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Executive Summary

This interim report documents the safety assessment of the ageing management aspects performed at Koeberg Nuclear Power Station (KNPS) in order to achieve the regulatory ageing management requirements and provide assurance for the safe long term operation (LTO). The content of the interim report describes the requirements of the assessment, the processes followed to perform the assessment and the assessment results achieved to date.

The SALTO Ageing Management Assessment achieved the following outcomes:

- The SALTO scope setting review of 209 774 systems, structures and components (SSC) identified 84 097 components and 4 433 cables requiring an ageing management review for LTO.
- The ageing management evaluation (AME), including the ageing management programme (AMP) review and ageing management review (AMR), identified 18 IGALL ageing management programmes required at KNPS and upgrades required of existing KNPS plant programmes in preparation for LTO.
- The validation of time limited ageing analyses (TLAA) identified 111 TLAAs for KNPS, of which 11 still need to be validated for LTO.

While the Koeberg SALTO Ageing Management Assessment identified gaps to be resolved in the current ageing management programme at KNPS, the assessment did not identify any ageing concerns that would prevent the plant from safely operating into LTO

The final SALTO Ageing Management Assessment Report will provide the results of the actions to ensure ageing management assurance into LTO.

1 Introduction

Long term operation (LTO) of a nuclear power plant is defined as operation beyond an established time frame set forth by licence terms, design bases, standards, or regulations that have been justified by means of a safety assessment with extensive consideration given to life-limiting age-related degradation effects of the plants SSCs. Eskom intends providing this justification to the National Nuclear Regulator (NNR) to attain the required authorisation to operate Koeberg Nuclear Power Station (KNPS) beyond its initial design life assumptions of 40 years, to an anticipated life of 60 years. This endeavour is achieved through a number of overlapping interventions.

One of these interventions is the ageing management safety assessment for LTO. The focus of the assessment is to review the completeness and comprehensiveness of existing ageing management practices and processes against national regulations and international standards and guidance. The assessment is performed as a project under the Koeberg SALTO Assessment Project (Project Number 08016) and is the subject of this report.

This interim report provides an overview of the process followed by the Koeberg SALTO Assessment Project to perform the assessment and the results obtained. The results are used to inform further actions required to improve the ageing management processes at KNPS in preparation for the demonstration that KNPS is prepared for LTO up to 60 years of operation.

This report will be updated on conclusion of the actions that are currently being executed within the Koeberg SALTO Assessment Project to produce the final SALTO Ageing Management Assessment Report.

2 Supporting Clauses

2.1 Scope of Interim Report

The scope of this interim report covers the background to ageing management at KNPS, the performance of the SALTO ageing management assessment (including scope setting, AME and TLAA validation for LTO as represented in Figure 2-1: SALTO Ageing Management Assessment Overview) and provides the SALTO ageing management assessment results.

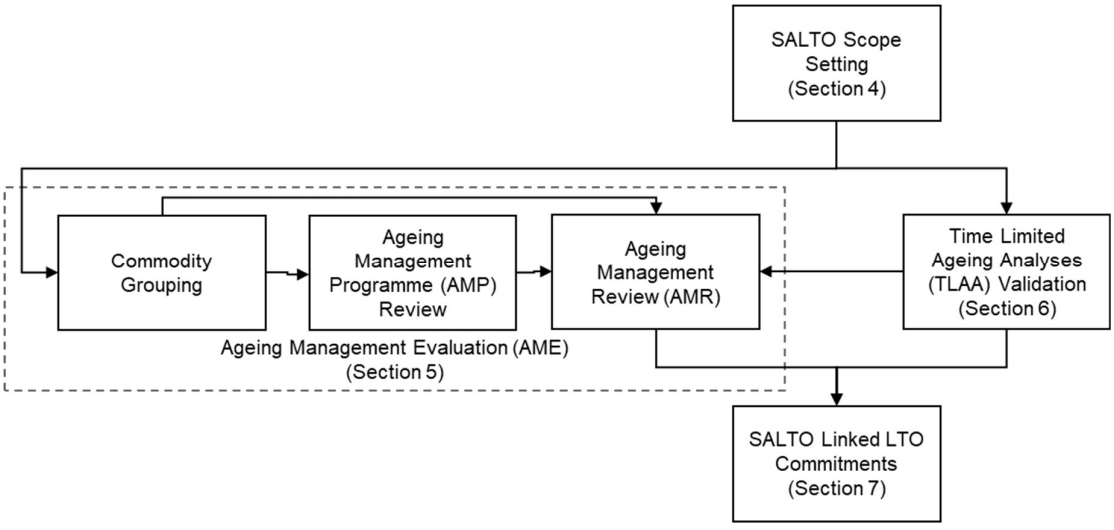

Figure 2-1: SALTO Ageing Management Assessment Overview

The report also provides an overview of the items currently planned for implementation as part of the LTO preparation.

NOTE: The SALTO ageing management assessment is an integral part of the ageing management requirements prescribed in RG-0027, “Interim Regulatory Guide - Ageing Management and Long Term Operations of Nuclear power Plants” [7]. Figure A-1: LTO Requirements and Conceptual Framework in Appendix A provides the broader context of LTO requirements for KNPS and places the contents of this report within this broader context.

2.2 Purpose of Interim Report

The purpose of this document is to meet the commitment agreed in 08016-S-LIC, “SALTO Project Licensing Strategy” [1],

This document provides the process and results of the SALTO ageing management assessment that was performed at KNPS. The process and results presented provides ageing management assurance for the continued safe operation of KNPS into LTO.

2.3 Structure of the Interim Report

This section defines the structure of the interim report and describes the information provided in each section. The report structure is as follows:

- Section 1 (Introduction) introduces the report.
- Section 2 (Supporting clauses) provides supporting clauses for the document, including the document scope and purpose, any normative/informative references, relevant definitions and abbreviations. It also lists the supporting documents for this report.
- Section 3 (Background) provides the historical evolution of the ageing management concepts and practices at KNPS. The Koeberg Safety Aspects of Long Term Operation (SALTO) Assessment Project is introduced and an overview of the SALTO ageing management assessment is provided.
- Section 4 (SALTO Scope Setting) provides the requirements for the scoping exercise to identify all the SSCs important to safety for which an ageing assessment must be performed. The classification system established at KNPS is defined and it is demonstrated how these classifications achieve the scoping requirements for the Eskom scoping methodology. The scope setting and verification process is described in this section. The databases of the results are listed and described in this section. The section concludes with organisational responsibility of managing the in-scope list of SSCs following the assessment.
- Section 5 (Ageing Management Evaluation) provides the background and requirements for the performance of the ageing management assessment of all in-scope SSCs. The Eskom methodology describes how the requirements are achieved through the AME, which covers the commodity grouping, the AMP review and the equipment AMR. The description of the AME implementation process is provided, along with the results and recommendations. The organisational responsibilities beyond the assessment are also described.
- Section 6 (Time Limited Ageing Analysis) provides the requirements for the identification and validation of TLAAs to confirm the plant design for an operational life of 60 years. The Eskom methodology for meeting the requirements and the implementation processes are provided.

The section concludes with organisational responsibility of managing TLAAs beyond the assessment.

- Section 7 (SALTO Ageing Management Commitments) is a placeholder for the ageing management commitments that will be provided in the final SALTO Ageing Management Assessment Report scheduled to be submitted in 2022.
- Section 8 (Conclusion) concludes that the methodologies and processes implemented under the ageing management assessment meet the assessment requirements and that all required improvements, changes and updates identified through the assessment have been actioned.

2.4 Normative/Informative References

2.4.1 Normative

[1] 08016-S-LIC: SALTO Project Licensing Strategy

[2] 240-125122792: Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses

[3] 240-125839632: Koeberg Long Term Operating (LTO) Scoping Methodology

[4] 240-128716554: Koeberg Safety Aspects of Long Term Operation (SALTO) Input Sources.

[5] IAEA SRS 82: Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)

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

[7] RG-0027: Interim Regulatory Guide-Ageing Management and Long Term Operations of Nuclear Power Plants.

2.4.2 Informative

[8] 08016-S-PMP: SALTO Project Management Plan

[9] 08016.ODCOF.049: Position on Current Conditions of SSCs for SALTO

[10] 08106.ROD.012: SALTO Non-Safety Affecting Safety (NSAS) equipment scope verification

[11] 08016.ROD.017: Adoption of COMSY Database for Ageing Management at KNPS

[12] 08016.ROD.018; Equipment Qualification Time limited Ageing Analysis

[13] 08016.ROD.021: Review of the Interim Regulatory Guide on Ageing Management And Long Term Operations of Nuclear Power Plants (RG-0027 Rev 0) against the current Ageing Management Programmes and Processes

[14] 08016.ROD.022: Review of the Electrical, Instrumentation and Control Ageing Management Evaluation (AME) Report L1124-GN-RPT-025 and Decisions by Eskom

[15] 08016.ROD.023: Review of the Mechanical Ageing Management Evaluation (AME) Report L1124-GN-RPT-023 and Decisions by Eskom.

[16] 08016.ROD.024: Scope stemming from a review of the Civil AME Report L1124-GN-RPT-024

[17] 08016.ROD.025: Comparison of the existing Plant Programmes with IAEA IGALL-AMP Requirements

[18] 240-8929359: (KSA-010) Nuclear Safety, Seismic, Environmental, Quality and Importance Classification

[19] 240-101650256: Ageing Management Matrix

[20] 240-102103854: Self-Evaluation 88540: Review of the Koeberg Plant Programmes to Assess Alignment with the IAEA Ageing Management Programmes

[21] 240-106374366: SALTO Work Breakdown Structure (WBS) and Initial SALTO Project Scope Report

[22] 240-106374672: SE 35244: Koeberg Pre-SALTO Self-Assessment Report

[23] 240-130611911: Environmental Qualification Requirements for Safety-Related Component Located in Mild Environments

[24] 240-134895976: Koeberg Long Term Operation - Licensing

[25] 240-143604773: Safety Evaluation Process

[26] 240-149139512: Standard: Ageing Management Requirements for Koeberg Nuclear Power Station

[27] 240-150483693: Ageing Management Programmes List

[28] 240-153477196: Technical Requirement Specification for Time Limited Ageing Analyses

[29] 240-153544432: TLAA Report Structure

[30] 240-153945942: User Requirement Specification for Management of SALTO Anomalies Evaluation and Rectification

[31] 240-154273661: User Requirement Specification for the Development of Ageing Management Programmes required for Koeberg Nuclear Power Station

[32] 240-157225915: User Requirement Specification for the Updates to Existing Ageing Management Programmes

[33] 331-93: Guide for Classification of Plant Components, Structures, and Parts

[34] 331-148: Programme Engineers' Guide

[35] 331-219: Environmental Qualification Maintenance Manual

[36] 331-275: Process for the Development and Control of Ageing Management Matrix

[37] 331-94: (KLA-001) Importance Category Classification Listing

[38] ANSI 18.2: American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurised Water Reactor Plants

[39] D02-ARV-01-138-106: (L1124-GN-RPT-031) Reactor Coolant Pumps TL5 and TL6 Activities

[40] D02-ARV-01-142-242: (L1124-GN-RPT-032) RPV Internals TL5 and TL6 Activities

[41] D02-ARV-01-143-003: (L1124-GN-RPT-037) CRDM TL5 and TL6 Activities

[42] D02-ARV-01-144-513: (L1124-GN-RPT-033) Reactor Pressure Vessel TL5 and TL6 Activities

[43] D02-ARV-01-144-514: (L1124-GN-RPT-034) Pressuriser TL5 and TL6 Activities

[44] D02-ARV-01-144-861: (L1124-GN-RPT-038) Steam Generators TL5 and TL6 Activities

[45] D02-ARV-01-145-030: (L1124-GN-RPT-035) Main Coolant and Surge Lines TL5 and TL6 Activities

[46] D02-ARV-01-146-690: L1124-GN-RPT-036) In-Core Instrumentation TL5 and TL6 Activities

[47] D02-ARV-01-149-074: (L1124-GN-RPT-046) Auxiliary and Secondary Lines TL5 and TL6 Activities

[48] EERT-11-015: Seismic Hazard Report

[49] EERT-11-019: The Explosion Hazard Report

[50] IEEE 323: Standard for Qualifying Class 1E Equipment for Nuclear Power Generating Stations

[51] JN195/NCI/ESKOM/J2/365: Koeberg Nuclear Power Station Internal Flooding Analysis

[52] JN377/AMEC/NCI/TR/6393: Seismic Event Fall-down Hazard Report

[53] K08016VAR: Koeberg Plant Life Extension

[54] KBA0022E02021: List of Components to be qualified to Post-Accident Containment Conditions

[55] L1124-CV-RPT-001: New Civil Components Report

[56] L1124-DE-GDL-001: SALTO Scoping and Verification Guide

[57] L1124-DE-GDL-002: SALTO Augmented Scope – Non-DBA Equipment Selection Criteria

[58] L1124-DE-GDL-004: Engineered Master Table Guide

[59] L1124-DE-MNL-001: SALTO Overall Concept Manual

[60] L1124-DE-PCD-001: SALTO Scoping – SSC Verification Control Procedure

[61] L1124-DE-PCD-002: SALTO Screening/Commodity Grouping Control Procedure

[62] L1124-DE-PCD-003: SALTO AME Control Procedure

[63] L1124-DE-PCD-004: Time Limited Ageing Analysis Evaluation Control Procedure

[64] L1124-DE-RPT-001: Scoping Data Verification Method

[65] L1124-DE-RPT-002: SALTO Commodity Grouping Methodology

[66] L1124-DE-RPT-003: Ageing Management Evaluation Methodology

[67] L1124-DE-RPT-004: Time Limited Ageing Analysis Evaluation Methodology

[68] L1124-EL-LIS-001: List of in-scope items for SALTO EQ TLAA

[69] L1124-EL-LIS-002: SALTO TLAA Result List

[70] L1124-EL-LIS-003: Cable List

[71] L1124-EL-LIS-004: EQ Cable List

[72] L1124-GN-LIS-001: Classification Master Table

[73] L1124-GN-LIS-002: The Engineered Master Table

[74] L1124-GN-LIS-006A: IGALL Commodity Group Matrix Linking Table – Commodity Group

[75] L1124-GN-LIS-006B: Ageing Management Matrix Linking Table – Commodity Group

[76] L1124-GN-LIS-009A: Lis of IGALL- AMP Task Requirements-AMP Mechanical

[77] L1124-GN-LIS-009B: List of IGALL-AMP Task Requirements-AMP Electrical

[78] L1124-GN-LIS-009C: List of IGALL-AMP Task Requirements-AMP Civil

[79] L1124-GN-LIS-010: Comprehensive List of Koeberg TLAAs

[80] L1124-GN-LIS-016: SALTO Room Master and Environmental Zones List

[81] L1124-GN-LIS-017: Component Failure List

[82] L1124-GN-LIS-020: Comprehensive list of all SSCs reviewed for SALTO Requirements

[83] L1124-GN-LIS-027: AMR data tables for commodity groups

[84] L1124-GN-RPT-002: SALTO Koeberg Classification Master Table

[85] L1124-GN-RPT-018: Time Limited Ageing Analysis Based on Initial Environmental Qualification

[86] L1124-GN-RPT-019: Validity of KNPS Containment Civil TLAA 301

[87] L1124-GN-RPT-020: Validity of Polar Crane

[88] L1124-GN-RPT-022: Report on Verified List of Existing Koeberg Time limited Ageing Analyses

[89] L1124-GN-RPT-023: AME Degradation Assessment Results Mechanical

[90] L1124-GN-RPT-024: AME Degradation Assessment Results Civil

[91] L1124-GN-RPT-025: AME Degradation Assessment Results Electrical

[92] L1124-GN-RPT-027: Report on Operational Experience for the Review of Existing Koeberg TLAAs

[93] L1124-GN-RPT-030: Comparison Report Existing KNPS Plant Programmes with IGALL-AMP Requirements

[94] L1124-GN-RPT-039: Component Failure Report

[95] L1124-GN-RPT-040: SALTO Room Master and Environmental Zones Report

[96] L1124-GN-RPT-041: SALTO Scoping Report

[97] L1124-GN-RPT-044: Containment Liner –SALTO Civil Assessment Report TLAA 303

[98] L1124-GN-RPT-045: Koeberg Containment Settlement – SALTO Civil Assessment Report TLAA 304

[99] L1124-PM-PLN-004: SALTO Consortium Documentation Management Plan

[100] RD-0034: Quality and Safety Management Requirements for Nuclear Installations

2.5 Definitions

2.5.1 Ageing Management: Engineering, operations, and/or maintenance actions that manages ageing effects within acceptable limits such that the intended functions will be maintained consistent with the current licensing basis.

2.5.2 Ageing Management Evaluation[1]: A process of performing an ageing assessment for all SALTO in-scope SSCs, including commodity grouping process, ageing management programme (AMP) review and the performance of ageing management review (AMR).

2.5.3 Design Basis Events: Postulated events used in the design to establish the acceptable performance requirements for the structures, systems, and components.

2.5.4 Equipment Qualification: Generation and maintenance of evidence to ensure that equipment will operate on demand, under specified service conditions, to meet system performance requirements.

[1] Note that the Consortium methodology and procedure documents define the term Ageing Management Evaluation (AME) to exclude commodity grouping and only consider the AMP review and AMR.

2.5.5 Importance Category: Importance category refers to the importance of functions, processes, services, software and SSCs, as they relate to nuclear safety and plant availability.

2.5.5 Non-Safety Affecting Safety (NSAS): SSCs that have not been designed and constructed with nuclear safety in mind whose failure may prevent SSCs important to nuclear safety from fulfilling their intended function.

2.5.6 Pericles Database: A database for the electrical cables, and control and instrumentation cables.

2.5.7 Qualified Condition: Condition of equipment, prior to the start of a design basis event, for which the equipment was demonstrated to meet the design requirements for the specified service conditions. These include certain post-accident cooling and monitoring systems that are expected to remain operational.

2.5.8 Qualified Life: The duration for which equipment has been demonstrated, through testing, analysis, or experience, to be capable of functioning within acceptance criteria during specified operating conditions while retaining the ability to perform its safety functions in a design basis accident.

2.5.9 Operating Organisation: Any organisation or person applying for authorisation or authorised to operate an authorised facility or to conduct an authorised activity and responsible for its safety.

2.5.10 Validation of Time Limited Ageing Analyses: Treatment of those plant specific safety analyses for which time limited assumptions were included in the original calculations to determine the design life of plant-specific SSCs. Validation is the exercise to confirm whether the existing TLAA is valid for LTO in its current state. If not, a re-analysis of the TLAA is required.

2.5.11 Time Limited Ageing Analysis (TLAA): Plant-specific safety analysis in the plant design basis that considers time and ageing of the SSCs within the scope of ageing management.

2.6 Abbreviations

Abbreviation	Explanation
AME	Ageing Management Evaluation
AMM	Ageing Management Matrix
AMP	Ageing Management Programme
AMR	Ageing Management Review
ANSI	American National Standards Institute
AR	Availability-Related
ASME	American Society of Mechanical Engineers
BACC	Boric Acid Corrosion Control
BNI	Balance of Nuclear Island
CAMP	Cable Ageing Management Programme
COMSY	Condition-Oriented Ageing Management System
CRDM	Control Rod Drive Mechanism
CSR	Critically Safety Related
DCRF	Document Control Resolution Form
DEC	Design Extension Conditions

Abbreviation	Explanation
DER	Design Extension Related
DPSA	Deterministic and Probabilistic Safety Analysis
DSE	System Design Document
EAF	Environmentally Assisted Fatigue
EDF	Électricité de France
EERT	External Events Review Team
EOP	Emergency Operating Procedures
EPRI	Electric Power Research Institute
EQ	Environmental Qualification
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IGALL	International Generic Ageing Lessons Learned
IQ Review	Module of Equipment Reliability Software
ISI	In-Service Inspection
ISIPRM	In-Service Inspection Programme
IST	In-Service Test
KNPS	Koeberg Nuclear Power Station
LOCA	Loss of Coolant Accident
LOPP	Life of Plant Plan
LS	Linked to Safety
LTAM	Long Term Asset Management
LV	Low Voltage
MV	Medium Voltage
NEV	Non-Environmental
NNR	National Nuclear Regulator
NPP	Nuclear Power Plant
NSA	Non-Safety or Availability Related
NSAS	Non-Safety Affecting Safety
NSF	No Safety Function
NSSS	Nuclear Steam Supply System
OE	Operating Experience
ORT	Operation at Reduced Temperature
OTS	Operating Technical Specifications
PER	Pressure Equipment Regulation
PLCM	Project Life Cycle Management
PLEX	Plant Life Extension
PSA	Probabilistic Safety Assessment
PSR	Periodic Safety Review

Abbreviation	Explanation
PWR	Pressurised Water Reactor
PWSCC	Primary Water Stress Corrosion Cracking
QA	Quality Assurance
QL	Qualified Life
QM	Quality Management
QMS	Quality Management System
ROD	Record of Decision
RPV	Reactor Pressure Vessel
SALTO	Safety Aspects of Long Term Operation
SAMG	Severe Accident Mitigation Guidelines
SAP	Systems, Applications, and Products (in Data Processing)
SAR	Safety Analysis Report
SGR	Steam Generator Replacement
SMOC	Salto Management Oversight Committee
SR	Safety-Related
SRSM	Safety-Related Surveillance Manual
SSC	System, Structure and Component
SSE	Safe Shut-Down Earthquake
TLAA	Time Limited Ageing Analysis
TPU	Thermal Power Uprate
TRM	Technical Review Meeting

2.7 Related/Supporting Documents

A supporting document suite intended for reference is provided in Appendix E. The document suite is split into documents related to the Koeberg SALTO Assessment Project oversight and LTO context in section E.1, and documents related to the ageing management assessment in E.2.

