Guidelines used) in the IIP (refer to Table 3 of Appendix C). Furthermore, deductions made from the impact analysis of SF deviations on FSFs, revealed no significant cumulative effect and consequently, no new GIs. However, the GA team recommended consideration be given to prioritising those improvements which may affect the integrity of the FSFs, relating to Core Cooling and Confinement of Radioactive Material, in the IIP (refer to Table 7 of Appendix C).

A total of 124 OT branches (mechanisms) were assessed for deviation impact, out of a possible 314 defined in IAEA SRS-46 (Rev.1) [33]. Although no cumulative effects of multiple deviations on D-i-D OT levels were observed and no new GIs identified, 8 deviations were recommended for re-grading relating to the coverage of DECs in station design and safety documentation. The 14 strengths, raised across the SFs were confirmed not to alter or downgrade the 113 deviations (See Section 3.3 of Appendix C).

The detailed assessment and results of D-i-D and FSF impact analysis is documented in Appendix C: Defence in Depth and Fundamental Safety Functions Impact Analysis and Attachment 1 of Appendix C.

5.5 Causal Analysis

The Causal Analysis step of the GA investigates the causes of deviations and determines the Corrective Actions required to prevent recurrence. In addition, the Causal Analysis seeks to identify whether several deviations have common causes, thus constituting a GI.

The Causal Analysis was performed for each deviation and a summary of the Causes is provided in Table 2 of Appendix D. A total of 15 Apparent Causes (ACs) and 26 CCs appeared multiple times in the assessment (refer to Table 3 of Appendix D). Table 4 of Appendix D provides the descriptions of the identified causes. These causes were grouped into common themes of 6 GIs as listed in Table 3 below.

Table 3: Global issues raised during the Causal Analysis

GI	GI Description and Grading
GI-002	Gaps in skilled resources and knowledge management within the Nuclear Operating Unit (NOU) support functions were found to cause deviations in the periodic safety review. Graded MEDIUM.
GI-003	Insufficient management oversight, inadequate procedure use and adherence, and inadequate processes were found to be causes of deviations in the periodic safety review. Graded LOW.
GI-004	New requirements and international good practices caused a significant number of deviations in the Periodic Safety Review. Graded LOW.
GI-005	Lack of strategic management of financial resource constraints was a cause of PSR deviations. Graded MEDIUM.
GI-006	Combination of individual deviations and observations with potential to have an impact on the effectiveness of the emergency preparedness and response to severe accidents affecting both units simultaneously. Graded LOW.
GI-007	Inconsistent demonstration of nuclear safety culture traits. Graded LOW.

Two additional GIs were raised, namely GI-001 (Inadequate identification, justification, and analysis of DEC events) and GI-008 (Culture of tolerance of long-standing issues and deficiencies) by the Consolidation process and the Interface analysis, respectively. Both these GIs are graded MEDIUM. The final step of the Causal Analysis required a common cause analysis of the MEDIUM graded GIs and GI-006 (EP), and a consideration of the proposed safety improvement actions to confirm their adequacy. A common cause analysis of the EP GI was conducted because of its importance relating to the response to accidents affecting both units. The identified ACs that were recorded against the GIs are broadly similar and focus on resource constraints (people or financial), which relate to inadequate prioritisation of work leading to delays in implementing actions from larger programmes of work, or those actions raised historically from previous assessments (SRA-II or External Events – Safety Re-Assessment, EE-SRA). The safety improvement actions for GI-001 are aimed at development and completion of the DEC analysis and updating the relevant documentation. From GI-002 and GI-005, safety improvements include a combination of actions to ensure a healthy pipeline of “appropriately authorised” resources, including an optimisation of the work planning process, to ensure the organisational objectives related to capacity building, and to ensure that productivity is met. Safety improvements to address GI-008 will ensure that Koeberg assesses the underlying causes of why there is a culture of tolerance to long standing issues and identify corrective actions to prevent recurrence and ensure Safety Related (SR) actions are implemented in a timely manner.

Detailed information corresponding to the Causal Analysis step is documented in Appendix D: Causal Analysis.

5.6 Safety Significance Evaluation (SSE) of Deviations

During the SF reviews, deviations were assigned a nuclear safety significance (grading) in accordance with the process described in Appendix B of the PSR Basis Document [1]. This initial grading was based on the information available at the time of PSR SF review phase and was independently assessed by the PSR Deviation Grading Committee for approval.

