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EXECUTIVE SUMMARY

This SALTO Ageing Management Assessment final report documents the safety assessment of the ageing management aspects performed at Koeberg Nuclear Power Station (KNPS) to achieve the regulatory ageing management requirements and provides assurance for the safe long-term operation (LTO). The content of the final report describes the requirements of the assessment, the processes followed to perform the assessment, the assessment results, and items identified for improvement.

The main sections of the report structure are as follows:

- Section 1.0 (Introduction) introduces the report.
- Section 2.0 (Supporting Clauses) provides supporting clauses for the document, including the document scope and purpose, normative/informative references, and relevant definitions and abbreviations. It also lists the supporting documents for this report.
- Section 3.0 (Background) provides the historical evolution of the ageing management concepts and practices at KNPS. The background to the Koeberg SALTO assessment project is provided, with an overview of the SALTO ageing management assessment process.
- Section 4.0 (SALTO Scope Setting) provides the requirements for the scoping exercise to identify all the systems, structures and components (SSCs) important to safety for which an ageing assessment must be performed. The classification system established at KNPS is defined, and it demonstrates how these classifications achieve the scoping requirements for the Eskom scoping methodology. The scope setting, verification process, and the databases of the results are listed and described in this section. The section concludes with KNPS's organisational responsibility of managing the in-scope list of SSCs following the assessment.
- Section 5.0 (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 ageing AME, which covers the commodity grouping, the ageing management programme (AMP) review, and the equipment ageing management review (AMR). The AME implementation process is described, along with the results and recommendations. The review of the AME results with a summary of the actions taken stemming from the AME review is provided. The KNPS organisational responsibilities beyond the assessment are also described.
- Section 6.0 (Time-Limited Ageing Analyses) 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 is provided. A summary of the TLAAs completed for validation for 60 years before entering LTO and those requiring further analysis is given. The section concludes with KNPS's organisational responsibility of managing TLAAs beyond the assessment.

- Section 7.0 (SALTO Ageing Management Assessment Commitments). The list of SALTO commitments will be kept updated in one consolidated LTO document referenced 331-618 (*Safety Case for Long-Term Operation of KNPS*) [89].
- Section 8.0 (Conclusion) concludes that the assessment results and recommendations have been reviewed, verified, and actioned to meet the regulatory expectations and assure safe operation into LTO.

The assessment demonstrates that effective ageing management practices and processes exist at KNPS to prevent the adverse effects of ageing from affecting the reliability of the plant equipment during the period of LTO.

The assessment results and recommendations have been reviewed, verified, and actioned to meet the regulatory expectations and assure safe operation into LTO.

1.0 INTRODUCTION

LTO of a nuclear power plant is defined as operating 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 SSCs. Eskom has provided this justification to operate KNPS beyond its initial design life of 40 years to an anticipated life of 60 years to the NNR. The justification is covered by a number of overlapping interventions.

One of these interventions is the ageing management safety assessment for LTO (this report). The focus of the assessment is to ensure the completeness and comprehensiveness of existing ageing management practices and processes at KNPS 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 final report is an update of 240-156945472 (*SALTO Ageing Management Assessment Report [Interim]*) [5]. It provides an overview of the process followed by the Koeberg SALTO Assessment project to perform the assessment. It also provides the ageing management activities and actions completed to demonstrate that KNPS is thoroughly prepared for LTO as far as ageing is concerned.

The interim report was submitted to the National Nuclear Regulator (NNR) via letter K-27141-E on 1 December 2020.

2.0 SUPPORTING CLAUSES

2.1 Scope of Final Report

The scope of this final 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 1, and provides the SALTO ageing management assessment results and its implementation into KNPS for LTO.