Under the SALTO ageing management assessment documents in section E.2, the document suite is further separated into the following key sections:

- Methodology documents (section E.2.1): These are Eskom documents defining the SALTO ageing management assessment methodologies to achieving the regulatory requirements.
- Process documents (section E.2.2): These are the process, method and governance documents used for the execution of the SALTO ageing management assessment.
- Process output documents (section E.2.3): These are the output documents from the SALTO ageing management assessment that contain the assessment results, gaps identified and recommendations for addressing the identified gaps.
- Eskom records of decision and close out documents (section E.2.4): These are the Eskom decision documents following the review of the process output recommendations where the resulting actions are documented and raised.

3 Background

This section provides the background to the evolution of ageing management at KNPS. It also provides background to the Koeberg SALTO Assessment Project and an overview of the SALTO ageing management assessment process.

NOTE: The Koeberg SALTO Assessment Project was established in support of the KNPS LTO initiative. For context to the background of LTO at KNPS, refer to Appendix A.

3.1 Evolution of Ageing Management at KNPS

Since the beginning of commercial operations, KNPS has maintained close ties with the Original Equipment Manufacturer (OEM) and Électricité de France (EDF), to gain information regarding ageing concerns on the EDF CPY reference fleet. When deemed necessary, AMPs were developed and implemented in accordance with international guidance. Some of the programmes were required due to regulation and others for asset management purposes.

Historically, the KNPS arrangements for ageing managements were aligned with the Plant Condition Management requirements in Annexure E of the Koeberg License Basis Manual (KLBM). The ageing management activities consisted of general asset management processes and programmes (such as In-Service Inspection [ISI], In-Service Testing [IST], Reactor Vessel Radiation Embrittlement Surveillance and Planned Maintenance) and augmented programmes such as Steam Generators, Flow Assisted Corrosion, and Boric Acid Corrosion.

During the second Safety Reassessment (SRA II) in 2011, a description of all the ageing management mechanisms used at KNPS was documented. It was noted that KNPS should have a comprehensive ageing matrix that provides confidence that all potential equipment degradations have been considered for all safety equipment.

KNPS subsequently followed the international trend of considering all potential ageing degradation associated with equipment by developing document 240-101650256, ‘Ageing Management Matrix’ [18]. KNPS adopted the EDF ageing matrix to derive a matrix that contains a list of components and the ageing mechanisms applicable to the components as defined in 331-275, ‘Process for the Development and Control of Ageing Management at Koeberg Operating Unit’ [36]. The ageing mechanisms and SSC combinations considered in the existing Koeberg Ageing Management Matrix (AMM) are based on EDF’s AMM, which was added to, updated and made Koeberg-specific.

A review by the Electric Power Research Institute (EPRI) in July 2011 of all issues documented in the EPRI Issue Management Tables versus what are being managed at KNPS, resulted in the identification of additional issues that were then treated via the existing KNPS processes.

Ongoing updates of the Koeberg AMM have continued to date, based on local and international Operating Experience (OE). The SALTO ageing management assessment extends on this practice by comparing the Koeberg AMM against the International Atomic Energy Agency (IAEA) International Generic Ageing Lessons Learned (IGALL) guidance in order to provide assurance that the Koeberg AMM is comprehensive and complete.

3.2 Koeberg SALTO Assessment Project

The Koeberg SALTO Assessment Project was initiated to manage the preparation work for the SALTO ageing management assessment. The project scope of work is based on the requirements

in the IAEA's SALTO guidance as well as gaps identified during the self-assessments[2] performed in preparation for the first IAEA pre-SALTO peer review in September 2015.

Some project activities needed further clarification before fully developing the complete scope of work for the ageing assessment. Therefore, the project, in accordance with the PLCM project structure, was developed as follows:

- Pre-project scope: the initial project work scope was defined through the pre-SALTO self-assessments and first IAEA pre-SALTO peer review and documented in 240-106374366, 'SALTO Project Scope and Work Breakdown Structure (WBS) Report' [21].
- Definition phase scope: during this project phase, potential gaps in the KNPS ageing management programme were identified. The most significant item of work under this phase was the execution of the once-off SALTO ageing management assessment. The ageing assessment compared the KNPS ageing management process to the IAEA IGALL expectations to verify the comprehensiveness and completeness of the KNPS processes. The objective of this comparison was to clearly define shortfalls to be addressed. The outcomes of the assessments performed in this phase of the project are the focus of this interim report.
- Execution phase scope: during this phase of the project, the ageing management gaps identified through the SALTO ageing management assessment are addressed in preparation for LTO. In addition, the ageing management activities that will be executed during the LTO period are defined and scheduled.

While some of the above-mentioned work was performed within the project as once-off initiatives, many of the output deliverables were improvements to existing plant processes and systems with organisational line group ownership. Therefore, the project had two approaches to executing the work scope to achieve the required output deliverables.

- The project executed once-off initiatives (such as the SALTO scope setting, AME and TLAA validation activities described in this document) with contracted support. Under the definition phase, this scope of work was managed and executed within the project with the support of a contract with a Consortium consisting of Framatome (the KNPS main Nuclear Steam Supply System [NSSS] OEM) and Lesedi NS (referred to in this report as the "Consortium").
- Actions for plant processes and system improvements were given to the organisational line groups to implement and address the gaps identified in the assessments. To control the scope of work being performed in the organisational line groups, the line group actions linked to the project were loaded on the DevonWay action tracking system for each line group.

The Koeberg SALTO Assessment Project is managed in accordance with 08016-S-PMP, 'SALTO Project Management Plan' [8]

Even though the quality assurance aspects of the Koeberg SALTO Ageing Management Assessment are mentioned throughout this report, a consolidated section relating to quality assurance for the Koeberg SALTO Assessment Project will be provided in the final SALTO Ageing Management Assessment Report.

The next section presents an overview of the SALTO ageing management assessment process.

[2] The self-assessment results are documented in 240-106374672, 'SE 35244: Koeberg Pre-SALTO Self-Assessment Report' [22] and in 240-102103854, 'Self-Evaluation 85540: Review of Koeberg Plant Programmes to Assess Alignment with the IAEA Ageing Management Programmes' [20].

3.3 SALTO Ageing Management Assessment Process Overview

The SALTO ageing management assessment process was developed to provide a comprehensive verification of the adequacy of KNPS ageing management processes for LTO. It was initially adopted from the IAEA SALTO process, as described in their Specific Safety Guide, SSG-48, 'Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants' [10], and is supported by the IAEA IGALL report, SRS 82, 'International Generic Ageing Lessons Learned' [5]. The process was adjusted to be specific for KNPS and to meet the regulatory requirements in accordance with RG-0027 [7]. The process has three main steps (scope setting, ageing management evaluation [AME] and TLAA validation) described in two Eskom methodology documents listed below:

- 240-125839632, 'Koeberg Safety Aspects of Long Term Operating (SALTO) Scoping Methodology' [3].
- 240-125122792, 'Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses' [2].

Applying the methodologies above, the Consortium established four implementation processes governed by independent method statements and procedures as listed below:

- Scope Setting and Verification:
  - Methodology - L1124-DE-RPT-001, 'Scoping Data Verification Method' [64];
  - Procedure - L1124-DE-PCD-001, 'SALTO Scoping/SSC Verification Control Procedure' [60].
- Commodity Grouping:
  - Methodology- L1124-DE-RPT-002,'SALTO Commodity Grouping Methodology' [65];
  - Procedure - L1124-DE-PCD-002, 'SALTO Screening/Commodity Grouping Control Procedure' [61].
- Ageing Management Evaluation[3]:
  - Methodology - L1124-DE-RPT-003, 'Ageing Management Evaluation Methodology' [66]
  - Procedure - L1124-DE-PCD-003, 'SALTO AME Control Procedure' [62].
- Time Limited Ageing Analysis:
  - Methodology – L1124-DE-RPT-004, 'Time Limited Ageing Analysis Evaluation Methodology' [67];
  - Procedure – L1124-DE-PCD-004, 'Time Limited Ageing Analysis Evaluation Control Procedure' [63].

[3] The Consortium definition of Ageing Management Evaluation excludes commodity grouping and only caters for AMP review and the AMR. Note that this differs from the definition used in the Eskom references and this document.

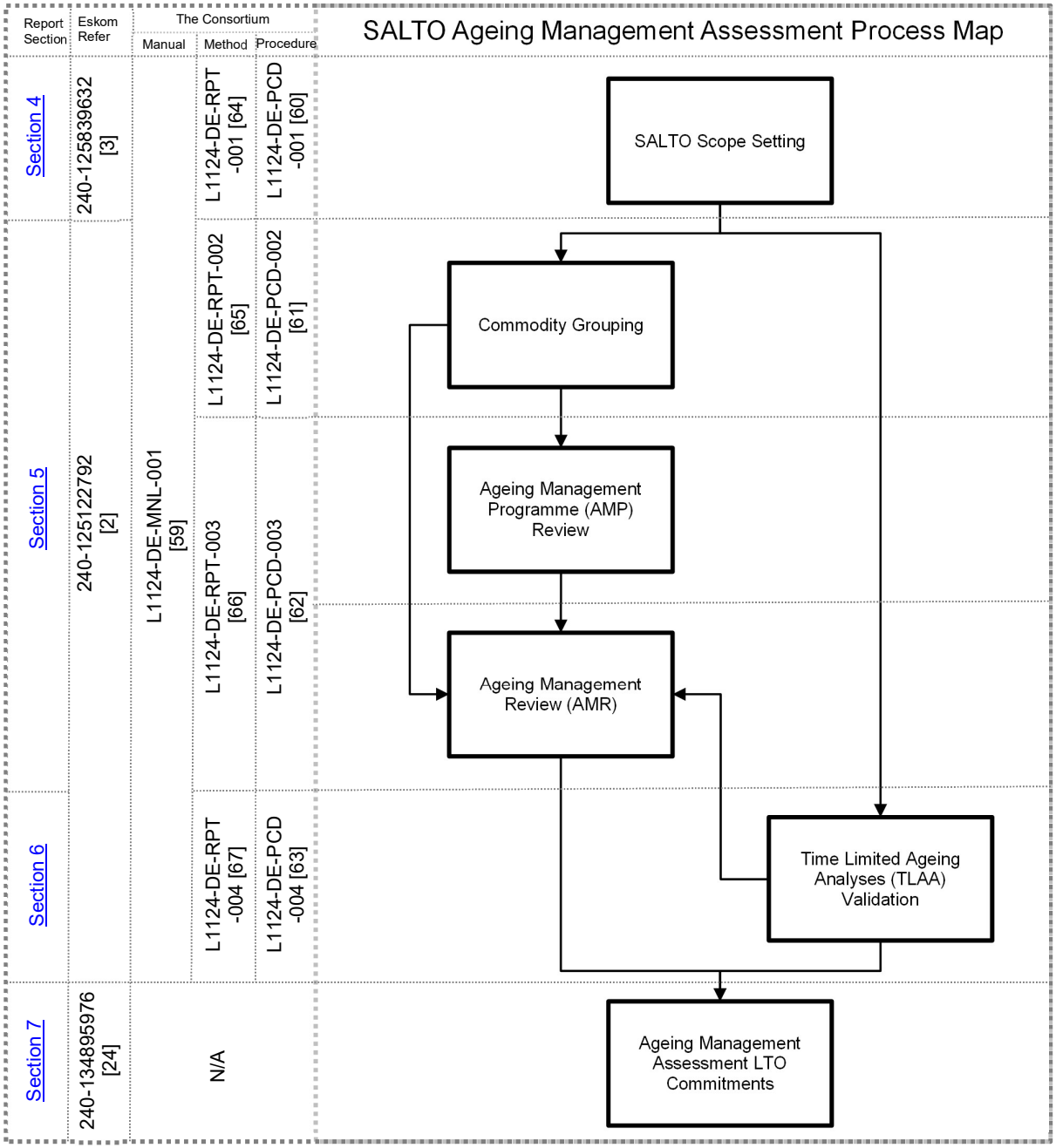

Figure 3-1: SALTO Ageing Management Assessment Process Map

The mapping of the assessment process to the interim report sections, Eskom and Consortium governance documents is provided in Figure 3-1: SALTO Ageing Management Assessment Process Map. All Consortium governance documents, procedures and output deliverables were technically reviewed and accepted by Eskom via contractual correspondence. The documents retain the Consortium numbering.

The iterative nature of the ageing assessment made it more effective for the Consortium to perform the assessment processes in parallel rather than sequentially. L1124-DE-MNL-001, 'Overall SALTO Concept Manual' [59] provides an overview of the processes followed and the quality steps taken throughout the assessment.

In the next three sections (4, 5 and 6) the main steps of the process will be discussed. The sections include the requirements, methods, process and outputs of the process steps as illustrated in Figure 3-1: SALTO Ageing Management Assessment Process Map.

4 SALTO Scope Setting

The first step in the SALTO ageing management assessment is to determine the scope of SSCs important to nuclear safety that require an AME. This section provides the SALTO scope setting approach implemented at KNPS.

4.1 Background

Internationally, the scope setting approach for ageing management and LTO is defined by the utility to meet the requirements established by the regulatory body. Therefore, the process can vary from utility to utility. KNPS has established and maintained an actively managed safety classification system that aligns with the requirements for identifying SSCs that require to an AME. KNPS utilises this unique classification system to identify the required SALTO scope.

This section provides the background to the historic scoping of ageing management at KNPS and the established KNPS classification system.

4.1.1 Background to Ageing Management Scope Setting at KNPS

Historically, the identification of scope for ageing management at KNPS was informed by the various requirements of KNPS's safety-related programmes. Each programme had its own scope of SSCs to which the programmes were applied. The individual programme scope of applicable SSCs was comprehensive in accordance with the specific programme requirements. Therefore, multiple KNPS equipment information sources exist for specific applications/programmes. Examples of such sources include: SAP; IQ Review (for preventative maintenance strategies); the importance classification listing (expanded later); ISI and IST list of equipment; and the Safety-Related Surveillance Manual (SRSM) lists for OTS equipment, and so forth. Each list was created for a specific purpose and maintained appropriately to achieve its programmatic needs to maintain plant safety. No integrated list of all safety related plant SSCs indicating which programmes apply to the SSCs previously existed.

Between 2008 and 2011, KNPS undertook its second PSR (also referred to as SRA II). Relating to ageing management, the major finding from SRA II was the lack of a comprehensive ageing management matrix (AMM). As a result, KNPS adapted the EDF AMM for the CPY reference fleet to be KNPS specific. The Koeberg AMM, 240-101650256, 'The Ageing Management Matrix' [18] is updated regularly and used for managing ageing at KNPS; and it will be updated with the scoping results following the completion of the scoping and AME activities.

4.1.2 Classification System Background

This section provides a general background of the classification system established at KNPS, which forms the basis of the SALTO scope setting process.

4.1.2.1 Establishment of Importance Categories and Importance Category Listing

Following plant commissioning, the original safety classes, which the design and manufacture of plant SSCs were based on were inadequate for defining the levels of control to be applied to operational plant processes when dealing with the equipment. This deficiency led to the establishment of 'Importance Categories' at KNPS and the related importance classification category

listing. Following a number of developments, KLA-001 Importance Category Listing was established and accepted by the NNR in 2006.

KLA-001 has subsequently been renumbered to 331-94, 'Importance Category Classification Listing' [37].

4.1.2.2 KNPS Classifications Overview

This section provides an overview of the classification systems used at KNPS. The classification standard, documented in 240-8929359, 'Nuclear Safety, Seismic, Environmental, Quality and Importance Classification' (previously KSA-010) [18], establishes the classifications used at KNPS. These are expanded below with short descriptions provided. Guidance for classifications is provided in 331-93 'Guide for Classification of Plant Components, Structures, and Parts' [33].

4.1.2.2.1 Design Safety Classes

The design safety classification is in accordance with the adopted ANSI 18.2, 'American National Standard Nuclear Safety Criteria for the Design of Stationary Pressurised Water Reactor Plants' [38]. These nuclear safety classes are the basis for seismic, environmental and safety management system levels classification. The following safety classes are applicable at KNPS:

- Mechanical classes - 1, 2, 3, Linked to Safety (LS), and
- No Safety Function (NSF); and Electrical classes - 1E and NSF.

4.1.2.2.2 Importance Categories

In addition to the design safety classifications stemming from design standards, the KNPS importance category is a classification that defines the nuclear safety importance of functions, systems, processes, components, structures, services, and software. It also provides for boundaries/interfaces between important-to-safety and not-important-to-safety functions.

The importance categories are defined as follows:

- Critically Safety Related (CSR):

  A category for components, systems, functions, structures, services and processes where the function is necessary to prevent or mitigate the consequences of a nuclear accident or which, by its failure, will directly result in a breach of the reactor coolant system pressure boundary. CSR is assigned to SSCs that either:

  - are designed to safety class 1 criteria;
  - actively perform a safeguard function; or
  - actively reduce the severity of core damage.

- Safety Related (SR):

  A category for components, systems, functions, structures, services, and processes other than those defined as CSR, or which, by its failure, has a significant impact on overall nuclear risk. SR is assigned to SSCs that either:

  - are designed to safety class 2, 3 or 1E criteria;
  - perform a safety function; or

- actively support a safety function.

Also consider the components required for the following or related functions:

- Meteorological monitoring components used to assess potential dispersion of radioactive materials from the plant.
- Components subject to fire protection requirements necessary to protect areas where CSR and SR equipment is located.
- Post-accident monitoring equipment and software.
- Components required for radioactive management that are subject to regulatory requirements.
- Components required to handle and store new, or cool spent fuel.
- Components on the environmental qualification (EQ) list.
- Components essential for OTS requirements.
- Components required for Emergency Operating Procedures.

- Design Extension Related (DER):

  A category assigned to systems, functions, components, structures, software, services or processes, not designated CSR or SR, that are designed for or required for the prevention or mitigation of DEC (that is, exceeding the original design basis). DER requires similar levels of maintenance and availability as those items with an importance category of CSR or SR, to ensure reliability and availability.

- Availability Related (AR):

  A category assigned to systems, functions, components, structures, software, services, or processes not designated CSR, SR or DER, which are required for maintaining plant availability and have an insignificant impact on nuclear risk.

- Not Safety or Availability Related (NSA):

  A category assigned to systems, functions, components, structures, software, services, or processes not required for either nuclear safety or plant availability.

4.1.2.2.3 Seismic Classes

Seismic classes for systems, components, structures, and parts are established during the design phase and assigned in accordance with the classes below:

- 1 Active (1A): A category assigned to SR components and structures whose active operation is required to perform a SR function during and after a design-basis earthquake.
- 1 Passive (1P): A category assigned to SR components and structures whose pressure boundary and structural integrity must be maintained during and after a design basis earthquake but whose active operation is not required.
- Non-Destruct (ND): A category assigned to components and structures that are not SR but whose integrity must be maintained during and after a design basis earthquake, that is, whose failure in the design basis earthquake could negatively affect adjacent SR equipment.
- Non-Classified (NC): A category assigned to components and structures for which seismic events need not be considered.

- Seismic 1 (1): A category assigned to parts of 1A, 1P and ND components.