The core objective of the SSE was to verify that the initial grading (and therefore the nuclear safety significance) of deviations takes into account the results of the GA (as described in Sections 5.2-5.5 of this report) as well as PSA and DSA insights. Where appropriate, based on the new GA information, regrading of the deviation or prioritisation of the improvement action is recommended.

During the SSE, 113 deviations were assessed. None of the deviations warranted re-grading because the GA tasks did not yield any new information that would significantly impact the severity of the deviation. In many cases, the deviations proposed for re-grading were already linked to a Global Issue which generally result in a higher ranking of the safety improvement actions, addressing both the common cause and the individual deviations. Further, the list of strengths identified during the SF reviews had no influence on the grading of the deviations. The deviation gradings were therefore confirmed to be correct and no deviations were dispositioned. The safety improvement actions to address the deviations 5F-03-D4, 6A-03-D1, 6A-03-D2 and 7I-03-D1 were however recommended for prioritisation in the IIP based on D-i-D analysis.

Detailed information corresponding to the SSE task is documented in Appendix E: Safety Significance Evaluation of Deviations.

5.7 Verification of Proposed Improvements

The objective of this assessment was to verify if the PSI(s) for each individual deviation effectively addressed the impacted provision based on the level(s) of D-i-D and FSFs (Section 5.4), the ACs identified as part of the Casual Analysis (Section 5.5) and to confirm if the affected provision (linked to the deviation based on D-i-D OTs) will be restored or enhanced by the PSI.

This activity confirmed that the vast majority of the originally proposed PSIs are appropriate and suitable for implementation. In a few cases, additional resolutions (PSIs) have been proposed for more comprehensive consideration of the impact on the affected provision or deviation cause. The list of additional proposals is provided in Table 1 of Appendix F and the rationale for these additional resolutions is presented in Attachment 1 of the same appendix.

Detailed information corresponding to the verification of PSIs task is documented in Appendix F: Verification of Proposed Safety Improvements.

5.8 Implementation Screening of Proposed Safety Improvements

The objective for the screening of PSIs is to verify that the proposed solutions meet the safety improvement objective criteria, are reasonable from a nuclear safety perspective and can be implemented in the required timescales.

The PSIs were screened against the safety improvement objective criteria listed in Appendix G, which systematically categorised the PSIs into "types of improvement", the anticipated benefit of implementation both from a plant safety perspective and alignment to the organisational strategic objectives, and for their respective impact on reducing the severity of deviations on the level (s) of D-i-D, FSFs, and adverse events such as those resulting in radiation exposure etc. Refer to Section 3 of Appendix G for a comprehensive list.

An important conclusion drawn from this exercise relates to the PSIs associated with the deviations linked to LTO, however these PSIs will be scheduled in accordance with the LTO safety case IIP. These PSIs are listed in Section 4 of Appendix H.

The total number of safety improvements is the result of consolidating the PSI actions to address deviations and GIs during the screening of proposed improvements process. The outcome is a reduced number of PSIs because some PSIs address more than one deviation.

The process of screening PSIs for implementation is contained in Attachment 1 of Appendix G. This activity confirmed that all PSIs including PSIs linked to GIs, and those related to LTO, can be implemented within the required timescales commensurate with their nuclear safety significance.

Detailed information can be found in Appendix G: Implementation Screening of Proposed Safety Improvements.

5.9 Ranking of Proposed Safety Improvements

The objective of this task is to rank the PSIs based on overall safety significance of the deviation, taking into consideration engineering judgement, its impact on D-i-D and the FSF, as well as the assignment of an implementation date aligned with the PSI ranking.

PSIs related to NNR requirements receive an additional ranking criterion and are prioritised accordingly to ensure timely resolution of deviations impacting the current licensing basis, commensurate with the deviation grading.

The PSI ranking category, associated descriptions and proposed PSR resolution period are shown in Table 4 below.

Table 4: Summary of the ranking criteria categories for Proposed Safety Improvement actions

Category	Description	Proposed Resolution Period[1]
H1	• Deviations linked to LTO • Deviations graded High related to an NNR requirement	• LTO safety case commitments • 28 June 2027
H2	Deviations graded High with no associated NNR requirement	28 June 2027
M1	• Deviations graded Medium related to an NNR requirement • L1 PSI, but PSI prioritised due to results of any of the GA analyses	Between 5 years and the start of the 4th KNPS PSR
M2	• Deviations graded Medium with no associated NNR requirement • L2 PSI, but PSI prioritised due to results of any of the GA analyses	Between 5 years and the start of the 4th KNPS PSR
L1	• Deviations graded Low related to an NNR requirement • PSI for Drop graded deviation associated with an NNR requirement	Prior to the start of the 4th KNPS PSR
L2	Deviations graded Low with no associated NNR requirement	Prior to the start of the 4th KNPS PSR