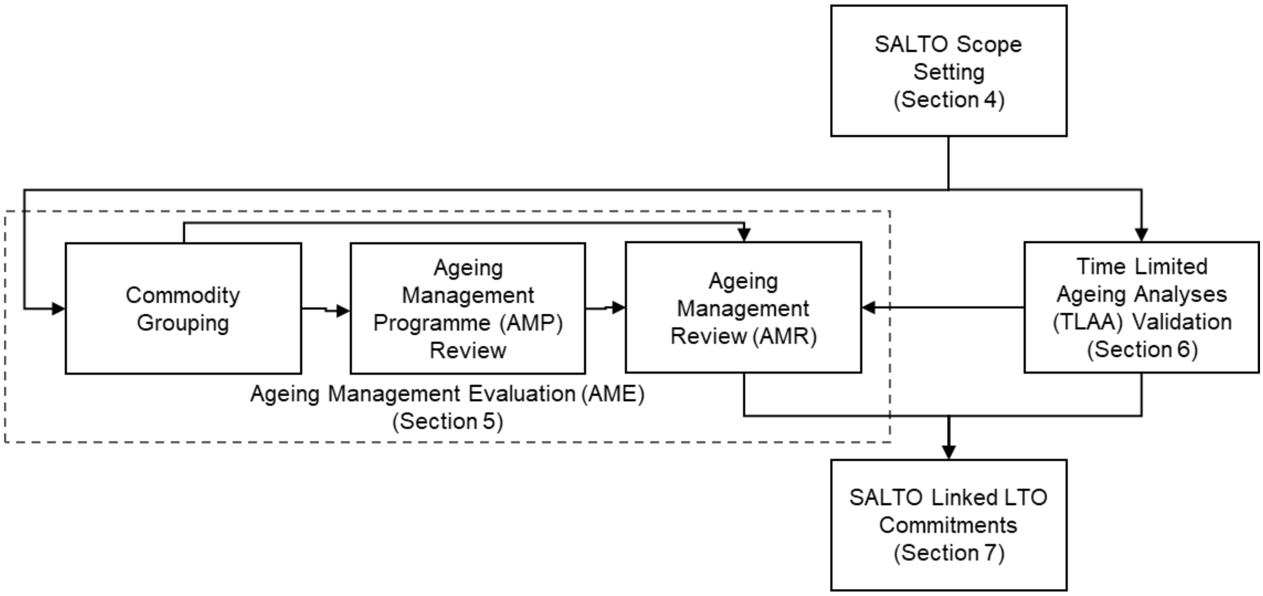


Figure 1: SALTO Ageing Management Assessment Overview

> ***NOTE:*** *The SALTO ageing management assessment is integral to the ageing management requirements prescribed in RG-0027 [8]. Figure A-1 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 Final Report

The purpose of this document is to meet the commitment agreed in 08016-S-LIC [1].

This document provides the process and results of the SALTO ageing management assessment performed at KNPS. Where 240-156945472 [5] provided the interim progress of the project until October 2020, this document includes the status until January 2024, highlighting the results for providing ageing management assurance for the continued safe operation of KNPS into LTO.

2.3 Normative/Informative References

2.3.1 Normative

[1] 08016-S-LIC — SALTO Nuclear Project Implementation and Licensing Strategy (LIC)

[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.1

[5] 240-156945472 SALTO Ageing Management Assessment Report (Interim)

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

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

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

2.3.2 Informative

[9] 08016.ODCOF.049 Position on the position on the approach KNPS adopted for the assessment of the current physical status of relevant SSCs for SALTO AME

[10] 08016.ODCOF.081 Close out of OD 7.109

[11] 08016.ODCOF.085 MRG verification that the requirements according to AMP 308 for the ageing effects due to irradiation are addressed in the existing corrosion monitoring programme

[12] 08016.ODCOF.105 Develop a New Programme Heat Exchanger as per SALTO Mechanical AME review

[13] 08016.ODCOF.107 A System Engineering assessment documenting the nuclear safety risk of blockage and flooding of floor drains and advising which action to be taken (if any or if not justifiable)

[14] 08016.ODCOF.119 Initiate SAP notifications for the execution of the civil one-time inspections

[15] 08016.ODCOF.139 Evaluate for applicability of AMP 134 External surfaces monitoring of mechanical components

[16] 08016.ODCOF.146 Develop a new Nuclear Engineering Position Paper (NEPP) and document the review of the maintenance practices, history and OE relating to solenoid valve actuators, motor actuators and motors

[17] 08016.ODCOF.152 Update plant modification design processes to comply with RG-0027

[18]	08016.ODCOF.153	A System Engineering assessment documenting the nuclear safety risk of blockage and flooding of floor drains in the containment and advising which action to be taken (if any or if not justifiable) by NSE
[19]	08016.ODCOF.202	Close-out of OD 6.1A-010: MRG Confirmation/Updated ISIPRM procedures
[20]	08016.ODCOF.252	Eskom's Response to TLAA 301 Recommendations (OD 10.1A)
[21]	08016.ODCOF.262	Eskom's Response to TLAA 108 Recommendations (OD 10.1B)
[22]	08016.ODCOF.263	A new liner programme for the spent fuel pool liners, reactor pool liners, and all steel and epoxy-lined sumps (OD 6.12 and OD 7.47)
[23]	08016.ODCOF.269	Updates to civil inspection procedures by I&T (OD 6.1A-00, OD 6.1A-001a, OD 6.1A-001b, OD 6.1A-001c, OD 6.1A-001d, OD 6.1A-001e, OD 6.1A-001f, OD 6.1A-001g, OD 6.1A-002a, OD 6.1A-002b, OD 6.1A-003i and OD 6.1A-011a)
[24]	08016.ODCOF.279	Review the results of the one-time inspection for the identified civil SSCs (OD 7.18C)
[25]	08016.ROD.012	SALTO non-safety affecting safety equipment scope verification
[26]	08016.ROD.017	Adoption of COMSY Database for Ageing Management at KNPS
[27]	08016.ROD.018	Equipment Qualification Time Limited Ageing Analysis Strategy
[28]	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
[29]	08016.ROD.022	Review of the Electrical, Instrumentation and Control Ageing Management Evaluation (AME) Consortium Report L1124-GN-RPT-025 and Decisions by Eskom