4.1.2.2.4 Environmental Category

Nuclear safety considerations make it essential that certain systems, components, structures, parts, software, and services remain functional in environmentally hostile environments, particularly in the containment building in post-LOCA conditions. These components are identified and qualified for operation in specified conditions during design and manufacturing.

The following environmental categories are applied to SSCs:

- Category 0: Components located outside containment and are required to operate in a normal external environment.
- Category 0A: Components located outside containment that are required to operate near a line that conveys reactor coolant or is subjected to similar radiation levels.
- Category 0B: Components located outside containment that are required to operate in a steam environment during an accident.
- Category 1: Components located inside containment that are not required to withstand accident/post-accident environment.
- Category 2: Components located inside containment that are required to operate only in the initial period following an accident.
- Category 3: Components located inside containment that are required to operate during and after an accident.
- Category 4: Components located inside containment that are required to operate after an accident.
- Non-environmental (NEV): Components that are not required to conform to any environmental qualification category.

4.1.2.2.5 Quality Category

Nuclear safety considerations underlying quality make it necessary to apply varying degrees of Quality Assurance (QA) during the design, manufacture, and procurement phases of structures, components, parts, software, services, and processes to ensure various levels of confidence.

Four quality levels, Q1 to Q4 are assigned to signify the appropriate level of QA required.

4.1.2.2.6 Management System Level

Management system levels are assigned to suppliers and sub-suppliers, in a tiered approach, based on the importance to nuclear safety of the structures, components, parts, and software as prescribed by the NNR requirements document, RD-0034, ‘Quality and Safety Management Requirements for Nuclear Installations’ [100]. The management system levels and their respective requirements are Level 1, 2 or 3.

4.1.3 Classifications Relevant for SALTO Scope Setting

The relevant KNPS classifications used for scoping are shown below and summarised in Table 4-1: Summary of the KNPS SALTO Scope Setting Requirements Interpretation :

- Design safety class;
- Importance category;
- Seismic class; and
- Environmental category.

4.2 Requirements

In accordance with section 6.6 of RG-0027 [7], KNPS implemented a scope setting process for the identification of scope to be included in the ageing management assessment to meet the following regulatory requirements:

1) A systematic scope setting ('scoping') process to identify SSCs subject to ageing management should be developed and implemented.
2) This process should be acceptable to the NNR and:
    a) Be based on relevant international standards and practices; and
    b) Include benchmarking of the in-scope SSC's.
3) A list or database of all SSCs at the NPP should be made available before the scope setting process is commenced.
4) The following SSCs should be included in the scope of ageing management:
    a) SSCs important to nuclear safety that are necessary to fulfil the fundamental safety functions for that nuclear facility.
    b) Other SSCs whose failure may prevent SSCs important to nuclear safety from fulfilling their intended functions.
    c) Other SSCs that are credited in the safety analyses (deterministic and probabilistic) as performing the function of coping with certain types of events, including design base extension conditions and severe accident management.
5) Structures and components that satisfy both (a) and (b) of the following conditions can be excluded from the scope of ageing management:
    a) Structures and components subject to periodic replacement or a scheduled refurbishment plan on the basis of predefined rules (based on a manufacturers recommendation or other basis and not on an assessment of the condition of the structure or component, which would comprise implementation of ageing management for the structure or component) within the period of LTO;
    b) Structures and components accepted by the NNR not to be included in the scope. Any adjustment to revise the frequency agreed upon should be submitted to NNR for approval.
6) If an SSC within the scope is directly connected to an SSC out of the scope, clear definitions of the boundaries between them should be established.

7) In addition, nuclear facility walk-downs should be used to check the completeness of the list of SSCs whose failure may prevent SSCs important to nuclear safety from performing their intended functions.
8) Since the subsequent process is carried out at the level of a structure or component (or its subcomponent), all structures or components and their subcomponents within the scope for ageing management should be identified. If the components or structures within a group have similar functions and similar materials and are in a similar environment, that group may be defined as a structure or component 'commodity group'. [4]
9) All information and conclusions with regard to the scope of ageing management review should be documented, including:
    a) A description and justification of the methods used to determine the structures or components that are subject to an ageing management review;
    b) An identification and listing of structures or components subject to an ageing management review and their intended function(s);
    c) The information sources used to accomplish the above, and any description necessary to clarify their use.
10) After the scope setting process, a clear distinction between SSCs within the scope and those out of the scope should be evident.

4.3 Methodology

The SALTO scoping methodology defined in 240-125839632 [3] documents the Eskom scope setting methodology required to meet the regulatory scope setting expectations. The methodology was initially developed based on the IAEA SALTO guidance. Following the issuance of the interim guidance RG0027 [7], the methodology was reviewed and updated to ensure that all the above-mentioned RG-0027 [7] requirements were addressed.

The scoping methodology provides the interpretation of the scope setting requirements for SSCs to be included in the AME and describes how this is achieved through criteria using the established classifications at KNPS. The methodology provides the description of the KNPS data sources to be used to develop the consolidated and verified scope list and the high-level approach for achieving the scope setting results. These elements are described in the sections below.

4.3.1 Requirement Interpretation

Clauses 4 and 5 of section 6.6 in RG-0027 [7] provide the requirements for the SSCs to be included and excluded from the AME. This section provides the Eskom interpretation of the requirements and the justification for the use of the established KNPS classifications for the scope setting criteria.

Interpretation of Clause 6.6 4) a)

Regulatory requirement 6.6 4) a) is expanded in the IAEA guide, SSG-48 [6] as follows:

[4] Commodity grouping is included under AME for the SALTO Ageing Management Assessment and not under Scope Setting.

5.16.(a) SSCs important to safety that are necessary to fulfil the fundamental safety functions:

a) Control of reactivity;

b) Removal of heat from the reactor and from the used fuel storage facility;

c) Confinement of radioactive material, shielding against radiation, control of planned radioactive releases, and limitation of accidental radioactive releases.

This requirement is interpreted as design-basis SSCs defined in accordance with the definitions of ANSI 18.2 [38]. For KNPS, SSCs required to fulfil the fundamental safety functions as described above, are design-basis SSCs and are assigned design safety classes: 1, 2, 3, LS (for mechanical SSCs), and 1E (for electrical SSCs).

Interpretation of Clause 6.6 4) b)

Regulatory requirement 6.6 4) b) is expanded in SSG-48 [6] into the following requirements

5.16.(b) Other SSCs whose failure may prevent SSCs important to safety from fulfilling their intended functions. Examples of such potential failures are:

a) Missile impact from rotating machines;

b) Failure of lifting equipment;

c) Flooding;

d) High-energy line break;

e) Leakage of liquids (e.g. from piping or other pressure boundary components).

It is interpreted that this requirement is addressed by the identification of non-safety SSC that can affect the design safety function, defined above, if they fail. For KNPS, the SSC is classified for seismic impact as seismic class 1A, 1P, and ND.

Non-safety class SSCs that meet this requirement are identified in specific commissioned studies, such as the fire, flooding, explosion, and seismic studies. Additional specific SSCs are added to the SALTO scope, irrespective of the classification, to prevent or mitigate against the failure of non-safety equipment. For example, all fire systems are included in the SALTO scope for the prevention and mitigation of fire.

Interpretation of Clause 6.6 4) c)

Regulatory requirement 6.6 4 c) above is expanded in SSG-48 [6] into the following requirements

5.16.(c) Other SSCs that are credited in the safety analyses (deterministic and probabilistic) as performing the function of coping with certain types of events consistent with national regulatory requirements, such as:

a) SSCs needed to cope with internal events (e.g. internal fire and internal flooding);

b) SSCs needed to cope with external hazards (e.g. extreme weather conditions, earthquakes, tsunamis, external flooding, tornados, and external fire);

c) SSCs needed to cope with specific regulated events (e.g. pressurised thermal shock, anticipated transient without scram and station black-out);

> *d) SSCs needed to cope with design extension conditions or to mitigate the consequences of severe accidents.*

This requirement is interpreted as SSCs needed to address risk-significant plant impacts, complimentary accidents, beyond-design-basis accidents, and other probabilistic risks.

For KNPS, these SSCs are identified by:

- Importance categories SR and CSR based on deterministic considerations;
- Importance category SR based on probabilistic considerations; and
- Importance category DER.

Additionally, SSCs that meet the requirement of the third bullet point were identified and included in the SALTO scope in the following way:

- SSCs in emergency operating procedures (EOPs) and severe accident mitigation guidelines (SAMGs).
- A list of SSCs used for fire risk management , a list of portable SSCs for DECs and external event accident mitigation as identified by the external events risk assessment are included in the SALTO scope. Examples of such SSCs are the diesel storage tanks, the JPS mobile low-pressure, high-flow pumps (0 JPS 001, 002, and 003 PO) and the emergency mobile diesel generators.

Interpretation of Clause 6.6 5) a)

Regulatory requirement 6.6 5 a) provide requirements for the exclusion of scope due to periodic replacement or a scheduled refurbishment plan according to the equipment original equipment manufacturer (OEM) guidance.

For KNPS, a comprehensive list of SSCs requiring periodic replacement or scheduled refurbishment is not well defined or identifiable from KNPS's maintenance plan or engineering programmes. As such, SSCs subject to a periodic replacement or a scheduled refurbishment plan based purely on a manufacturer's recommendation are included in the scope of SALTO ageing management assessment. The scope of SALTO also includes qualified equipment and those SCs that are replaced periodically based on condition assessments.

4.3.2 Scope Setting Criteria

Continuing from the above sections, Table 4-1 below summarises the KNPS SALTO scope setting requirements interpretation.

Table 4-1: Summary of the KNPS SALTO Scope Setting Requirements Interpretation

RG-0027 requirements	Safety class	Importance category	Seismic class	Other
NNR Requirement 6.6 4) a) "Design basis equipment (ANSI 18.2)"	1, 2, 3, LS, 1E	CSR SR		

NNR Requirement 6.6. 4) b) "Non-safety equipment affecting safety function"		CSR SR	ND	Studies and assessments[5]
NNR Requirement 6.6 4) c) "Complementary accidents, beyond-design-basis accidents, and risk-significant concerns"		CSR SR DER		

From Table 4-1, it is deduced that the scope setting criteria for the SALTO scoping methodology is defined as follows:

- Importance category SR / CSR (this envelops safety class 1, 2, 3, LS, and 1E).
- Importance category DER.
- Seismic classes 1A, 1P, and ND.
- SSCs identified from studies and specific scope for inclusion.

The boundary between SSC within the scope and those out of the scope is defined by the classifications assigned to SSCs

4.3.3 SSCs Excluded from the Scope of the Ageing Management Assessment

SSCs that do not meet the criteria as defined in section 4.3.2 are, by default, excluded from the scope list. This can include SSCs that are important for the execution of regulatory programmes, even though these SSCs are not considered for fundamental safety functions (such as reactivity, cooling and confinement). A review of the Koeberg Licensing Basis Manual (KLBM) and NNR regulatory requirements has identified regulatory programmes that use non-plant SSCs that do not meet the scoping inclusion criteria of section 6.6.4 in RG-0027 [7] nor that of SSG-48 [6]. These SSCs are related to the specific following license binding programmes:

- Radiation Protection;
- Emergency Planning (partial exclusion);
- Security;
- Environmental and Chemistry plant and laboratory analysis equipment; and
- Full-scope Training Simulator.

Typically, these SSCs do not fall directly under traditional AMPs, and are therefore best managed under their specific license binding programmes. Even though these SSCs are not included in the SALTO scope, these SSCs are still subjected to ageing management activities (such as maintenance, obsolescence management, etc.) through their respective programme requirements. The reliability of these SSC will be reported to the NNR in the annual NNR reports in accordance with RG 0027 [7]. The approach still seeks to maintain a high degree of reliability for these SSCs that have many off-the-shelf components - and can readily be replaced without long lead times.

This approach to dealing with these type of excluded SSCs have been benchmarked through engagements with IAEA Scoping SMEs and this approach was found to be consistent with other

[5] Reports for previously performed fire studies, seismic and flooding hazard assessment, and explosion risk assessment were used in identifying non-safety equipment that could impact on safety.

plants that follow the IAEA SSG-48 [6] SALTO process. The ageing management of these SSCs is discussed in the scoping methodology procedure, 240-125839632 [3]. An ageing management assessment of these will still be performed for long term operation and documented in the LTO Safety Case.

4.3.4 Input Information Sources

International guidelines recommend a list or database of all SSCs (a master equipment list) be available before scope setting commences. However, due to the lack of an integrated, consolidated and verified list of SSCs, the Koeberg SALTO Assessment Project had to identify all the SSCs information sources available to be used for scoping. As a result, document 240-128716554 'Koeberg Safety Aspect of Long Term Operation Input Sources' [4], which lists multiple input SSCs information sources available was developed prior to the scope setting activity. The input information sources collated for the scoping process fall under one or more of the following categories as represented in Figure 4-1: The Scoping Process Flow Diagram (non-exhaustive examples for each category are provided):

- Digital SSC sources: 331-94, 'Importance Category Classification Listing' [37], Design Engineering classifications catalogue, SAP equipment listing, IQ Review (preventative maintenance equipment listing), etc.
- Digital cable sources: Pericles Database (originally installed electrical cables database); cable number allocation database and cable list of electrical cables installed through modifications;
- Plant documentation - scoping sources: System designs files (DSEs); plant drawings such as P&IDs (process & instrumentation drawings) and isometric drawings; the Koeberg Safety Analysis Report (SAR), etc.
- Plant documentation - ageing management sources: Working procedures; operating procedures; operator training manuals; Devonway; SAP history; IQ Review strategies; etc.

Relating to the information sources and the exchange of information between the consortium and Eskom, formal exchange of input source documents and deliverable documents distributed or transmitted across interfaces were properly documented and controlled in accordance with the L1124-PM-PLN-004, 'SALTO Consortium Documentation Management Plan' [99].

4.3.5 High-Level Approach

The SALTO scoping methodology document [3] provides a high-level approach for executing the scope setting process. This includes:

- the extraction of equipment information from the various equipment information sources;
- the linking of identified equipment with their classifications;
- documenting the criteria for SSC scope inclusion/exclusion for the subsequent ageing assessment;
- the approach to the scoping of cables; and
- the verification and confirmation of included and excluded scope.

This high-level approach was the basis for the Consortium scope setting process and is the subject of the next section of this report.

4.4 Process

Figure 4-1: The Scoping Process Flow Diagram depicts the process followed during the scoping activities. The following section provides a brief description of the scoping process elements as depicted in the flow diagram.

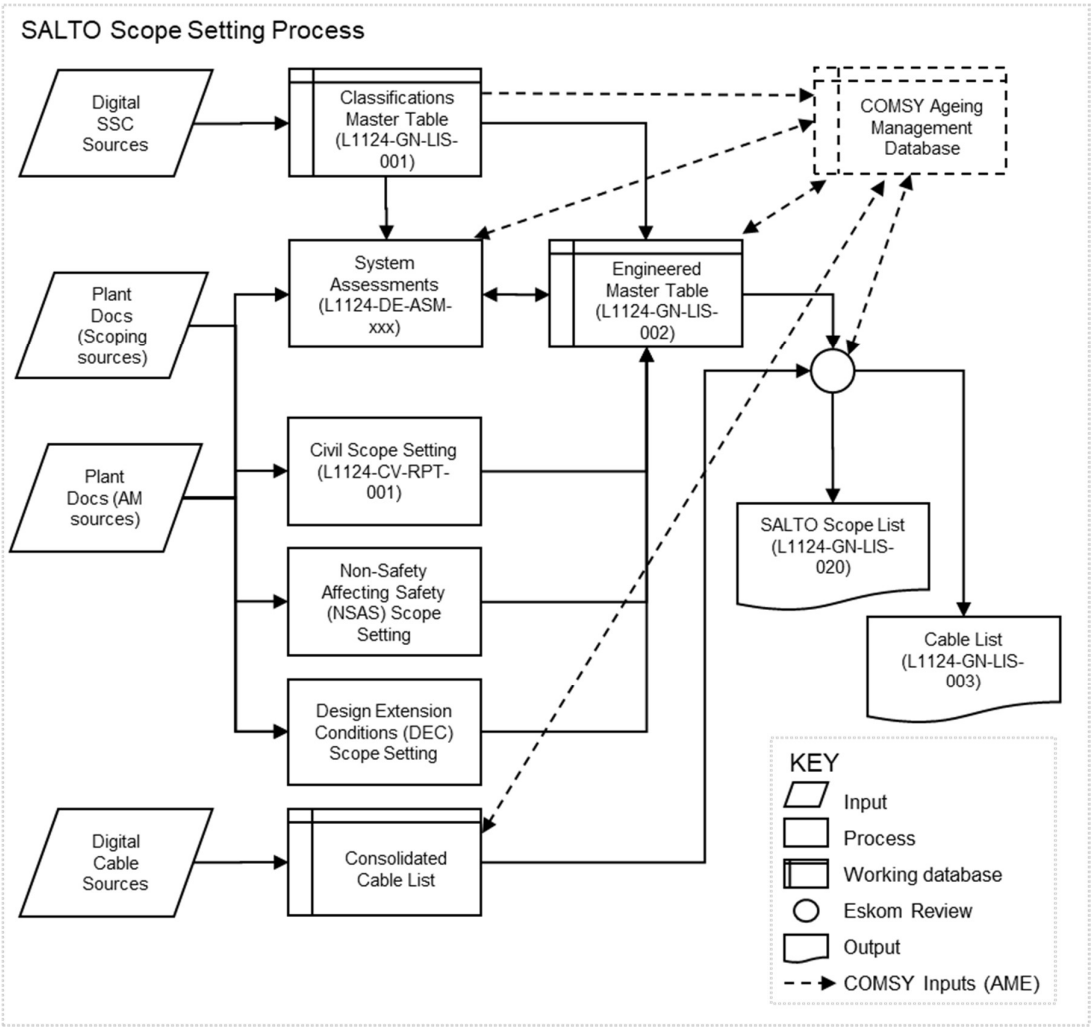

Figure 4-1: The Scoping Process Flow Diagram

4.4.1 Classification Master Table

The classification master table is a consolidated list of information obtained from specific digital sources, and it was the initial step for the scoping of components. SSCs information in digital sources, such as component identifiers, description, and classifications were used to compile the classification master table, and the sources of the information (similar or different) were recorded. The classification master table reflects the as-is-state of existing digital sources. No alterations or corrections to the input information were made at this point.

The process used to develop the classification master table, including all the sources and how they were ranked, the decisions made and the anomalies identified is provided in L1124-GN-RPT-002, 'SALTO Koeberg Classification Master Table' [84]. The classification master table is documented in L1124-GN-LIS-002, 'Classification Master Table' [72].

4.4.2 System Assessment Sheets

From the input information sources and the classification master table mentioned above, system assessment sheets were created to capture the scoping information. The 173 system assessment sheets (one worksheet per plant system with a numbering format of 'L1124-GN-ASM-xxx' and labelled with the system trigram) contained technical and design information.

In preparation for the AME, these system assessment sheets allowed for capturing of information including: component identifier (trigrams and descriptions); safety classes; room numbers (component locations); component material; nominal diameter; schedule; medium (type of process fluid and its characteristics [such as pH]), normal operating temperatures, nominal operating pressures, flow rates and operating periodicities for components. See section 5.2.4.1 for further details.

The assessment sheets were also used for confirming and verifying the consolidated equipment list. SSCs information captured from plant documentation and procedures were compared with the information in digital sources (obtained from the classifications master table). Components or equipment missing from digital sources were identified in plant documentation and added to the system assessment sheets. The use of multiple sources also facilitated verification of SSCs since components or equipment were identified in both digital sources and plant documentation.

4.4.3 Civil Scoping

Structures and buildings housing SSCs important to safety are included in the scope as primarily identified in 331-94 [37] and plant layout drawings. The list of structures and buildings included in the SALTO scope is listed in Appendix C.

A review of the data sources used for civil components revealed that the level of detail for civil and structural components associated with the civil and building structures of the plant is not sufficiently detailed to allow for ageing evaluation. Individual components and parts comprising buildings and structures were not uniquely identifiably and some components would experience different ageing, for example, due to the exposure environment being inside or outside.

To facilitate commodity grouping and subsequently AME, buildings and structures were therefore fragmented into individual components, and new unique identifiers were created and assigned to these components. An example of such a trigram creation is shown in the table below:

Table 4-2: Civil Trigram Example

Building name: Unit 1 fuel building:	1HKAOOOBG
Room number in the fuel building:	K113
The civil component is the concrete floor slab, its bigram, is:	OS
The resulting unique identifier for the floor slab in building 1	1HKAOOOBG-K113-0S

HKAOOOBG room K113 of the Unit 1 Fuel Building is, therefore:	

The detailed methodology for the creation of new civil components is documented in L1124-CV-RPT-001, 'New Civil Component Report' [55].