Table 4 Note 1: *Proposed resolution period is aligned with IIP's 'Proposed completion date of implementation as per PSI ranking criteria' column. While the actual implementation date of the safety improvement is reflected in the IIP's 'Organisational proposed completion date' column.*

Safety improvements assigned to deviations graded as Drop have a negligible impact on nuclear safety. Therefore, safety improvements associated with Drop and are not associated with an NNR requirement will be tracked through the CAP and will not form part of the IIP but will form part of the final PSR report. This will ensure focus is maintained on H, M and L PSI actions in the IIP. The deviations graded as Drop have been assessed in all GA analyses.

The PSI ranking task yielded to eleven Screening of Proposed Improvements (SPIs) ranked as H1, one H2, seven M1, seven M2, 35 L1, 32 L2 and four SPIs associated with Drop deviations. The ranked SPI actions in categories H, M and L, are transferred to the next step of GA, the formulation of IIP, while those for drop graded deviations will be tracked through the Corrective Action Program (CAP) process.

The detailed explanation of how ranking is conducted, and the results are documented in Appendix H: Ranking of Proposed Safety Improvements.

5.10 Integrated Implementation Plan

The IIP is the culmination of the GA process and represents the safety improvement actions to be undertaken in support of the SCO case. The IIP represents the identified safety improvements required to enhance or maintain nuclear safety levels through a set of specific interventions.

The IIP is compiled utilising existing Koeberg processes (adapted to the PSR where necessary) and commitments related to:

- The existing Nuclear Portfolio Investment Plan containing existing capital expenditure projects.
- The existing LTO commitments agreed between the NNR and Eskom
- The PSR ranking of safety improvements (see Section 5.9 of this report) for the prioritisation and categorisation of the PSI actions

The review ensures organisational alignment in terms of the proposed resolutions and the timescales for discharging the work activities.

The list of PSI actions identified following the screening for proposed improvement process (Section 5.8) was rationalised down to 93 safety improvements for inclusion in the IIP. A large proportion of the improvement actions are related to the undertaking of further analytical (studies and analyses) and programmatic work (Programmes, procedures, or processes). Safety improvement actions and assigned due dates were reviewed and agreed upon by the manager responsible for implementing the safety improvement actions and endorsed by the NSRC.

The Eskom Chief Nuclear Officer endorsed the IIP for submission to the NNR. Progress on implementation of the IIP actions will be monitored through CAP and reported on a six-monthly basis to the KOU executives.

The first 5-year window of the IIP schedule for the completion of safety improvements ranked as H1 or H2, and not linked to LTO, ends on 28 June 2027, as indicated in Table 4. This 3rd PSR window ends when the 4th 10-yearly PSR is expected to start in 2029.

The development of the Koeberg IIP and the strategy for implementation is described in Appendix I-Integrated Implementation Plan.

5.11 Case of Suitability for Continued Operation

Regulatory guide RG-0027 (Ageing Management and Long-Term Operations of Nuclear Power Plants) [25] provides guidance on the content of the LTO safety case and a systematic approach to AM across various aspects including management systems, operations, design, organisational arrangements, etc. It also provides for the PSR to be used as an input to the LTO safety case license application. The purpose and objective of the SCO is to present the basis for the determination of Suitability for Continued Operations considering several inputs. The inputs for the SCO assessment were derived from:

- The outcomes of individual SF Reports assessing the current status of the plant against national and international requirements.
- Demonstrating that the fundamental safety objectives are met utilising the IAEA SF-1 FSPs [28] as criteria for the assessment.
- Assessment of cumulative effects arising from a holistic view of the deviations identified against the available provisions (preventive and mitigative measures) established through the application of D-i-D.
- An assessment of the collective impact of the deviations on the maintenance of plant FSFs
- An evaluation of deviations of interest because of their grading and impact on LTO.
- Impact of the PSR deviations on the DSA assumptions
- Impact of the PSR deviations on the PSA baseline risk
- Impact of deviations on Emergency Planning and Accident Management.

- Demonstration of the SCO of Koeberg based on the overall risk of plant, *with and without* safety improvements remaining at an acceptable level.