4.4.4 Non-Safety Affecting Safety (NSAS)

The process for identifying other SSCs where their failure may prevent SSCs important to safety from fulfilling their intended functions is as follows:

- Using primarily their importance classifications.
- The previously undertaken seismic hazards studies provided assessments of the seismic event fall-down hazard posed by non-seismic designed SSCs during a safe shut-down earthquake (SSE), and the robustness of KNPS's design to maintain its safety functions when challenged by a seismic hazard beyond design basis. The reports EERT-11-015, 'Seismic Hazard Report' [48] and JN377/AMEC/NCI/TR/6393, 'Seismic Event Fall-down Hazard Report' [52][51] for KNPS were assessed to identify components or equipment where their potential fall or disintegration could affect SSCs important to safety. The reports are based on extensive walk downs of the plant to identify and assess the seismic risks.
- The previously undertaken JN195/NCI/ESKOM/J2/365, 'Koeberg Internal Flooding Analysis' [51] focused on immersion of SSCs within 24 hours and spraying or dripping (where the source is in sight). The report for this analysis was assessed to identify potential sources of flooding. This report brought into consideration the ASG, DVH, EAS, PTR, RCV, RIS, RRI, SEC systems, and the spent fuel pool overflow as sources of flooding. All of these system's SSCs are already in-scope due to their importance category classification.
- The Explosion hazard analysis, performed as part of the external events review team (EERT), focused on the probability and impact of explosions and what could be done to prevent or mitigate such explosions. The scope of this analysis was the assessment of the primary system. EERT-11-019, 'The Explosion Hazard report' [49] was used for identifying SSCs posing a risk of explosion to safety related components for inclusion into the SALTO scope.
- Specific SSCs that prevent or mitigate against hazards or failure of other SSCs not important to safety were also added to the SALTO scope. This is expanded on in document L1124-DE-GDL-002 SALTO, 'Augmented Scope – Non-DBA Equipment Selection Criteria' [57]. As a way of example, all fire systems were added to the SALTO scope.

4.4.5 Design Extension Conditions

SSCs for mitigation or prevention of DEC were identified during the review of:

- Emergency operating procedures (EOPs);
- Severe accident management guidelines (SAMG); and
- Lists of fire risk management emergency equipment, and portable equipment for design extension condition and external event accident mitigation.
- 331-94 [37], 'Importance Category Classification Listing'.

SSCs that could be linked to the mitigation or prevention of design extension conditions were assigned or tagged as 'SALTO DER' on the engineered master table, L1124-GN-LIS-002 [73] and

L1124-GN-LIS-020, 'The Comprehensive List of All SSCs Reviewed for SALTO,' [82] which is a reference to importance category DER, introduced in 240-89294359 [18] and assigned to SSCs classified for use in mitigation of design extension conditions.

4.4.6 Engineered Master Table

This is a comprehensive database that consolidates all the information collected for scoping. At this point in the process, all information identified is imported into the engineered master table, except process parameters collected for AME (contained in the system assessment sheets). The engineered master table was used for improving the integrity of collected information. The engineered master table is not the final scope list but rather an input source of the Condition-Oriented Ageing Management System (COMSY) database and the final SALTO scope list. The engineered master table was used to consolidate the source verification and has additional information such as verification status, which indicates whether components were identified in controlled and trusted sources (or not), and tracking notes for verifying the validity of components.

The engineering master table is documented in L1124-GN-LIS-002, 'The Engineered Master Table' [73] and the use and management of the engineered master table is described in L1124-DE-GDL-004, 'Engineered Master Table Guide' [58].

4.4.7 SALTO Scope List

The SALTO scope setting output has two main deliverables: the SALTO scope list and the SALTO cable list (described in section 4.4.8 below).

The SALTO scope list was extracted from the engineered master table. The list has all SSCs (except cables) considered for the SALTO scope, and the criteria for in-scope or out-of-scope used for filtering. The final SALTO scope list, L1124-GN-LIS-020 [82], is described under the results section 4.5.1 below.

4.4.8 SALTO Cables List

Data for the complete SALTO electrical cable scope was obtained from:

- The Pericles database, which was in use at KNPS after the commissioning of the units.
- A list of cables installed through various plant modifications.
- MS Access cable's allocation database.

Over 10 000 electrical cables were considered for the SALTO scope. Cables connected to electrical and instrumentation and control (I&C) components included in the SALTO scope were identified in the aforementioned sources and included in the scope.

Due to the differing format of the cable data, the SALTO in-scope cables are consolidated in a separate list from the SALTO in-scope SSC list. The cable numbers differ from SSC trigrams and cables require origin, destination and routing information.

The SALTO cables list is provided in L1124-GN-LIS-003, 'Cable List' [70].

4.4.9 COMSY

Condition-Orientated Ageing Management System (COMSY) software, developed by Framatome, was used as a database for AME. This database/software tool is designed to provide degradation assessments and degradation surveillances for the technical equipment of power plants of different designs. It is designed to support the commodity grouping process based on input data regarding design, materials, operating conditions and environmental data.

COMSY links the equipment, materials, and environments to the IGALL potential degradations and programme actions to existing KNPS actions to enable the evaluation of existing ageing management programmes.

The COMSY software is used as an ageing management database and evaluation tool for the SALTO ageing management assessment. Verified scoping information, process and environmental parameters collected during the scoping activities were exported from the classification master table, the system assessment sheets, the engineered master table, and the cable list into the COMSY database for ageing management evaluation (as per section 5).

4.5 Results

The output from the scoping process provided two sets of results, namely: the SALTO Scoping Lists and the identified anomalies. The results are summarised in the sections below.

4.5.1 Scope Setting Results

209 774 items were evaluated and considered for the SALTO scope. These items include components, structures, and parts.

The scoping process outputs (deliverables) were:

- The full SALTO SSC scope list, L1124-GN-LIS-020, ‘Comprehensive List of all SSCs Reviewed for SALTO Requirements’ [82], which contains:
  - SSCs important to nuclear safety that are necessary to fulfil the fundamental safety functions for that nuclear facility (Included in SALTO Scope).
  - SSCs for DEC (In-scope, SSCs tagged “*SALTO DER”* in the list*).*
  - NSAS (tagged as explosion, fire mitigation, flooding, or seismic).
  - A field for justification of including a component or equipment in the scope.
  - “*SALTO scope*” field (for SSCs tagged *“in”, “out” or “N/A”).* Note: *N/A* refers to errors or anomalies typically items that are not physical such as signals, duplicated components, or non-existent components.
  - Generic items: these are SCCs without labels or trigrams, and generic approach to certain SSCs as shown in the last worksheet of L1124-GN-LIS-020 [82].
- The full SALTO cables scope list, L1124-EL-LIS-003, ‘Cable List’ [70]; and
- The scope setting and verification report, L1124-GN-RPT-041, ’SALTO Scoping and Verification for Koeberg Power Station’ [96].

A summary of the scope setting results is provided in Table 4-3: Summary of Scope Setting Results.

Table 4-3: Summary of Scope Setting Results

SSC Count (all KNPS units)	Scope setting result description
209 774	Total number of items (includes SSCs and non-valid items) considered for SALTO scope.
84 097	SSCs included in the SALTO scope (excluding electrical cables)
101 911	SSCs excluded from the SALTO scope (exclusion scope)
23 766	Number of items classified as “N/A” (errors or anomalies)
2 123	Number of SSCs in SALTO scope due to Design Extension Related aspects. Tagged DER in SALTO scope list.
6 069	SSCs in SALTO scope for mitigation or prevention of fires
2 484	Number of non-safety SSCs in SALTO scope for prevention or mitigation of internal hazards (e.g. fire, explosion or fall-down hazards), including SSCs posing failure hazards to SSCs important to safety
4 433	Electrical cables in SALTO scope

4.5.2 Anomalies

During the scoping and data verification process, discrepancies, inconsistencies, and errors were discovered within plant documentation. The following types of anomalies, inconsistencies, or documentation errors were discovered during the scoping process:

- Classification discrepancies: these ranged from questionable SSC classifications that the Koeberg SALTO Assessment Project could not verify, proposed classification changes (that is re-classifications) and classification inconsistencies between various data sources, (for example different safety classifications for a given SSC in the DSEs, P&ID, and classification catalogue).
- Description variances between various input data sources: for example description variances between SAP, IQ review, and the SALTO scope list. Technical documentation discrepancies: these are mostly inconsistencies between various documents and apparent errors in plant documentation (e.g. errors on P&IDs, or inconsistencies between the P&IDs of units 1 and 2).
- Trigram discrepancies: a number of trigrams were identified that are obsolete and for which plant systems could not be identified.

- Bigram discrepancies: bigram usage is not always consistent with the definition provided in KNPS's controlled bigram master list.
- Cable information discrepancies: the Koeberg SALTO Assessment Project identified inconsistencies in the three sources used for cable information sourcing. The three sources are: Pericles database, MS Access database and the cable list sourced from Koebec.
- Plant layout drawings inconsistent: plant layout inconsistencies between various documentation sources.

Anomalies impacting the SALTO scope decision were immediately resolved as part of the scoping process. Anomalies not impacting the SALTO scope are still to be resolved. 240-153945942, 'User Requirement Specification for Management of SALTO Anomalies Evaluation and Rectification' [30] was developed to secure external support to implement the anomaly corrections. The Configuration Management Group with support from the Design Engineering Group will manage the resolution of all anomalies in accordance with KNPS Configuration Management Process in the execution phase of the Koeberg SALTO Assessment Project.

4.6 Verification

This section describes the processes for verification of the SALTO scope.

4.6.1 Consortium Verification

Verification of the scope was performed to confirm the existence of an SSC captured from existing digitised plant data sources, such as SAP, by checking or observing its existence within technical documents or procedures such as the DSEs, logic diagrams, feeder diagrams, flow diagrams (P&ID), SIP and SIN drawings. The system assessment sheets provided the means of capturing this information. L1124-DE-GDL-001, 'SALTO Scoping and Verification Guide' [56] describes this process in detail.

4.6.2 Consortium Independent Review

Independent reviews were conducted for each system sheet. Depending on the complexity of a system, and the number of unverified components, a second independent review of a system or a sheet was performed, based on the recommendation of the technical lead.

A Consortium independent review of the full scope list was also performed by senior ex-KNPS staff at Lesedi to provide further confidence in the approach taken and output provided.

4.6.3 Eskom Verification

This section covers the verification of the scope list provided by the Consortium, including the formal Eskom review and acceptance of the scope list, and the follow on scope verification walk downs.

4.6.3.1 Scope List Review and Acceptance

The process for Eskom's review and acceptance of the scope of components and equipment considered for the SALTO scope is discussed in this section and recorded in the Document Control Resolution Forms (DCRF) generically used for Consortium document review and acceptance.

A comprehensive review of the scope for SALTO identified a detailed review of each SSC included in scope and excluded from the scope. However, with 209 774 components (and over 10 000 electrical cables) considered for the SALTO scope, a sample review approach was necessitated. To achieve a high level of confidence in the review, without reviewing every one of the 209 774 components (including the associated operating parameters), the approach adopted was to group reviews into five review group types, each with a specific goal. The review groups are defined below:

Scoping Review Group A – Deep-Dive Review

A random 1,7% (1 500 of approximately 84 100 items in SALTO scope excluding cables) sample representative of the components included in the SALTO scope list was randomly selected from the entire SALTO scope, and 35 engineers were identified for this review and allocated 40 line items per reviewer.

- A detailed line-by-line review of the identified sample data of in-scope equipment was performed so that the SALTO scope list could be confirmed. The purpose of this review was verifying the accuracy of the SALTO scope and data collected for ageing management.
- No SSCs were added or removed from the SALTO scope as result of this review

Scoping Review Group B – Excluded Scope Review

An overview of all the excluded scope was performed, for this review, by 13 engineers. The purpose of the review was to identify any system/component/equipment in the excluded scope list, that can potentially be linked with nuclear safety and, therefore, should be included in the SALTO scope.

The review of the out-of-scope list verified that no important-to-safety SSCs that are credited in the safety analysis for the two KNPS units have been excluded. However, a concern raised by this review, was that many incidents (operational faults and anomalies) that may be experienced on the KNPS units are not always described in the SAR (which deals predominately with design basis accidents) and may potentially be excluded from the SALTO scope. To address this, an additional review was performed to determine whether there was safety significant SCCs used in the KNPS incident procedures that were not included in the SALTO ageing management scope. The review revealed that two components, considered safety significant, were missing from the SALTO scope, namely GCT 503 CC and REA 411 ID. The two components have subsequently been added to the SALTO scope.

Scoping Review Group C – Included Scope

An overview of all the components, structures, and equipment identified as in-scope was performed for this review. This general review was intended to identify inclusion errors and equipment/components captured in this list that should be in the excluded scope. That is, the intention is the identification of equipment that has no link to nuclear safety or with no impact on nuclear safety. The review comments by 10 engineers did not result in SSCs being removed from the SALTO scope.

Scoping Review Group D – Generic Scope

This was a review of the Consortium scoping reports performed by the Koeberg SALTO Assessment Project team. The focus was on consistency, sufficient description of activities, logical presentation of results, alignment to client requirements, and so forth. Where comments were noted, these were addressed/corrected by the Consortium prior to the final issue (and accepted by Eskom).

Scoping Review Group E – Specialised Scope

Review group E focused on three specific review topics for the SSCs included (and excluded) in the SALTO scope. These topics were:

- E1—Electrical cables.
- E2 – Piping.
- E3 – DER and NSAS.

Reviews E1, E2 and E3 had five, two and nine engineers assigned for these reviews respectively.

The general findings for the above reviews and corrections were:

- The justifications provided for either including or excluding scope were insufficient. This resulted in the Consortium relooking at the SALTO scope and improving the justifications for SALTO scope inclusion or exclusion.
- Known in-scope SCCs without trigrams or labels were not represented on the scope list. For example, cable trays and lightning protection were not represented on the scope list even though these were scoped in. This was resolved by the creation of generic items list within L1124-GN-LIS-020 [82] for capturing of these SSCs.
- Multiple safety classes assigned to SSCs in the SALTO scope list were questioned by the reviewers. It was clarified that these items were defined as per the input information and therefore no changes were made to the SALTO scope. However, questionable classifications categories identified during the SALTO scope reviews are to be resolved as part of the anomalies resolutions discussed in section 4.5.2.

The outcomes of the SALTO scope setting results reviews provide confidence in the comprehensiveness and completeness of the SALTO scope list for the purposes of the ageing management evaluation.

4.6.3.2 Scope Verification Walk Downs

During the execution phase of the Koeberg SALTO Assessment Project, plant walk-downs were performed for confirming and verifying the completeness of the scope. The objective was to verify comprehensiveness of the list of in-scope non-safety related SSCs. The plant walk-downs were performed on a sample of safety risk-significant active components as identified by the Deterministic & Probabilistic Safety Analysis (DPSA) Group. The decision and approach to plant walk downs is recorded in 08016.ROD.012, 'SALTO Non-Safety affecting Safety equipment scope verification' [10]. The findings of these walk downs will be documented in the report 240-158189320, 'Plant Walk-downs for SALTO Scope Confirmation'. The current indication is that the findings will not have a significant impact on the final scope list. Any actions stemming for this review will be addressed in the line functions as described under section 4.7 below.

The result of the reviews indicated that all SSCs important to nuclear safety were already included in the SALTO ageing management scope and a high confidence in the final in-scope list being conservative.

4.7 Organisational Responsibility for the Scope Setting Deliverables

Following the review and acceptance of the final scope list, the comprehensive list of SSCs considered for the SALTO scope (L1124-GN-LIS-020 [82]) was formally submitted to the Design Engineering Department, through letter correspondence reference NPM-044-2020. The list includes SSCs in the SALTO scope and those excluded from the scope. It is noteworthy that the list is a significantly more comprehensive list compared to the current 331-94 [37]. The list is now under the control of the Design Engineering Group. The list L1124-GN-LIS-020 [82] is planned to be merged with the existing importance category listing 331-94 [37].

Reference in the Design Engineering Process to the ageing management standard, 240-149139512 [26] and the Koeberg AMM, 240-101650256 [18] will be introduced in the following Design Engineering Processes/Procedures:

- 331-94, 'Importance Category Classification Listing' [37] (previously KLA-001);
- Detailed design template; and
- Classification forms/process for SCCs.

These updates will facilitate updating of the Koeberg AMM as new components, ageing mechanisms, or classification changes are introduced by plant modifications.

This section will be expanded on in the final SALTO Ageing Management Assessment Report.

This concludes the SALTO Scope Setting section of the report. The next section will focus on the Ageing Management Evaluation.

5 Ageing Management Evaluation

RG-0027 [7] requires that the ageing management review address the categorisation of SSCs with regard to degradation and ageing processes and the review of ageing management programmes in accordance with current NNR and/or international safety standards and operating practices. To achieve this, an ageing management evaluation (AME) was performed for all SALTO in-scope SSCs as defined in 4.5.1.

AME refers to a process of performing an ageing management assessment for the identified SALTO in-scope SSCs, including commodity grouping process, ageing management programme review and the performance of equipment ageing management review.

The validation of time limited ageing analyses (TLAAs) is described separately in section 6 of this report.

5.1 Requirements

In 2019, the NNR issued RG-0027 [7] which provides the requirements for ageing management and LTO for NPPs. The AME activities required by RG-0027 [7] are provided in section 6 of the regulatory guide and can be categorised into three main activities, namely:

- Commodity Grouping;
- Review of ageing management programmes;
- Equipment ageing management review.

In order to address the AME regulatory objectives and ensure that the above-mentioned requirements are achieved, the SALTO AME procedure 240-125122792, ‘Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses’ [2] was developed, which provides a high-level process for performing the AME. This will ensure that the relevant ageing degradation mechanisms and ageing effects for in-scope SSCs are comprehensively identified and assessed, and the ageing management programmes to manage the identified ageing effects and degradation mechanisms are in place. . This procedure further provides the process for identification and validation of the TLAAs applicable to KNPS for LTO.

5.2 Process and Results

The AME process followed by the Consortium in performing the Ageing Management Evaluation of Mechanical, Electrical and I&C as well as Civil SSCs is provided in the sections below.

5.2.1 Process Overview

Figure 5-1 below provides the AME process overview which includes the following three elements:

- Commodity Grouping;
- Ageing Management Programme (AMP) Review;
- Equipment Ageing Management Review (AMR).

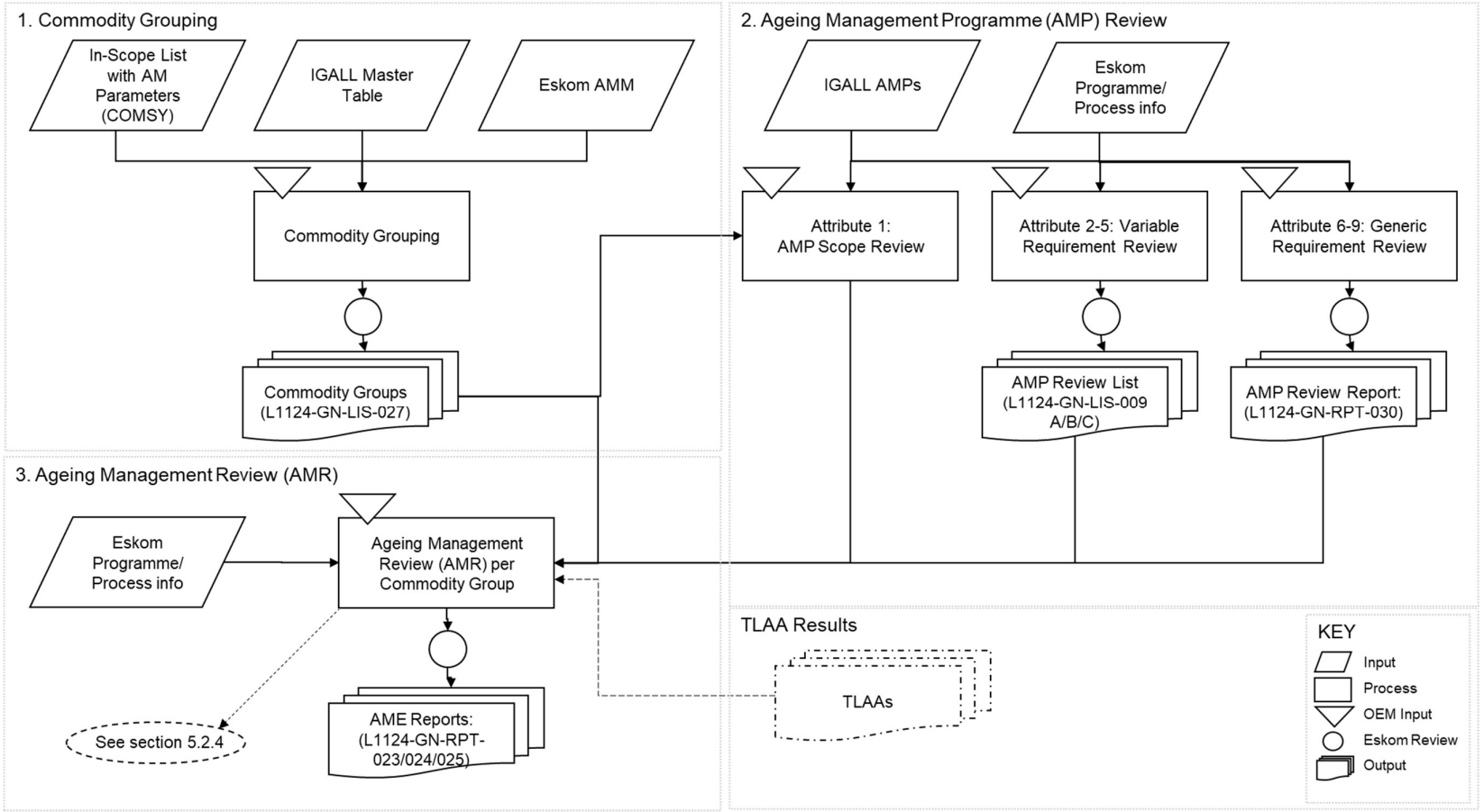

Figure 5-1: Ageing Management Evaluation (AME) Process Overview

5.2.2 Commodity Grouping

In order to ensure that the AMR is performed effectively, where applicable, the list of identified SSCs susceptible to degradation due to ageing was arranged into commodity groups. This allowed for the assessment of an entire group with a single review task.

In accordance with requirements stipulated in SALTO AME procedure 240-125122792 [2], the methodology developed and applied to perform the SALTO commodity grouping is defined in L1124-DE-RPT-002, 'SALTO Commodity Grouping Methodology' [65]. The methodology is based on the IGALL Master Table and the Koeberg AMM.

The grouping of structures or components was based on characteristics such as similar design, similar materials of construction, similar ageing management practices, and/or similar environments. In-scope SSCs that could not be grouped into commodity groups were evaluated as stand-alone structures and components.

5.2.2.1 Commodity Grouping Process

As shown in Figure 5-1: Ageing Management Evaluation (AME) Process Overview above, the following inputs were used for informing the structure of KNPS commodity groups:

- **SALTO Scope List**

  The result of the scoping process as discussed in sub-section 4.5.1 of this report. The requirements stipulated in 240-125122792 [2] apply to relevant SSCs identified for an AME in accordance with the Koeberg SALTO scoping methodology, 240-125839632 [3].

- **IAEA IGALL Master Table**

  The IAEA IGALL Master Table (2018 version) was used as the primary source for the creation of the commodity groups. The IGALL Master Table provides an agreed approach by the IAEA member states for the evaluation of ageing mechanisms for PWR plants. In addition, the IGALL Master Table provides links between the commodity groupings and the predefined AMPs.

  The IGALL Master Table was used as an internationally agreed basis for what constitutes an acceptable AMP for each critical location/part of SSCs, ageing effect/degradation mechanism, material, and environment.

- **Koeberg Ageing Management Matrix**

  The existing Koeberg AMM comprehensively documents ageing couples for SSCs or commodity groups relevant to KNPS. The existing Koeberg AMM commodity groups were compared and validated against the IGALL Master Table during the SALTO AMR process (section 5.2.4).

  The use of the existing Koeberg AMM provides insights stemming from the EDF ageing management approach and extensive EDF OE, which is of additional benefit to the IGALL information.

- **Framatome Adjustment (OEM OE)**

  Engineering judgement (Framatome adjustment) based the Framatome experience was applied in cases where the group of bigrams could not be linked to any generic IGALL or Koeberg AMM commodity group. In these cases new commodity groups were created.

The commodity grouping process was performed using the COMSY software. Commodity groups were created and in-scope SSCs were linked to their respective commodity groups.

The COMSY software tool (not represented in Figure 5-1) is designed to support the commodity grouping processes. Based on the pre-defined structure of the IGALL Master Table and the Koeberg AMM, the COMSY software is able to link the in-scope SSCs stored in the COMSY Ageing Management Database with categories, commodity groups, and sub-commodity groups.

In order to create the KNPS-specific COMSY ageing database, the following steps were followed:

i. The ageing database was populated (as per section 4.4.9) with information (such as material, temperature, medium, flow conditions etc.) for the in-scope SSCs in accordance with document L1124-DE-RPT-002 [65].

ii. A list of commodity groups for in-scope SSCs was developed based on the IGALL Master Table and the Koeberg AMM. In-scope items that could not be grouped into commodity groups were listed as stand-alone structures and components.

5.2.2.2 Commodity Grouping Results

There are 83 civil, 29 electrical and 571 mechanical commodity groups identified through the commodity grouping process. L1124-GN-LIS-027, 'AME Data Sheet for Commodity Grouping' [83], provides a comprehensive list of commodity groups for each discipline and the associated SSCs.

5.2.3 Ageing Management Programme Review

RG-0027 [7] requires that programmes that are credited for ageing management and used in evaluations for LTO, should be consistent with the following nine attributes[6]:

1. Scope of the ageing management programme
2. Preventive actions to minimise and control ageing degradation
3. Detection of ageing effects
4. Monitoring and trending of ageing effects
5. Mitigating ageing effects
6. Acceptance criteria
7. Corrective actions
8. Operating experience feedback and feedback of research and development result.
9. Quality management

As part of the IGALL, the IAEA has developed AMPs based on proven practices from its member states. The IGALL AMPs provide ageing management benchmarks for the safe operation of the NPPs to ensure that the capability of SSCs can perform their intended functions throughout the lifetime of the plant.

[6] Note that the 9 generic attributes for an effective AMP provided in RG-0027 [7] are similar to those provided in the IAEA SSG-48 [6] guidance.

The primarily objective of the ageing management programme (AMP) review was to check whether the KNPS's existing plant programmes fulfil the requirements of the generic IGALL AMPs in dealing with the known ageing degradations and effects.

Only published IGALL AMPs applicable to a Pressurised Water Reactor (PWR) type plant were considered relevant to KNPs. IGALL AMP applicable to Boiled Water Reactor (BWR) and CANDU reactors were excluded. Although KNPS is a PWR there are some AMPs that are not applicable due the design of KNPS as provided in report L1124-GN-RPT-030 [93].

5.2.3.1 AMP Review Process

As shown in Figure 5-1 above, the review was achieved by a comparison of the tasks originating from the KNPS maintenance databases and plant ageing management programmes with the generic IGALL AMPs. In order to facilitate the comparison, the IGALL AMP tasks were broken down into well-defined and subdivided tasks.

In the event where all IGALL AMP tasks were covered by tasks of a plant or maintenance programme, the existing AMP was deemed adequate due to its conformity with IGALL requirements.

The attributes were grouped and separately reviewed.

5.2.3.1.1 Attribute 1 – AMP Scope

Compliance of the existing plant programmes with Attribute 1 was checked as part of the AMR process. The outcome of the AMR was reported in the COMSY data sets L1124-GN-LIS-027 [83], and the following AME reports:

- L1124-GN-RPT-023, 'AME Degradation Assessment Results Mechanical' [89];
- L1124-GN-RPT-024, 'AME Degradation Assessment Results Civil' [90] and
- L1124-GN-RPT-025, 'AME Degradation Assessment Results Electrical' [91].

5.2.3.1.2 Attributes 2 to 5 – AMP Variable Requirements

IGALL AMP Attributes 2 to 5 covers elective or complementary activities such as maintenance, inspection, mitigation, and monitoring. The existing KNPS plant programmes were checked for consistency against these attributes. The results of this assessment are documented in:

- L1124-GN-LIS-009A, 'List of IGALL-AMP Task Requirements – AMP Mechanical' [76];
- L1124-GN-LIS-009B, 'List of IGALL-AMP Task Requirements – AMP Electrical' [77] and
- L1124-GN-LIS-009C, 'List of IGALL-AMP Task Requirements – AMP Civil' [78].

5.2.3.1.3 Attributes 6 to 9 – AMP Generic Requirements

Attributes 6 to 9 are generic programme requirements that must all be attained by the existing KNPS plant programmes. The Consortium checked existing KNPS plant programmes for compliance.

Based on the review outcome, a number of suggested gaps with proposed corrective actions were documented in report L1124-GN-RPT-030, 'Comparison Report of the Existing KNPS Plant Programs with IGALL AMP Requirements' [93].

5.2.3.2 Ageing Management Programme Review Results

The results of this AMP review for each discipline are expanded in the sections below.

5.2.3.2.1 Civil

The civil AMP review is documented in report L1124-GN-RPT-030 [93] and resulted in the following:

- 5 AMPs that meet the IGALL requirements;
- 7 AMPs that partially meet the IGALL requirements; and
- 1 AMP that needs to be developed to meet the IGALL requirements.

5.2.3.2.2 Electrical and I&C

The electrical and I&C review is documented in report L1124-GN-RPT-030 [93] and resulted in the following:

- 12 AMPs that meet the IGALL requirements;
- 3 AMPs that partially meet the IGALL requirements;
- 2 AMPs with full gaps that needs to be developed to meet the IGALL requirements; and
- 3 AMPs were considered as not applicable for KNPS.

5.2.3.2.3 Mechanical

The mechanical review is documented in report L1124-GN-RPT-030 [93] and resulted in the following:

- 25 AMPs that meet the IGALL requirements;
- 8 AMPs that partially meet the IGALL requirements; and;
- 7 AMPs that need to be developed in order to meet the IGALL requirements.

Eskom reviewed the above results and recommendations relating to AMP reviews and established the Eskom position for all recommendations, documented decisions with appropriate justifications and captured corrective actions in the AME recommendation review reports for mechanical, civil, electrical and I&C as discussed in the AME results section of this report (refer to section 5.3).

5.2.4 Ageing Management Review

The ageing management review (AMR) for in-scope SSCs (commodity groups and stand-alone items) was performed in order to demonstrate that ageing management at KNPS is comprehensive and that ageing concerns will be effectively managed so that the intended function(s) of the SSCs is maintained for the period of extended operation through LTO.

In accordance with requirements stipulated in Eskom AME procedure, 240-125122792 [2], the methodology developed and applied by the Consortium to perform the AMR activities is defined in L1124-DE-RPT-003, 'SALTO Ageing Management Evaluation Methodology' [66]. The document provide a process whereby SSCs were evaluated for ageing effects based on their materials of construction, operating environments, and operating experience.

The ageing management review systematically assessed the ageing effects and their related degradation mechanisms that are experienced or are anticipated for specific commodity groups and SSCs. This was conducted to provide the assurance of the ability of the SSCs to perform their intended function(s) throughout the extended plant life.

The AMR was performed by following the main steps shown in Figure 5-2: Ageing Management Review (AMR) Process and discussed below.

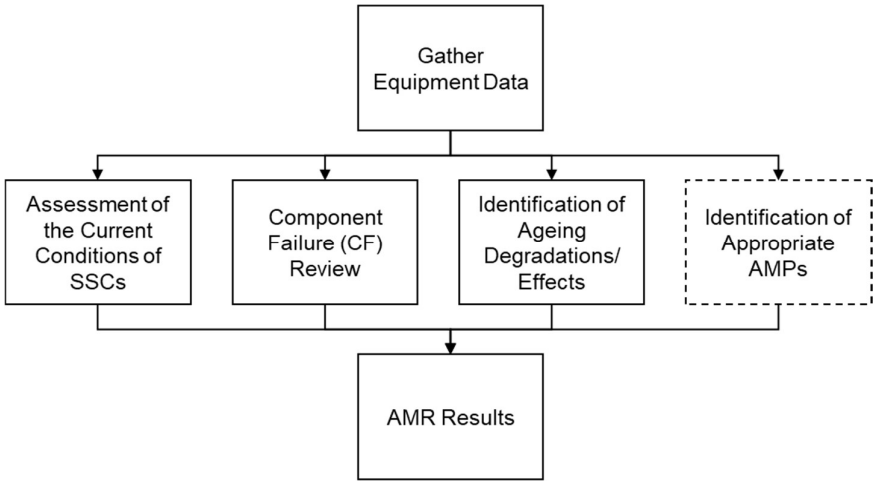

Figure 5-2: Ageing Management Review (AMR) Process

5.2.4.1 Gathering Equipment Data

The following data was collected during the scoping process in the system assessment sheets (described in section 4.4.2) as an input into the AMR and included into L1124-GN-LIS-002, 'The Engineered Master Table' [72]. The SSC data consisted of the following and was collected during the scoping phase:

- Material information:
  - For mechanical and civil, material specification (steel grade, concrete strength class, design information, coating system, expansion joints synthetic material, seals and sealant layer);
  - For electrical and I&C, ageing sensitive materials of component and component datasheets in order to identify service limits of the SSC.
- Data required for assessing electrical and I&C equipment such as ageing susceptible parts and materials, temperature, radiation, electrical voltage, humidity, rated current and rated power.
- Installation information and position (defined in terms of rooms numbers or environmental zones);
- A comprehensive list of environmental zones based on room numbers and the prevailing environmental conditions in each building, room, and plant area. The report L1124-GN-RPT-040, 'SALTO Room Master and Environmental Zones Report' [95] provides details of all the buildings, rooms, and locations where SALTO in-scope equipment is found at KNPS. The

results are provided in L1124-GN-LIS-016, 'SALTO Room Master and Environmental Zones List' [80].

- Information on whether the SSC is active or passive;
- Service conditions:
  - For electrical and I&C: Service conditions consist of operational conditions i.e. voltage, rated current, frequency and environmental conditions e.g. temperature, humidity, and/or radiation.
  - For mechanical and civil: Service conditions consist of operational conditions i.e. fluid conditions (such as temperature, pressure, mass flow rate and internal medium) and environmental conditions (e.g. temperature, pressure and humidity of the external medium);
- List of commodity grouping, consisting of IGALL commodities and, if applicable, sub-commodities, based on the Koeberg AMM;
- IGALL Master Table information;
- IGALL generic AMPs;
- Koeberg AMM information;
- List of existing KNPS plant programmes;
- Plant Drawings (such as P&ID, isometrics and electrical drawings);
- Current Maintenance strategies and activities from the IQ Review database and the SAP database;
- Information on whether the component is subject to time limited ageing analysis, including its qualified life (for electrical and I&C) validity at the point in time of being assessed.

The information was collected into the system assessment sheets and L1124-GN-LIS-002 [72], and later uploaded into the COMSY database. The Engineered Master Table was used as a database of SSCs and the relevant information applicable to the SSCs were obtained from Eskom technical sources with the primary purpose of formalising and enhancing the extent and accuracy of the in-scope SSCs.

5.2.4.2 Assessment of the Current Conditions of SSCs

Eskom has developed and implemented different plant programmes and processes to monitor and maintain KNPS SSCs in good condition. Implementation of these programmes not only provided confidence that the long term ageing degradations of SSCs were managed effectively, but it also provided insight into the current condition of the in-scope SSCs. The plant programmes implemented at KNPS as well as the results of programme outcomes continue to provide information on the condition of the in-scope SSCs and the condition of the SSCs was therefore known before conducting the AMR. The assessment of the current conditions of in-scope SCCs was further augmented by performing the component failures (CFs) review (discussed in Subsection 5.2.4.3).

The position on the approach KNPS has adopted for the assessment of the current physical status of relevant SSCs for SALTO AME has been documented in the draft output deliverable close-out form (ODCOF), 08016.ODCOF.049, 'Position on Current Conditions of SSCs for SALTO' [8]. This provides the justification for taking credit for the existing programmes and processes at KNPS in

confirming the current conditions of the relevant SSCs. This is in accordance with the requirements stipulated in the SALTO AME procedure 240-125122792 [2].

5.2.4.3 Component Failure Review

During the AMR process, component failures (CFs) reported at KNPS were reviewed. The review compared international failure rates with those of Koeberg. This review provided information on the physical condition of SCCs.

Although there were limited records of component failures until 2003 (due to a change in data retention software), more records were obtained from 2004 onwards. More than 15 years of data was considered a good sample basis.

L1124-GN-RPT-039, 'Component Failure Report' [94], and L1124-GN-LIS-017, 'Component Failure List' [81], were compiled to report on the review of these component failures.

The review of the CFs indicated that where failures occur, these were dealt with sufficiently and affected components were restored to their good health. The review also confirmed that the plant programmes and processes credited for ageing management are effective in maintaining the condition of SSCs in good health.

5.2.4.4 Identification of Ageing Degradations and Associated Ageing Effects

Potential ageing mechanisms and subsequent applicable ageing effects were identified and assigned to a commodity group or SSC within COMSY. The capability and functionality of the COMSY software is explained in section 4.4.9. COMSY was used to obtain the comprehensive link of all potential ageing mechanisms to the commodity group or SSC, based on the IGALL Master Table and the Koeberg AMM. Through the AMR process, the industry OE, KNPS specific OE and the Framatome OE were applied.

The AMR systematically assessed ageing effects and their related degradation mechanisms that have been experienced or anticipated. The AMR process included the identification of relevant ageing effects and degradation mechanisms for each structure or component (and the appropriate plant programmes to manage the identified ageing effects and degradation mechanisms [as per section 5.2.3]).

5.2.4.5 Identification of Appropriate Ageing Management Programmes

For ageing effects requiring management, the process defined in L1124-DE-RPT-003 [66], also determines the relevant ageing programmes needed to manage the ageing effects and associated degradation mechanisms.

The identified ageing effects and degradation mechanisms that require ageing management should be managed using existing ageing management programmes or existing plant programmes (possibly with improvements or modifications), or new programmes should be developed.

The AMP review was performed in two stages;

- Stage 1: A programmatic review against the IGALL AMPs to identify programmes that are required by IGALL but do not exist at KNPS. This included the review of the existing KNPS plant programmes used for ageing management against the nine generic attributes of an effective AMP as defined in IGALL and RG-0027 [7].

- Stage 2: An AMP task level review of the required IGALL AMPs tasks against the existing KNPS plant programmes tasks implemented to manage applicable ageing degradations. This was performed at a commodity group or SSC level during the AMR.

The details and results of the programmatic review (stage 1) are provided in section 5.2.3. These results were used as inputs into the AMR to support the AMP task level review (stage 2) and to ensure that the ageing degradations identified for in-scope SSCs are effectively managed. In some case, new programmes or updates to existing plant programmes were recommended to manage the identified ageing degradations.

5.2.4.6 Ageing Management Review Results

The results of the ageing management review are documented in the COMSY data sets L1124-GN-LIS-027 [83] and in the discipline specific AME reports.

Each AME report provides information on the following:

- A list of SSCs/commodity groups evaluated;
- An assessment of the ageing effects and degradation mechanisms using the IGALL Master Table, the Koeberg AMM and Framatome experience;
- New ageing degradations and ageing effects for commodity groups or in-scope SSCs and relevant plant programmes requiring updates as results of these additional ageing degradations.
- Plant programmes or activities to manage the ageing effects and degradation mechanisms for each commodity grouping or SSC;
- The effectiveness of the existing plant programmes to manage the identified ageing degradations and their adequacy for LTO.
- The recommendations which include updates to existing plant programmes (such as additional SSCs to be included in the programme scope or additional tasks for the management of identified degradation mechanics and ageing effects) or the need for new plant programmes.

The results are documented in Civil Degradation Assessment Results Report, L1124-GN-RPT-024 [90], Electrical Degradation Assessment Results Report, L1124-GN-RPT-025 [91] and Mechanical Degradation Assessment Results Report L1124-GN-RPT-023 [89]. These reports provides the identified potential ageing management gaps with recommended actions.

While the results of the AMR identified gaps in the current ageing management programmes at KNPS, the assessment did not identify any ageing concerns that would prevent the plant from safely operating into LTO.

5.2.5 Management of the Review and Acceptance of the AME Deliverables

The following steps were taken during the AME process to ensure the quality of data and the AME results:

- Interface with the Eskom Technical Team

  During the AME there was continuous interface and engagements between the Consortium and the Eskom technical team to confirm understanding and interpretation of the KNPS situation, implementation, and application.