Specific consideration of the findings from SFs 1-5, 10 & 12 with respect to LTO, Safety Case Preparation Guide [18] and Safety Justification Preparation [19] were used to support the development of the justifications for SCO. Notable conclusions from the SCO are listed below:

- While the SFs identified 113 deviations which required timeous resolution, all the SF reviews concluded that it is safe to continue to operate. The overall nuclear safety performance of Koeberg is at an acceptable level (SF 8).
- The SFs that specifically covered aspects of LTO as directed by the PSR Basis document [1] also concluded that there are no challenges to LTO provided the deviations linked to LTO are resolved timely.
- The current design of the plant is adequate when assessed against the licensing basis and national and international standards. The plant design processes and procedures are adequately robust to maintain the ongoing integrity of plant design and safety case.
- The overall risk of the current plant, without any new safety improvements, remains acceptable as no new deviations were identified that required immediate justification for continued operations.
- The current licensing basis remains valid, and it is likely that Koeberg will continue to meet its licensing basis for the duration of LTO, with the implementation of the IIP.
- All deviations identified have suitable improvement actions and the timescales for their implementation are considered appropriate and are commensurate with their safety impact.

Detailed discussion on the SCO of Koeberg beyond the originally planned period of operations can be found in Appendix J-Suitability for Continued Operations.

6. Conclusions

The scope and objectives of the GA as defined in RG-0028 [26] have been demonstrated to be fulfilled using the methodology as detailed in the GA and IIP Methodology document [2]. The outcomes of the GA have been used to develop the Koeberg IIP and support the justifications for the SCO of Koeberg.

A total of 113 deviations were raised across 12 SFs, owing to a decade of evolving international standards and requirements with increasing demand for more rigorous assessment of DECs and external events which have contributed to a high proportion of these deviations that were linked to external events. This, together with the SSR that is currently being updated, requires Eskom to place particular emphasis and prioritisation on resolution of the deviations relating to (external) hazards.

The GA integrated the results of the individual SF reviews considering all 113 deviations, 14 strengths, 8 GIs into 93 safety improvements. The findings were consolidated, evaluated to determine the causes for deviations and assessed against the level(s) of D-i-D, FSFs and FSPs to understand the overall impact on nuclear safety. The assessments uncovered adverse impact on Levels 4A and 4B of the D-i-D model, a recurring issue relating to the tolerance for long-standing issues (GI-008) and the need to continue to ensure robustness of Core Cooling and Confinement of Radioactive Material capability. These findings were not judged significant to compromise Koeberg's aspirations to operate beyond the originally planned station life, provided that they are effectively resolved/actioned in the required timescales in accordance with the IIP. Overall, the analyses were judged to be both extensive and thorough, facilitated by collaborative working amongst the GA team and SMEs, as well as independent PSR/GA experts and numerous confirmatory steps to validate the results.

Resulting safety improvement actions were rationalised, ranked and scheduled to resolve all deviations and GIs identified. Improvement actions include upskilling of personnel, improving management oversight and business processes to allow the rapid implementation of mitigating actions. These safety improvements were used to develop the Koeberg IIP, providing a practicable means of addressing the GIs and deviations prior to the next PSR and/or LTO, commensurate with their nuclear safety significance. It is judged that the resolution of the GIs will result in a marked improvement in organisational capability to implement safety improvements on time.

Based on the analyses contained in the GA and the outcome of the SCO, it is judged that continued safe operation of KNPS including LTO, is supported with the implementation of the improvements in the IIP.

7. Acceptance

This document has been seen and accepted by:

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8. Revisions

Date	Rev.	Compiler	Remarks
October 2023	3	S Saban	To address NNR comments in letter K-28705-E. GI-006 and the appendices below were updated as a result of changes made in the SF-13 report: • Appendix A • Appendix H • Appendix I • Appendix J
May 2022	2	B Oaker	Update following NNR review comments from letter reference number k28352N. Updated the temporary unique identifier, 32-T-IPDK-001, with the permanent unique identifier, 331-608.
February 2022	1	L Ali-Miah	First revision of the GA and IIP report compiled as a result of KNPS 3rd PSR.

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10. Acknowledgements

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11. Appendices

Appendix A – PSR Consolidation Findings

Appendix B – Fundamental Safety Principles (FSP) Interface Analysis

Appendix C – Defence in Depth (D-i-D) and Fundamental Safety Functions (FSF) Analysis

Appendix D – Causal Analysis

Appendix E – Safety Significance Evaluation (SSE)

Appendix F – Verification of Proposed Safety Improvements (PSI)

Appendix G – Implementation Screening of Proposed Safety Improvements

Appendix H – Ranking of Proposed Improvements

Appendix I – Integrated Implementation Plan (IIP)

Appendix J – Suitability for Continued Operation (SCO)