The formal exchange of input source and deliverable documents transmitted across interfaces were properly documented and controlled in accordance with the L1124-PM-PLN-004, 'SALTO Consortium Documentation Management Plan' [99].

- Interface with Eskom SMEs and programme engineers

  During the AME process, the Consortium engaged directly with the Eskom SMEs and programme engineers, as required. The Koeberg SALTO Assessment Project technical team facilitated the engagements

- Consortium/Eskom technical meetings

  In addition to the Consortium and Koeberg SALTO Assessment Project technical team direct engagements, there were meetings held between the Consortium technical team (often including back office staff/experts situated overseas) and the Koeberg SALTO Assessment Project technical team to address any technical challenges and anomalies relating to the AME.

- Focused workshops

  Focused workshops were arranged to discuss specific technical topics covering the process, the results, and challenges where Eskom support was required.

- Eskom review of the final AME deliverables

  All AME deliverables were submitted to Eskom that utilised the Koeberg SALTO Assessment Project technical team and Eskom SMEs to review, and accept the final AME deliverables. Formal document review forms tracked all comments to ensure resolution prior to acceptance.

5.3 Recommendations Verification

Following the acceptance of the AME deliverables, a verification (i.e. review, evaluation, and consideration) of the recommendations was performed in order to determine actions required to address the recommendations.

Figure 5-3 depicts the final AME deliverables by the Consortium and the verification process by the Eskom technical team and plant SMEs. As shown in Figure 5-3, the recommendations made by the Consortium were submitted to Eskom that utilised the Technical Team (which included the SALTO technical Team, plant SMEs, and plant/programmes engineers) to:

- Technically review the recommendations;
- Formulate Eskom positions on the Consortium's findings and recommendations;
- Determine corrective measures required to address any gaps (with justifications, if required for the measures proposed). The corrective actions could include any of the following actions:
  - No further action required by providing sufficient justification;
  - One-time inspections to determine further potential actions;
  - Updates to existing programme or maintenance activities;
  - New plant programme required;
  - Further engineering assessment required.

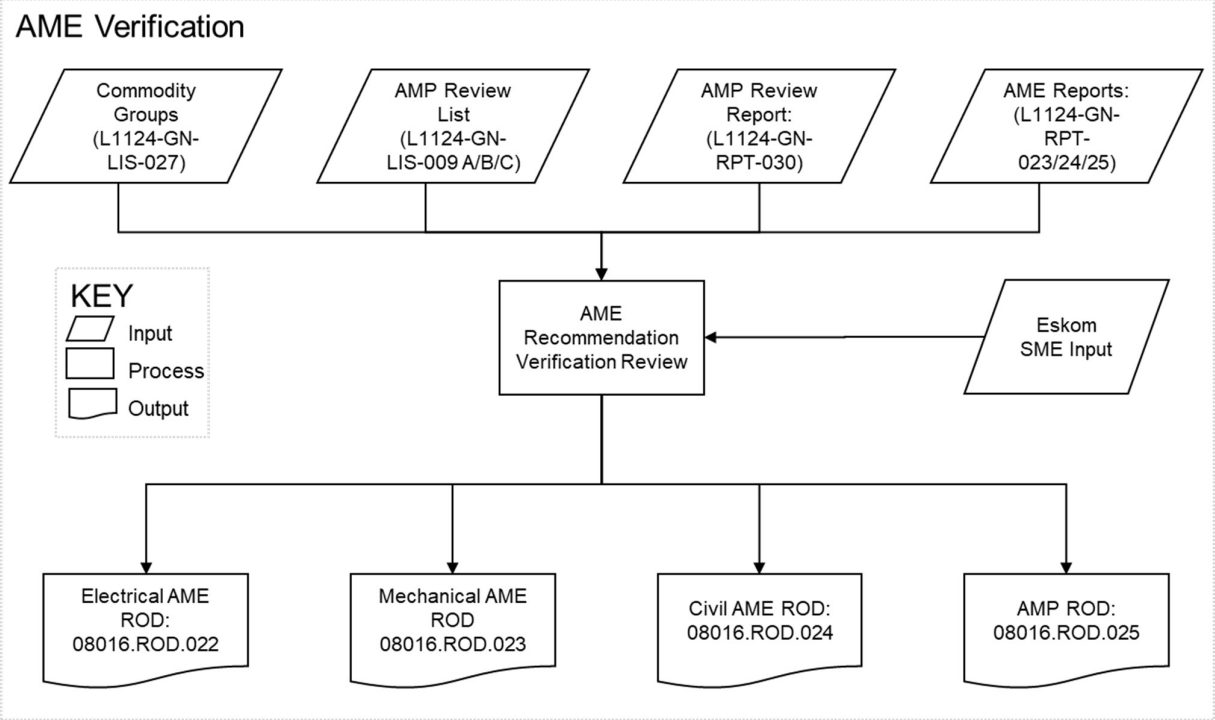

Figure 5-3: Eskom AME Verification Process

For each discipline, a Record of Decision (ROD) was compiled comprising of the technical review considerations and decisions, the confirmation of the gaps as well as the corrective actions required to address the gaps identified. The review reports were then submitted and presented to the Programmes Engineering Technical Review Meeting (TRM) for further technical review and acceptance.

The RODs to address the shortfalls identified was submitted to the SALTO Management Oversight Committee (SMOC) for endorsement and inclusion into the Koeberg SALTO Assessment Project scope. The actions identified were captured as corrective actions on DevonWay and actioned for implementation by the various responsible line groups. The identified actions are to be executed to ensure that the safe long term operation of KNPS is not be impacted.

For each discipline, the results of the review and verification of the recommendations conducted by the Eskom technical team are briefly discussed below.

5.3.1 Civil

The process followed to review the recommendations in report L1124-GN-RPT-024 [90], the review results and associated corrective actions were captured in ROD 08016.ROD.024, 'Scope stemming from review of the Civil AME Report L1124-GN-RPT-024' [16]. Refer to CR 115457 for the actions loaded in DevonWay.

A summary of the actions are as follows:

- 2 new AMPs required:
  - A new liner-monitoring programme is required to implement the requirements of

AMP 306 and AMP 309 for metallic and non-metallic/epoxy lined pools and sumps (for the Spent Fuel Pool liners, Reactor Pool liners and all Steel & Epoxy Lined Sumps).

- Updates to existing plant programme and inspection documents:
  - Updates to the existing Civil Monitoring Programme Inspection/Monitoring procedures to address the identified gaps and satisfy the requirements of AMP 301, 305, 306, 307, 308, 311 and 313.
  - Address civil programmatic gaps identified in L1124-GN-RPT-030 [93] and documented in ROD 08016.ROD.025, 'Comparison of the existing Plant Programmes with IAEA IGALL-AMP Requirements' [17].
  - Confirmation that requirements in accordance with AMP 308, 'Protective Coating Monitoring and Maintenance', for the ageing effects due to irradiation are addressed in the existing Corrosion Monitoring Programme.
  - Confirmation that the requirements in accordance with AMP 306 for the ageing of paints, vibration fatigue and the thermal cracking of steel liners are addressed in the existing ISI Programme.
- One-time inspections required:
  - Perform one-time inspections of the vent stack and chimney, joints, penetrations, containment joints, and containment structural concrete commodities to identify the present state of condition. These results will then be evaluated, and a decision will be taken whether a periodic inspection task or a new plant programme will be required. (Typically, these are potential ageing/degradation concerns based on partial applicability and no previous KNPS history or documented failures.)
- Engineering assessments required:
  - System engineering assessment documenting the nuclear safety risk of blockage and flooding of floor drains (in the containment structures, fuel buildings, connecting building, electrical buildings, and HQB) and advise which action to be taken (if any or if not justifiable).

5.3.2 Electrical

The process followed to review the recommendations in report L1124-GN-RPT-025 [91], the review results and associated corrective actions were captured in ROD 08016.ROD.022, 'Review of the Electrical, Instrumentation and Control Ageing Management Evaluation (AME) Report L1124-GN-RPT-025 and Decisions by Eskom' [14].

A summary of the actions are as follows:

- 6 new AMPs to be developed:
  - AMP 210 – Condition monitoring of electrical and I&C cables subject to EQ requirements;
  - AMP 212 and AMP 215 – Electrical enclosures and switchgears and other active components, not subject to EQ requirements;
  - AMP 213 – Whiskers and capacitors with liquid electrolyte;
  - AMP 218 – Electronic equipment not subject to EQ requirements; and
  - AMP 220 – Lightning protection and grounding grid not subject to EQ requirements.

- Updates to existing plant programmes/maintenance activities:
  - Update to the existing cable ageing management programme (CAMP) with the additional scope of cables, cable connections, and associated measures required for different voltage levels.
  - Review and update the scope of the current maintenance procedures/service notes for the inspections of electrical penetrations to include additional scope.
  - Review and update of life-of-plant plan LOPP-162 for 6,6 kV/380 V dry-type transformers.
  - Address programmatic gaps identified in L1124-GN-RPT-030 [93] and documented in ROD 08016.ROD.025 [17].
- Engineering position:
  - Document the engineering position based on the current maintenance strategy, operating experience and applicable IGALL AMPs requirements for electrical motors, motor actuators, solenoids valve actuators, and oil-filled transformers.
- Qualified equipment:
  - The strategy of the qualified equipment is discussed under TLAA results (section 6.4) and documented in 08016.ROD.018, 'Equipment Qualification Time limited Ageing Analysis Strategy' [12].

5.3.3 Mechanical

The results of the review and verification of the recommendations conducted by the Eskom technical team concluded with 18 corrective actions. These actions were raised for implementation by line groups as tracked under CR 116340 and loaded in DevonWay. Further details on the review, Eskom' decisions and the recommended actions can be found in 08016.ROD.023, 'Review of the Mechanical Ageing Management Evaluation (AME) Report L1124-GN-RPT-023 and Decisions by Eskom' [15].

A summary of the actions are as follows:

- 10 new AMPs to be developed[7]:
  - AMP 112 - Thermal ageing embrittlement of cast austenitic stainless steel;
  - AMP 119 - One-time inspections;
  - AMP 120 - Selective leaching;
  - AMP 121 - One-time inspections Class 1 small-bore piping;
  - AMP 135 - Inspection of internal surfaces in miscellaneous piping and ducting components;
  - AMP 137 - Monitoring of neutron absorbers other than Boraflex;
  - AMP 154 - PWR pressuriser;
  - AMP 156 - PWR main coolant piping;
  - AMP 157 - Internal coatings and linings;

[7] Several of these topics are addressed at KNPS by some method, but judged to be incomplete or insufficient.

- AMP 161 - High-cycle fatigue monitoring.

- Updates to existing programmes and maintenance activities:
  - Thermal Fatigue Programme;
  - Chemistry Programme;
  - Fire water system;
  - Preventive maintenance programme;
  - External surfaces monitoring of mechanical components;
  - Closed treated water systems;
  - Heat Exchanger Programme.

5.3.4 Generic AMP Programmatic Updates

The recommendations review and accepted actions for updates to existing programmes to address programmatic gaps identified due to the AMP generic requirements review (as defined in section 5.2.3.1.3) that are documented in L1124-GN-RPT-030 [93] is provided in 08016.ROD.025, 'Comparison of the existing Plant Programmes with IAEA IGALL-AMP Requirements' [17].

Two user requirements specification documents have been developed to obtain support with the development and updating of KNPS programmes as required by the raised actions. These are documented in:

- 240-154273661, 'User Requirement Specification for the Development of Ageing Management Programmes required for Koeberg Nuclear Power Station' [31]; and
- 240-157225915, 'User Requirement Specification for the Updates to Existing Ageing Management Programmes' [32].

5.4 Organisational Responsibility for the AME Deliverables

The AME deliverables completed during the Koeberg SALTO Assessment Project Definition Phase have been provided to Programmes Engineering Department via letter NPM-043-2020 as the custodian of the overarching Ageing Management Programme at KNPS.

In Programmes Engineering, the AMPs are managed in the Material Reliability Group (MRG). The Ageing Management Programme owner has been appointed to oversee the plant-level ageing management process, including the implementation thereof. MRG is responsible for continuous review of plant programmes and the creation of new AMPs, as required.

The following processes exist for ageing management at KNPS:

- Ageing Management Standard

  240-149139512, 'Ageing Management Requirements for Koeberg Nuclear Power Station' [26], was developed to provide overall requirements for the ageing management of equipment important to safety at KNPS and to meet the requirements of RG-0027 [7]. The standard provides the requirements and the framework for physical ageing management processes at KNPS for the life of the plant, including LTO. It covers all stages of equipment life of the plant, that is: design; construction; manufacturing; commissioning; operating; LTO; suspended operation; and decommissioning.

- Ageing management programmes list

  The list of plant programmes that are identified for use in ageing management is documented in 240-150483693, 'Ageing Management Programmes List' [27]. New plant programmes identified during the AME process are required to be developed in accordance with the nine attributes documented in 240-149139512 [26] and those programmes will be added to the list of AMPs.

- Process for the development and control of ageing management (AM) at Koeberg Operating Unit.

  331-275, 'Process for the development and control of AM at Koeberg Operating Unit' [36] describes the process used to manage (develop, control, and update) the Koeberg AMM, including the roles and responsibilities for updating of the information contained therein. The document further describes the Koeberg AMM oversight roles and how ageing aspects requiring improved management are corrected. It demonstrates how the effects of ageing degradation are managed and monitored for the in-scope SSCs throughout plant operating life, including the planned period of LTO.

- Programme engineers' guide

  331-148, 'Programme Engineers' Guide' [33] provides guidance for programme engineers who develop, maintain, optimise, and perform programme oversight on the ageing management programmes allocated to them.

- Ageing management matrix

  240-101650256, 'Koeberg Ageing Management Matrix' [18] is used to identify the ageing mechanisms relevant to KNPS and the SSCs that are affected by ageing mechanisms or degradations that can affect equipment life or capability. 08016.ROD.017, 'Adoption of COMSY Database for Ageing Management at KNPS' [8], recorded the Eskom decision to the use of commodity groups from the IAEA IGALL Master Table for ageing management at KNPS and adopt the COMSY software tool to support this. COMSY will replace the current Koeberg AMM.

In addition, MRG conducted a review of RG-0027 [7] against the current Ageing Management Programme and processes established at KNPS. The purpose of the review was to confirm alignment of all current processes and programmes which fall within the scope of Ageing Management to the regulatory requirements stipulated in RG-0027 [7]. In instances where gaps were identified, actions were raised to the responsible line groups and/or departments to review the finding and develop a resolution to fill the gap and comply with RG-0027 [7]. The self-evaluation report SE 38545 was compiled with 18 corrective actions (CAs). 08016.ROD.021, 'Review of the interim regulatory guide on ageing management and long term operations of nuclear power plants (RG-0027 Rev 0) against the current ageing management programmes and processes' [13]) was compiled to include the tracking of the raised CA's under the scope of the Koeberg SALTO Assessment Project.

This concludes the Ageing Management Review section. The next section will focus on Time Limited Ageing Analyses.

6 Time Limited Ageing Analyses

TLAAs are plant-specific safety analysis in the plant design basis that considers time and ageing of the SSCs within the scope of ageing management. These time limited assumptions are typically based on an initially assumed period of operation and/or anticipated operational transients, design considerations, or licence terms.

This section provides the requirements for TLAAs, describes the methods and processes used by Eskom to meet these requirements, provides descriptions of relevant TLAAs, and presents the verifications that were performed in order to conclude on their adequacy for LTO. Furthermore, this section provides an overview of the TLAA results to date and further work required to update or create those TLAAs that are not yet satisfactory for LTO. The section concludes with the TLAA organisational responsibilities beyond the Koeberg SALTO Assessment Project scope.

6.1 Requirements

In accordance with RG-0027 [7], for in-scope SSCs, Eskom identified all TLAAs and should demonstrate either that all these analyses will remain valid for the planned period of LTO, or that the SSCs will be replaced, or that further operational maintenance or AM actions will be implemented.

As stipulated in section 6.9 of RG-0027 [7], TLAAs should meet all six of the following criteria:

a) TLAAs should involve SSCs within the scope for AM.

b) TLAAs should consider ageing effects. Ageing effects include, but are not limited to loss of material, changes in dimension, changes in material properties, loss of toughness, loss of pre-stress, settlement, cracking, and loss of dielectric properties.

c) TLAAs should involve time limited assumptions defined by the current operating term. The specified operating term should be explicit in the analysis. The simple assertion that a component is designed for a particular service life or plant lifetime is not sufficient. Any such assertion should be supported by calculations or other analyses that explicitly include a time limit or a time-based assumption.

d) TLAAs should have been determined to be relevant by the operating organisation in making a safety determination as required by national regulations. Relevance is a determination that the operating organisation makes based on of a review of the information available. A calculation or analysis is relevant if it can be shown to have a direct bearing on the action taken as a result of the analysis performed. Analyses are also relevant if they provide the basis for the safety determination for the plant where, in the absence of the analyses, the operating organisation might have reached a different safety conclusion or taken a different safety action.

e) TLAAs should involve conclusions or provide the basis for conclusions relating to the capability of the SSC to perform its intended function(s).

f) TLAAs should be contained or incorporated by reference in the current licensing basis. The current licensing basis includes the technical specifications as well as design basis information, or commitments of the operating organisation documented in the plant specific documents contained or incorporated by reference in the current licensing basis including, but not limited to: SAR, regulatory safety evaluation reports, the fire protection plan or hazard analysis, correspondence with the regulatory body, the documentation of the management system, and topical reports included as references in the safety analysis reports. If a code of record is in the SAR for a particular group of structures or components, reference material

should include all calculations called for by that code of record for those structures or components.

Safety analyses that meet all criteria except for criterion (f), and that have been developed to demonstrate preparedness for the intended period of operation, should also be considered as TLAAs.

The validity of TLAAs over the intended period of operation should also be assessed by demonstrating satisfaction against one of the following criteria:

a) The analysis should remain valid for the intended period of operation. The time dependent parameter value for the intended operating period should not exceed the time dependent parameter value used in the existing analysis.

b) The analysis should have been projected to the end of the intended period of operation. The value of the analysis parameter value should be changed based on the time dependent parameter projected for the intended operating period, and the value of the analysis parameter should continue to meet the regulatory limit or criterion.

c) The effects of ageing on the intended function(s) of the structure or component should be adequately managed for the intended period of operation. The value of the analysis parameter should be managed (using an AMP) to ensure that ageing effects are adequately managed and that the value of the analysis parameter will continue to meet the regulatory limit or criterion throughout the intended period of operation.

If the TLAAs cannot be found acceptable using criterion (a), (b), or (c) above, then corrective actions should be implemented. Depending on the specific analysis, corrective actions could include:

- Refinement of the analysis to remove excess conservatism;
- Implementation of further actions in operations, maintenance or AMP;
- Modification, repair, or replacement of the structure or component.

6.2 Methodology

Historically, no consolidated list of KNPS TLAAs existed. Consequently, the TLAA evaluation methodology selected by Eskom to satisfy the regulations included the following steps:

- Identification and verification of existing plant TLAAs;
- Comparison of existing plant TLAAs with expected IGALL TLAAs;
- Validation of TLAAs applicable to KNPS for 60 years operation;
- Corrective actions for TLAAs not found acceptable using criterion (a), (b), or (c) as stated above;
- Review and approval of TLAAs;
- Documenting the TLAA evaluation results;
- Updating of the affected documents in the current licensing basis (in most cases the SAR including the actual analysis or reference thereto); and
- Regulatory review and approval.

This methodology is documented in 240-125122792, 'Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses' [2].

Regulatory review and approval will be required for updated, validated, re-analysed, new TLAAs, changes to the SAR, other associated licensing basis documents, and the supporting safety evaluations and/or safety justifications as required by 240-143604773, 'Safety Evaluation Process' [25].

6.3 Process

This section describes the steps taken by the Consortium for the process used in the identification and evaluation of TLAAs. This methodology, as defined in L1124-DE-RPT-003, 'Time Limited Ageing Analysis Evaluation Methodology' [67], requires the following steps:

- Identification and verification of existing KNPS TLAAs.
- Review international OE and internal experience to ensure that all relevant TLAAs have been identified. The relevant sources/references used to identify relevant TLAAs were well documented.
- Compilation of a comprehensive list of TLAAs that include reference documentation.
- Comparison of the KNPS TLAAs identified with the IGALL TLAAs.
- Compile a list of IGALL TLAAs that do not apply to KNPS with justification.
- Validation of existing TLAAs for a 60 year life of plant.
- Compilation of a list of TLAAs that require re-analysis.

6.3.1 Identification and Verification of Existing Plant TLAAs

The existing KNPS TLAAs were identified by the Consortium searching various input sources, including the Koeberg SAR, DSEs and other design-basis documents using key-words as documented in L1124-GN-RPT-022, 'Report on Verified List of Existing Koeberg Time limited Ageing Analyses' [88].

A review of international OE from stations with a similar design was also used to identify any further applicable TLAAs. These included:

- Tihange NPP;
- Doel NPP;
- Borssele NPP;
- Ringhals NPP;
- KORI 1 NPP;
- RE Ginna NPP;
- DC Cook NPP;
- Davis Besse NPP;
- North Anna and Surry NPPs;

- VC Summer NPP; and
- EDF CPY plants.

The review of international experience is documented in L1124-GN-RPT-027, 'Report on Operational Experience for the Review of Existing Koeberg TLAAs' [92].

6.3.2 References Not Considered as TLAAs

During the TLAA search of the input sources the following references shown below were identified. However, upon investigation, they did not fulfil the NNR or IAEA criteria and have therefore not been considered as TLAAs. Their exclusion is documented in L1124-GN-RPT-022 [88].

- 331-260, 'Reactor Pressure Vessel – Cracking of the Core Barrel Bolts';
- 331-262, 'Ferritic Inclusions – Significant Deficiency SD 027';
- KBA0022NNEPONEPP134, 'Thermal Fatigue in the Mixing Zones on NSSS and BNI Piping';
- KBA0022NNEPONEPP034, 'Thermal Stratification and Thermal Fatigue of the Dead End and Interspace Piping';
- ISIPRM AUG 13, 'Main Steam Piping'.

Despite the documents mentioned above not being TLAAs, the SSCs that are referred to above are still included in the in-scope list and subject to the AME as described in section 5.

6.3.3 Comparison with the IGALL TLAAs

The IAEA IGALL document, SRS 82 [5], provides a list of typical TLAAs based on input from participating member states. The identified KNPS TLAAs were compared with the IGALL list of applicable pressurised water reactor TLAAs and tabled below as documented in L1124-GN-RPT-027 [92].

Table 6-1: IGALL TLAA Comparison

TLAA title	Existing KNPS TLAAs	Additional IGALL TLAAs required by KNPS
IGALL TLAAs for mechanical components		
TLAA101 Low-Cycle Fatigue Usage	X	
TLAA102 RPV Neutron Embrittlement	X	
TLAA103 Crack Growth Analyses	X	
TLAA104 Corrosion Allowances		X
TLAA106 Environmentally Assisted Fatigue		X
TLAA107 High-Cycle Fatigue for Steam Generator Tubes		X
TLAA108 Fatigue of Cranes		X
TLAA109 PWR RPV Internals Swelling		X

TLAA title	Existing KNPS TLAAs	Additional IGALL TLAAs required by KNPS
TLAA110 Thermal Ageing of Cast Austenitic Stainless Steels	X	
TLAA112 Main Circulation Pump Flywheel		X
TLAA115 Fatigue and Thermal Ageing Analysis of Manufacturing Flaws	X	
TLAA116 Thermal Ageing of Low Alloy Steels	X	
TLAA117 Under Clad Cracking	X	
TLAA118 Components with Undocumented Restrictions On Operation		X
TLAA119 High-cycle Thermal Fatigue		X
TLAA120 PWR RPV Internals Vibrations		X
TLAA121 IASCC Fluence Limit for Stainless Steel		X
TLAA122 Thermal Ageing of Martensitic Stainless Steels		X
IGALL TLAAs for electrical components		
TLAA201 Environmental Qualification of Electrical and I&C Components	X	
IGALL and New TLAAs for civil structures		
TLAA301 Concrete Containment Tendon Pre-stress		X
TLAA303 Cumulative Fatigue Damage of Containment Liners and Penetrations		X
TLAA304 Foundation Settlement due to Soil Movement		X

6.3.4 Validation of TLAAs Applicable to KNPS for 60 years

Based on the identification efforts, a comprehensive list of all the KNPS TLAAs was compiled in L1124-GN-LIS-010, ‘Comprehensive List of Koeberg TLAAs’ [79].

Each TLAA was researched and evaluated and a report generated per component or component type. These reports described the ageing mechanisms and effects relating to the components and their parts. The applicable IGALL TLAAs were identified for each of these components as well as any other potential degradation mechanisms (that could be linked to time limited assumptions as per the insights and experience of the Consortium, particularly Framatome as the KNPS NSSS OEM). Where there were original analyses, these were then studied and where possible, their TLAAs were validated and justified for 60 years.

As part of the Steam Generator Replacement (SGR Project), modification no. 07092, the impact of reversing operation at reduced temperature (ORT) and possible thermal power uprate (TPU) was

analysed. These analyses covered several of the TLAAs identified during the Koeberg SALTO Assessment Project and justified for 60 years as part of the SGR Project work.

The TLAAs that were identified but not validated for 60 years by the Consortium or the SGR Project were recommended for creation, analysis, or re-analysis.

6.4 Results

As indicated in section 6.3.4, TLAA reports were generated per component. A list of these Consortium documents is presented below. Where documents were later updated by Framatome, their document number is listed with the original Consortium number shown between brackets.

Table 6-2: TLAA Reports

Document number	Title
D02-ARV-01-138-106 (L1124-GN-RPT-031)	Reactor Coolant Pumps
D02-ARV-01-142-242 (L1124-GN-RPT-032)	RPV Internals
D02-ARV-01-143-003 (L1124-GN-RPT-037)	Control Rod Drive Mechanism
D02-ARV-01-144-513 (L1124-GN-RPT-033)	Reactor Pressure Vessel
D02-ARV-01-144-514 (L1124-GN-RPT-034)	Reactor Pressurizer
D02-ARV-01-144-861 (L1124-GN-RPT-038)	Steam Generators
D02-ARV-01-145-030 (L1124-GN-RPT-035)	Main Coolant and Surge Lines
D02-ARV-01-146-690 (L1124-GN-RPT-036)	In-Core Instrumentation
D02-ARV-01-149-074 (L1124-GN-RPT-046)	Auxiliary and Secondary Lines
L1124-GN-RPT-018	Time limited Ageing Analysis Based on Initial Environmental Qualification
L1124-GN-RPT-019	Validity of KNPS Containment Civil TLAA 301
L1124-GN-RPT-020	Validity of Polar Crane
L1124-GN-RPT-044	KNPS Containment Liner
L1124-GN-RPT-045	KNPS Containment Settlement Civil

A comprehensive list of the TLAAs is provided in L1124-GN-LIS-010 [79]. Appendix D lists the TLAAs still requiring validation for 60 years.

The mechanical and civil results are summarised in the table below:

Table 6-3: Mechanical and Civil TLAA Result Summary

TLAAs	Mechanical	Civil
Existing TLAAs that are validated for 60 years operation	66	0
Newly identified TLAAs that were validated for 60 years operation	32	2
Components that still require analyses to validate them for 60 years operation	8	2

The complete scope of electrical and I&C components which is to be environmentally qualified and validated is documented in list L1124-EL-LIS-001, 'List of in-scope items for SALTO EQ TLAA' [68]. The list of qualified cables that provide the cable identification numbers as well as the cable types is provided in the document L1124-EL-LIS-004, 'EQ Cable List' [71].

The TLAAs of environmentally qualified equipment, as required by the IAEA IGALL TLAA 201, was performed and the results documented in the report, L1124-GN-RPT-018, 'EQ TLAA report' [84], together with the associated results sheet L1124-EL-LIS-002, 'SALTO TLAA Result List' [69] This report justifies for the extension of the qualified life (QL) for some components. Identified components with a QL shorter than 60 years require re-analysis or replacement before start of the LTO period. Guidance and recommendations for electrical and I&C components given in IAEA IGALL TLAA 201, AMP 207, and AMP 209 were used for the EQ TLAA.

A total of 262 EQ components and 363 EQ cables are included in the scope of the EQ TLAA.

The results of the EQ TLAA validation and verification are summarised below:

- 67 EQ items are periodically replaced and this strategy will be maintained and therefore there is no need to subject these items to further re-analysis.
- Some items (mainly transmitters in mild environments) were validated for LTO but not 60 years. They will have to be replaced before their QL expire.
- Some items were validated for 60 years
- Some items were confirmed to be valid for 40 years and not suitable for LTO. These components must be re-analysed, or the components must be replaced before the start of the LTO period.

Table 6-4: EQ TLAA Result Summary

Components	Unit 1	Unit 2
QL valid for 60 years	161	157
QL not valid for 60 years	26	26
QL valid for 40 years	75	79
Total of EQ equipment	**262**	**262**
Total EQ cables	**363**	**363**

A specific EQ TLAA Strategy was developed by Eskom for the EQ TLAA results and documented in 08016.ROD.018, 'Equipment Qualification Time limited Ageing Analysis Strategy' [12]. The strategy covers the qualified equipment where the QL was not valid for 60 years and the equipment where the QL was valid for only 40 years. For the equipment that has a QL for 40 years, the strategy is to either replace the equipment; perform modifications to the plant; or perform a re-analysis of the applicable component qualification. For the equipment that has a QL not valid for 60 years and with QL expiry in 2030 or 2035, the re-analysis of the QL must be performed before the expiry date. These are mainly components located in mild environments. A complete list of the EQ items requiring replacement and re-analysis, including LTO commitments, is provided in the EQ TLAA Strategy. The list of EQ TLAAs requiring re-analysis of the QL is found in L1124-GN-RPT-018 [84].

6.5 Verification

This section describes the processes for verification of the SALTO TLAA scope as followed by both the Consortium and Eskom.

6.5.1 Consortium Verification

Verification was performed by Consortium engineers to confirm the existence of TLAAs captured from existing digitised plant data sources, the majority from the SAR, DSEs, other design-base documents, IGALL, local, and international OE.

L1124-DE-RPT-004, 'Time Limited Ageing Analysis Evaluation Methodology,' describes the methodology used for this process in detail.

6.5.2 Eskom Verification

A comprehensive evaluation and review of all of the Consortium TLAA reports were conducted by Eskom subject matter experts. The SMEs captured their review comments on DCRF spreadsheets and these review comments were discussed directly with the compilers (Framatome GMBH for civil and EQ scope, Framatome SAS for mechanical scope) to enable agreement of changes, updates, and corrections. Specific focus was placed on identification of additional work required under the execution phase of the Koeberg SALTO Assessment Project.

6.6 Documenting of the KNPS TLAAs

In the execution phase of the Koeberg SALTO Assessment Project, all the TLAAs (validated existing TLAAs, validated new TLAAs, re-analysed, and analysed will be documented in a report format[8] similar to 240-153544432, 'TLAA Report Structure' [26].

Direct negotiations are currently taking place with Framatome to perform the remaining studies required for the TLAAs requiring re-analysis and further analysis as defined in the technical requirements specification, 240-153477196, 'Technical Requirement Specification for Time Limited Ageing Analyses' [26]. This includes the packaging of the TLAAs for submission to the NNR. All documented TLAAs and related SAR updates will be provided to the NNR for approval. This section will be expanded on in the final SALTO Ageing Management Assessment Report.

[8] Discussions are currently still ongoing with Framatome on the structure and contents of the report and may thus still change upon agreement by Eskom

6.7 Organisational Responsibility for the TLAA Deliverables

As the TLAAs are not yet fully finalised, they have not yet been handed over from the Koeberg SALTO Assessment Project to the responsible Eskom organisational group, Design Engineering Group (DEG). DEG owns the plant design and the control thereof. TLAAs are included in the plant design but historically not explicitly identified. DEG has been actioned to update existing design procedures and processes to ensure configuration management and control of TLAAs.

This section will be expanded on in the final SALTO Ageing Management Assessment Report to clarify the continued management processes for TLAAs at KNPS.

This concludes the Time Limited Ageing Analyses section. The next section will focus on the SALTO Ageing Management Assessment commitments for LTO.

7 SALTO Ageing Management Assessment Commitments

This section is included as a place-holder for the final SALTO Ageing Management Assessment Report that will include a list of future activities stemming from the SALTO ageing management assessment that the operating organisation will commit to completing before reaching 40 years of operation and during the LTO period. At this point, this list is not yet available.

This section will be expanded on in the final SALTO Ageing Management Assessment Report.

8 Conclusion

This interim SALTO Ageing Management Assessment Report documents the requirements for the performance of the LTO ageing assessment at KNPS. It demonstrates that the methodologies developed, and processes implemented are performed in a systematic approach that is aligned with international practices and achieve requirements as defined in RG-0027 [7].

The assessment results and recommendations have been reviewed, verified, and actioned to meet the regulatory expectations and assure safe operation into LTO. This result will form part of the application to obtain the required nuclear installation licence variation before LTO.

A summary of the results is as follows:

- SALTO Scope Setting:
  - 209 774 SSCs were reviewed, 84 097 in-scope components and 4 433 in-scope cables were identified.
- Ageing Management Evaluation
  - 683 commodity groups (83 civil, 29 electrical and 571 mechanical) were identified and populated.
  - The development of new ageing management programmes are required to address 18 lacking IGALL AMPs (2 civil, 6 electrical and 10 mechanical).).
  - Some ageing management programme updates, inspections and further engineering assessments are required and actioned.
- Time Limited Ageing Analyses Validation
  - Mechanical: 106 TLAAs were identified, 98 are valid for LTO, 8 still have to be validated;
  - Civil: 4 TLAAs were identified, 2 are valid for LTO, 2 still have to be validated;
  - Equipment Qualification (EQ):
    - Unit 1 – 262 components and 363 cables were identified, 161 components were revalidated for LTO, 26 are valid for entry into LTO but not 60 years, 75 components and all cables still to be validated for LTO.
    - Unit 2 – 262 components and 363 cables were identified, 157 components were revalidated for LTO, 26 are valid for entry into LTO but not 60 years, 79 components and all cables still require validation for LTO.

This interim report will be updated with the results of the remaining actions to form the final SALTO Ageing Management Assessment Report. All LTO commitments stemming from the SALTO ageing management assessment will be documented in the final update to this report in 2022.

9 Acceptance

This document has been seen and accepted by:

Name	Designation
A Kamroodien	Middle Manager – Programmes Engineering and Engineering Support (Acting)
J Kotze	Middle Manager – LTO Programme Manager
D Malale	Middle Manager – Integrated Plant Design – Koeberg (Acting)
M Theron	Manager – Nuclear Regulatory and Licensing
R Cassim	Manager – Materials Reliability
R Goldstein	Middle Manager – Design Engineering

10 Revisions

Date	Rev.	Compiler	Remarks
October 2020	1	A Oosthuizen	Authorised version of initial draft.
October 2020	0	A Oosthuizen	Initial compilation of report to inform the regulator on the status of the Koeberg SALTO Assessment Project.

11 Development team

The following people were involved in the development of this document:

- A Nambiar: Chief Engineer – Integrated Plant Design – Koeberg
- A Oosthuizen: Senior Technologist – Integrated Plant Design – Koeberg
- D Bissell: Project Engineer – Integrated Plant Design – Koeberg
- G Mdluli: Senior Technologist – Materials Reliability Group
- I Malgas: LTO Programme Integration Engineer – Nuclear Engineering
- K Moroka: Senior Engineer – Materials Reliability Group
- M Koopman: Technologist – Component Engineering
- R Maapola: Engineer – Design Engineering

Appendix A: Interim Report in Context to the KNPS LTO Programme

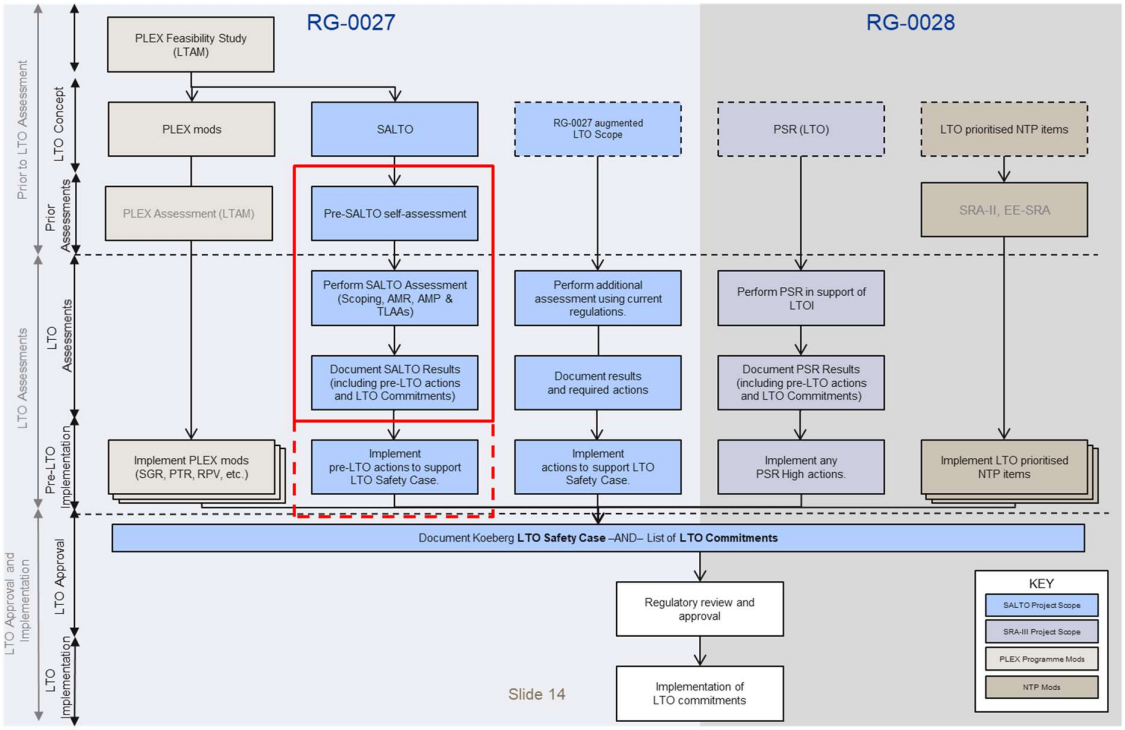

Figure A-1: LTO Requirements and Conceptual Framework[9]

The scope of this interim report is highlighted by the solid red line in the LTO Programme diagram above. The dotted red line will be included in the final SALTO Ageing Management Assessment Report.

[9] Source: Updated from the Koeberg LTO Strategy document, 240-134895976, 'Koeberg Long Term Operation - Licensing' [24]

Appendix B: Background to LTO at Koeberg Nuclear Power Station

In 2008, due to concerns on the long term integrity of its steam generators, KNPS required Eskom approval for an investment decision to replace its six steam generators. Due to the magnitude of the investment, it was required to present an acceptable business case for this significant investment. The investment required a certain payback period in order to make the capital outlay feasible. This paved the way for a more significant decision to invest not only in new steam generators but also in other plant upgrades that would enable operation for an additional 20 years.

By 2010, Eskom completed an economic study associated with Plant Life Extension (PLEX), which concluded that although capital investment for some component replacements will be required, there is no known life-limiting component (that is impossible to repair or replace) that would preclude safe PLEX of the KNPS units up to 60 years.

The actions which subsequently followed were: the initiation of the projects to replace significant plant components that would enable plant life extension; and the commencement of an ageing management assessment to verify whether the KNPS ageing management programmes are adequate to ensure the safe operation of all important to safety SSCs for an additional 20 years.

B.1 Global Approaches to Long Term Operation

Internationally, among nuclear utilities, the demonstration of safe long term operation has been achieved in a number of ways:

- For utilities in the United States of America (USA), the United States Nuclear Regulatory Commission provides the requirements for license renewal in 10-CFR-54, “Requirements for Renewal of Operating Licenses for Nuclear Power Plants”, which is supported by the Generic Ageing Lessons Learned (GALL) report and Standard Review Plan (NUREG-1800). The approach is well established and almost all the reactors that are currently operational in the United States have achieved license renewal through this process (including plants that have applied for subsequent license renewals that extend plant life from 60 to 80 years). While the process is well documented and supported, it relies on the full implementation and adherence to supporting regulations (such the Maintenance Rule), which can make the process challenging to follow for utilities outside the United States regulatory environment.
- Many European states make use of the Periodic Safety Review (PSR) process to demonstrate readiness for -and justify- LTO of their nuclear power plants. In these states, the PSR is used as the main licensing approach to secure regulatory permission to operate the plant for the period defined by the PSR.
- In other countries, utilities depend on specific detailed instructions from their nuclear regulators and these can be more or less cumbersome, complex, and specific to the country regulatory and legal environment, making these approaches difficult to adequately emulate. A good example is France where there are no life limits in the operating licences but life extension approval is obtained on a 10 yearly basis.
- The International Atomic Energy Agency (IAEA) provides safety standards and guidance publications for the safe continued operation of NPPs through the IAEA SALTO process. This approach utilises the technical support of the International Generic Ageing Lessons Learned (IGALL) workshops and publications. While the

approach does not prescribe regulatory requirements, it does stipulate what should be completed to prepare for safe LTO and provides for a peer review service to ensure that the SALTO process is adequately supported and effectively implemented.

B.2 The Eskom Approach Adopted for Long Term Operation of KNPS

Since 2010, there was a number of ageing management approaches considered by Eskom for LTO, including: simplistic and limited justification in the next PSR; use of elements of the USA license renewal process; and the adoption of an adapted French approach. All of these contained weaknesses and limitations, together with significant financial implications that may not result in a quality, defendable approach. In 2014, Eskom selected the approach provided by the IAEA in SALTO guidance publications as an internationally acceptable way to achieve the LTO objective. In accordance with the IAEA SALTO process, utilities are required to scope plant equipment related to nuclear safety for review, perform specific ageing analysis, and review all age-related design inputs. In addition, all established processes and procedures required to support ongoing plant operation must be reviewed and adjusted (if required) for LTO.

Since 2014, the IAEA has provided support to Eskom in the preparation for LTO: in the form of workshops describing the SALTO process; delivering technical support missions (2018 and 2020); and conducting two pre-SALTO peer review missions in 2015 and 2019. All recommendations and suggestions from these missions have been actioned and prioritised. The full SALTO peer review mission is scheduled for September 2021 with a follow-up mission planned for 2023.

In 2019, the NNR published RG-0027, 'The Interim Regulatory Guide for Ageing Management and Long Term Operation of Nuclear Power Plants'. While similar to the IAEA requirements for the demonstration of safe LTO, RG-0027 also provided the process to be followed and submissions to be issued for NNR approval, including a PSR in support of LTO, as well as an LTO Safety Case to support an application for the variation of the nuclear installation license to 60 years of operation.

B.3 LTO Regulatory Requirements

The Interim Regulatory Guide, RG-0027, provides the process and requirements for obtaining a licence variation to operate for the LTO period.

RG-0027 provides an illustration of the process and requirements for the achievement of LTO. The next section will present each step of the process and will explain how Eskom has achieved some of the requirements - and how the outstanding requirements will be achieved.

The figure below starts with illustrating how the expected benefits from LTO, as well as other regulatory requirements, should provide inputs into the feasibility study for LTO.

In accordance with the NNR RG-0027, before the LTO assessment, the first step in the LTO process is to conduct a feasibility study to determine the advantages and disadvantages of LTO, as illustrated in Figure B.3.1 below (extracted from RG-0027).

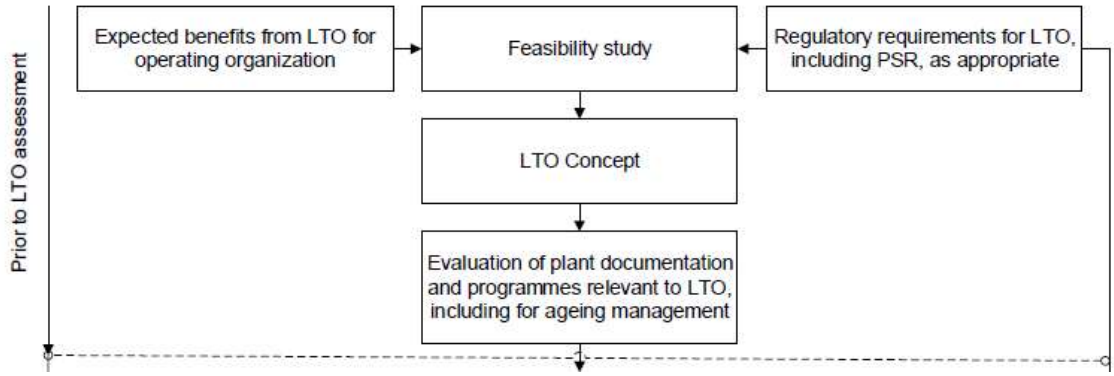

Figure B.3.1: Steps in a programme for LTO (prior to LTO Assessment) – RG-0027

Eskom's feasibility study for PLEX is documented in K08016VAR, 'Koeberg Plant Life Extension'. It contains the expected benefits as well as the economic justification for LTO, taking into account the governing regulatory requirements at the time.

Following the LTO concept (shown above), Eskom decided to follow the IAEA SALTO process for assessing and ensuring readiness for LTO. The SALTO ageing and LTO readiness review process is an internationally recognised, comprehensive, safety review directly addressing the strategy and key elements for the safe LTO of NPPs. The evaluation of programmes and programme performance is based on the IAEA's Safety Standards and other guidance documents. Prior to the NNR issuing RG-0027, it was considered that the SALTO approach would satisfy possible national regulations when these were to be published and that the SALTO approach would be sufficient to demonstrate safe long term operation.

In 2015, Eskom performed an assessment of KNPS plant programmes relevant to LTO, including ageing management. This assessment was followed by an IAEA pre-SALTO review of KNPS's current plant programmes as well as Eskom's operational readiness for LTO. From this assessment, initial actions were developed for defining the scope of required ageing management activities in preparation for LTO. Included in these actions was the establishment of the Koeberg SALTO Assessment Project to: scope the important to safety SSCs; subject these to an ageing management evaluation; and perform a review of TLAAs.

The SALTO ageing management assessment for determining additional activities that will prepare KNPS for LTO as well as the determination of the list of SCCs for ageing management evaluation has been performed in accordance with the NNR's RG-0027 utilising the IAEA SALTO process guidance document SSG-48.

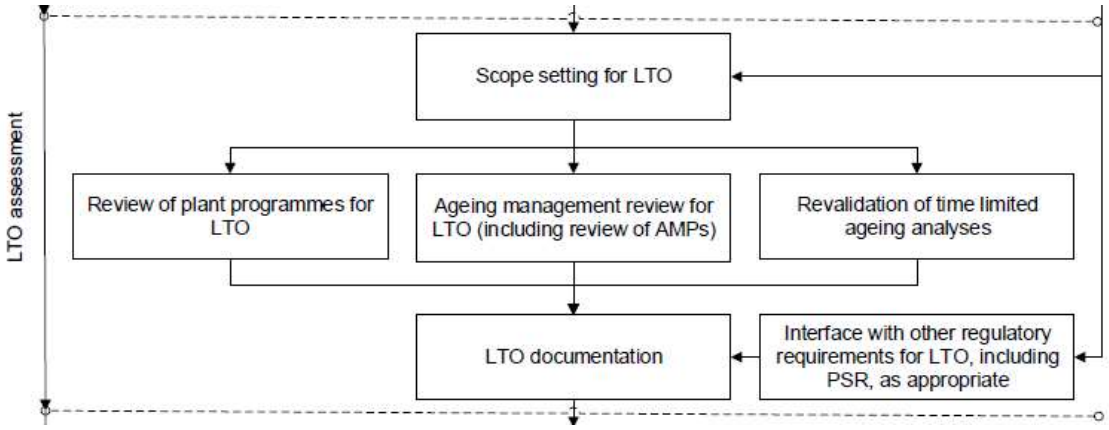

Figure B.3.2: Steps in a programme for LTO (LTO Assessment) – RG-0027

As shown in Figure B.3.2 above, the LTO assessment starts with the *scope setting of SSCs* that require further ageing management assessment. Once completed, the process is followed by the review of plant programmes, the ageing management evaluation, and the validation of TLAAs.

The *review of plant programmes* includes a comprehensive review of plant ageing management programmes and their adequacy for LTO.

The *ageing management review* requires a review of important-to-safety SSCs including the application of ageing management programmes that apply to these SSCs.

The *revalidation of TLAAs* covers the review, validation or update of the TLAAs of identified SSCs.

The SALTO ageing management assessment culminates in the updating of the plant *documentation to support LTO* as shown in Figure B.3.2 above. This includes the Safety Analysis Report, important-to-safety plant programmes, and associated operational requirements to secure safe LTO. It includes a review and confirmation of plant policies, processes, organisational and administrative requirements that should be established or enhanced for the period leading up to LTO (before reaching 40 years of operation) as well as the LTO period (beyond 40 years of operation).

RG-0027 requires that a comprehensive 'Programme for LTO' be established and implemented for ensuring the safe long term operation of the plant beyond a time frame established in the current licence conditions, design limits, safety standards, and/or regulations.

At the time of writing this document, the Programme for LTO consists of the SALTO ageing management assessments in accordance with IAEA SALTO process and a related project organisation to track activities and develop required implementation actions for LTO in accordance with RG-0027. The 'Programme for LTO' will include additional activities that need to be performed to achieve LTO objectives. It is envisaged that the 'Programme for LTO' scope related to ageing management will be refined and become more detailed once the AME is fully completed and formulation of the specific ageing management actions to achieve the LTO objectives are developed and scheduled for implementation on the SAP work management system.

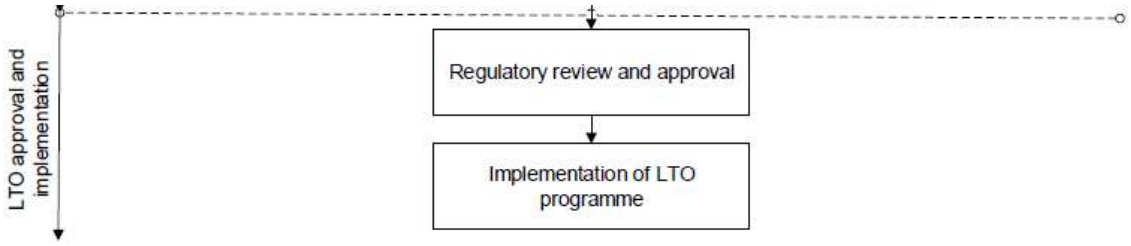

Figure B.3.3: Steps in a programme for LTO (Approval and Implementation) - RG-0027

Following the ageing management assessment, when the updates to KNPS's licensing basis documents (such the AMPs, the KLBM and the SAR) have been initiated and/or completed, Eskom will submit to the NNR the final SALTO Ageing Management Assessment Report with the ageing management implementation actions and its conclusions.

In summary, RG-0027 provides the regulatory requirements for achieving the ageing management objectives for LTO. The synopsis in this appendix has provided a high-level overview of these requirements. The details of these requirements, as well as the approaches that Eskom has embarked on to meet these requirements with respect to ageing management are also described.

Appendix C: List of Buildings Included in the SALTO Scope

Trigram	Building Name
1 HRX 000 BG	1 HRX 000 BG Reactor Building Unit 1 HRX
2 HRX000 BG	2 HRX 000 BG Reactor Building Unit 2 HRX
1 HDA 000 BG	1 HAD 000 BG Diesel Building Train A 1LHP
1 HDB 000 BG	1 HDB 000 BG Diesel Building Train B 1 LHQ
1 HKA 000 BG	1 HKA 000 BG Fuel Building HKA
1 HKB 000 BG	1 HKB 000 BG Refuelling Water Storage Tank"
1 HLX 000 BG	1 HLX 000 BG Electrical Building Unit 1
1 HPA 000 BG	1 HPA 000 BG Essential Service Water Pumping Station U 1
1 HRE 000 BG	Auxiliary Feedwater Tanks (ASG)
2 HDA 000 BG	Diesel Building Train A 2 LHP
2 HDB 000 BG	Diesel Building Train B 2 LHO
1 HRC 000 BG	Gantry Structure
2 HRC 000 BG	2 HRC 000 BG Gantry Structure
9 HBO 000 BG	9 HBO 000 BG Outfall Works
9 HBI 000 BG	9 HBI 000 BG Cooling Water Intake Basin
9 HDC 000 BG	Diesel Building 9 LHS HDC
9 HLX 000 BG	Electrical Building Unit 9 HLX
9 HNA 000 BG	Nuclear Auxiliary Building Zone A *
9 HNB 000 BG	Nuclear Auxiliary Building Zone B *
9 HNC 000 BG	Nuclear Auxiliary Building Zone C*
9 HND 000 BG	Nuclear Auxiliary Building Zone D*
9 HNE 000 BG	Nuclear Auxiliary Building Zone E*
9 HNF 000 BG	Nuclear Auxiliary Building Zone F*
9 HNI 000 BG	Aseismic Bearing Vault Upper & Lower Raft
2 HKA 000 BG	Fuel Building Unit 2
2 HKB 000 BG	Refuelling Water Storage Tank"
2 HLX 000 BG	Electrical Building Unit 2
2 HPA 000 BG	Essential Service Water Pumping Station U2
2 HRE 000 BG	Auxiliary Feedwater Tanks (ASG)

Appendix D: TLAAs Requiring Validation for 60 years

No	Components	TLAA	Degradation Mechanism	References
1	Reactor pressure vessel	Additional TLAA	PWSCC in nickel alloys	L1124-GN-RPT-033
		Additional TLAA	Wear of the adaptor flanges on the unit 1 RPV head	
		Additional TLAA	Thermal stratification phenomenon	
2	Reactor pressure vessel internals	TLAA 106 Environmentally-assisted fatigue	Fatigue	L1124-GN-RPT-032
		TLAA 110 Thermal ageing of cast austenitic stainless steels	Thermal ageing	
		TLAA 120 PWR RPV internals vibrations	Vibration degradation	
		TLAA 122 Thermal ageing of martensitic stainless steels	Thermal ageing	
		Additional TLAA	RPV internals neutron embrittlement	
3	Steam generators *(this will be done under SGR)*	TLAA 106 Environmentally-assisted fatigue	Fatigue	L1124-GN-RPT-038
4	Pressurizer	TLAA 103 Crack growth analyses	Liquation and solidification cracking of spray nozzles	L1124-GN-RPT-034

		TLAA 106 Environmentally-assisted fatigue	Fatigue	
		TLAA 115 Fatigue and thermal ageing analysis of manufacturing flaws and flaw tolerance	Liquation and solidification cracking of spray nozzles	
		Flaw tolerance calculation due to thermal ageing and fatigue	Liquation and solidification cracking of spray nozzles	
5	Reactor coolant pumps	TLAA 103 Crack growth analyses	Fatigue crack propagation	L1124-GN-RPT-031
		TLAA 106 Environmentally-assisted fatigue	Fatigue	
		TLAA 112 Main circulation pump flywheel	Fatigue	
6	Control rod drive mechanism	TLAA 106 Environmentally-assisted fatigue	Fatigue	L1124-GN-RPT-037
7	Main coolant lines and surge lines	TLAA 106 Environmentally-assisted fatigue	Fatigue	L1124-GN-RPT-035
8	Auxiliary and secondary lines	TLAA 106 Environmentally-assisted fatigue	Fatigue	L1124-GN-RPT-046
9	Polar Crane	Fatigue of Cranes (TLAA 108)	Fatigue	L1124-GN-RPT-020

10	Containment	TLAA 301 Concrete containment tendon pre-stress	Tendon relaxation	L1124-GN-RPT-019
11	Multiple EQ Components (refer to L1124-GN-RPT-018 [84])	TLAA 201 Environmental Qualification	Equipment Qualification	L1124-GN-RPT-018

Appendix E: Related/Supporting Documentation Package

E.1 LTO and SALTO Koeberg Assessment Project Documents

- 240-134895976: Koeberg Long Term Operation - Licensing
- 08016-S-LIC: SALTO Project Licensing Strategy
- 08016-S-PMP: SALTO Project Management Plan

E.2 SALTO Ageing Management Assessment Documents

E.2.1 Methodology Documents

- 240-125839632: Koeberg Long Term Operating (LTO) Scoping Methodology
- 240-125122792: Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses

E.2.2 Process Documents

- L1124-DE-MNL-001: SALTO Overall Concept Manual

E.2.2.1 Scope Setting Process Documents

- L1124-DE-PCD-001: SALTO Scoping – SSC Verification Control Procedure
- L1124-DE-RPT-001: Scoping Data Verification Method
- L1124-DE-GDL-001: SALTO Scoping and Verification Guide

E.2.2.2 AME Process Documents

- L1124-DE-PCD-002: SALTO Screening/Commodity Grouping Control Procedure
- L1124-DE-RPT-002: SALTO Commodity Grouping Methodology
- L1124-DE-PCD-003: SALTO AME Control Procedure
- L1124-DE-RPT-003: Ageing Management Evaluation Methodology

E.2.2.3 TLAA Process Documents

- L1124-DE-PCD-004: Time Limited Ageing Analysis Evaluation Control Procedure
- L1124-DE-RPT-004: Time Limited Ageing Analysis Evaluation Methodology

E.2.3 Process Output Documents

E.2.3.1 Scope Setting Process Output Documents

- L1124-EL-LIS-003: Cable List
- L1124-GN-LIS-020: Comprehensive List of All SSCs Reviewed for SALTO Requirements

E.2.3.2 AME Process Output Documents

E.2.3.2.1 Commodity Grouping Output Documents

- L1124-GN-LIS-027: AMR data tables for commodity groups

E.2.3.2.2 AMP Review Output Documents

- L1124-GN-LIS-009A: IGALL AMP-Task Requirements-Mechanical
- L1124-GN-LIS-009B: IGALL AMP-Task Requirements-Electrical
- L1124-GN-LIS-009C: IGALL AMP-Task Requirements-Civil
- L1124-GN-RPT-030: Comparison Report Existing KNPS Plant Programs with IGALL-AMP Requirements

E.2.3.2.3 AMR Results Output Documents

- L1124-GN-RPT-023: AME Degradation Assessment Results Mechanical
- L1124-GN-RPT-024: AME Degradation Assessment Results Civil
- L1124-GN-RPT-025: AME Degradation Assessment Results Electrical

E.2.3.2.4 TLAA Process Output Documents

- D02-ARV-01-138-106 (L1124-GN-RPT-031): Reactor Coolant Pumps TL5 and TL6 Activities
- D02-ARV-01-142-242 (L1124-GN-RPT-032): RPV Internals TL5 and TL6 Activities
- D02-ARV-01-143-003 (L1124-GN-RPT-037): CRDM TL5 and TL6 Activities
- D02-ARV-01-144-513 (L1124-GN-RPT-033): Reactor Pressure Vessel TL5 and TL6 Activities
- D02-ARV-01-144-514 (L1124-GN-RPT-034): Pressuriser TL5 and TL6 Activities
- D02-ARV-01-144-861 (L1124-GN-RPT-038): Steam Generators TL5 and TL6 Activities
- D02-ARV-01-145-030 (L1124-GN-RPT-035): Main Coolant and Surge Lines TL5 and TL6 Activities

- D02-ARV-01-146-690 (L1124-GN-RPT-036): In-Core Instrumentation TL5 and TL6 Activities
- D02-ARV-01-149-074 (L1124-GN-RPT-046): Auxiliary and Secondary Lines TL5 and TL6 Activities
- L1124-GN-LIS-010: Comprehensive List of Koeberg TLAAs
- L1124-GN-RPT-018: Time Limited Ageing Analysis Based on Initial Environmental Qualification
- L1124-GN-RPT-019: Validity of KNPS Containment Civil TLAA 301
- L1124-GN-RPT-020: Validity of Polar Crane
- L1124-GN-RPT-044: Containment Liner –SALTO Civil Assessment Report TLAA 303
- L1124-GN-RPT-045: Koeberg Containment Settlement – SALTO Civil Assessment Report TLAA 304

E.2.4 Eskom Records of Decisions and Close Out Documents

E.2.4.1 Scope Setting ROD

- 08016.ROD.012: SALTO Non-Safety affecting safety equipment scope verification

E.2.4.2 AME ROD

- 08016.ROD.022: Review of the Electrical, Instrumentation and Control Ageing Management Evaluation (AME) Report L1124-GN-RPT-025 and Decisions by Eskom
- 08016.ROD.023: Review of the Mechanical Ageing Management Evaluation (AME) Report L1124-GN-RPT-023 and Decisions by Eskom
- 08016.ROD.024: Scope stemming from review of the Civil AME Report L1124-GN-RPT-024
- 08016.ROD.025: Comparison of the existing Plant Programmes with IAEA IGALL-AMP

E.2.4.3 TLAA ROD

- 08016.ROD.018: Equipment Qualification Time limited Ageing Analysis