[30]	08016.ROD.023	Review of the Mechanical Ageing Management Evaluation (AME) Consortium report L1124-GN-RPT-023 and Decisions by Eskom
[31]	08016.ROD.024	Scope stemming from a review of the Civil AME report L1124-GN-RPT-024
[32]	08016.ROD.025	Comparison of the existing Plant Programmes with IAEA IGALL-AMP Requirements
[33]	08016.ROD.031	Requalification of Design Base Accident Qualified Cables for Long-Term Operation
[34]	08016.ROD.032	De-link TLAA 120 from LTO
[35]	08016-S-PMP	SALTO Project Management Plan
[36]	240-102103854	Self-Evaluation 88540: Review of the Koeberg Plant Programmes to Assess Alignment with the IAEA Ageing Management Programmes
[37]	240-106374672	SE 35244: Koeberg Pre-SALTO Self-Assessment Report
[38]	240-112278820	(Supplier Quality Audit and Surveillance Process)
[39]	240-127002040	Guide to Determine Quality Programme Monitoring and Verification Requirements
[40]	240-129867163	Materials Requirement Planning Work Instruction
[41]	240-129883544	Procurement Quality Engineering Requirements
[42]	240-141494955	Thermal Fatigue Management Programme Manual
[43]	240-143604773	Safety Evaluation Process
[44]	240-143890978	Detailed Design Template
[45]	240-149053169	Motor-Operated Valve Programme
[46]	240-149139512	Standard: Ageing Management Requirements for Koeberg Nuclear Power Station
[47]	240-149867926	Nuclear Steam Supply System Design Transients Monitoring Programme
[48]	240-153477196	Technical Requirements Specification for Time-Limited Ageing Analyses
[49]	240-153544432	TLAA Report Structure

[50] 240-153945942 User Requirements Specification for Management of SALTO Anomalies Evaluation and Rectification

[51] 240-154215724 Heat Exchanger Management Programme

[52] 240-160477589 Ageing Management of Oil-Filled Transformers

[53] 240-160675265 Plant Walkdowns for SALTO Scope Confirmation

[54] 240-163295286 Ageing Management of Solenoid Valves

[55] 240-164732871 Monitoring Receipt Inspection Processes

[56] 240-164966115 Ageing Management of Switchboards Associated Switchgear Components and their Metal Enclosures

[57] 240-165295505 The Pressuriser Programme Manual

[58] 240-165386950 Environmental Condition Monitoring Programme (ECMP) for Medium and Low Voltage Cables with Associated Equipment

[59] 240-165424554 Ageing Management Programme for the Electronic Equipment Whiskers and Capacitors

[60] 240-165425812 (EME-961) Civil Ageing Management Programme Manual

[61] 240-166148961 (KAU-030) Basis and Scope for Licence Building Civil Surveillances at KNPS

[62] 240-166149425 (KAU-029) Basis and Scope for Non-Licence-Binding Civil Surveillances at KNPS

[63] 240-166150229 (KAA-671) Management of Licence-Binding Civil Monitoring Programme Surveillances at KNPS

[64] 240-166150507 (KAA-672) Management of Non-Licence-Binding Civil Monitoring Programme Surveillances at KNPS

[65] 240-166151023 (KSA-128) Civil Ageing Management Programme Standard

[66] 240-166828385 Cable Master List

[67] 240-166957253 Ageing Management Programme for Lightning Protection and Grounding Grid

[68] 240-166959159 (EME-976) Manual for Stainless Steel-Lined Compartments and Epoxy-Coated Sumps

[69] 240-166959251 Selective Leaching Ageing Management Programme

[70] 240-167231099 Assessment of the Spent Fuel Pool for Long-Term Operation

[71]	240-89294359	(KSA-010) Nuclear Safety, Seismic, Environmental, Quality and Importance Classification
[72]	240-95405347	Procurement of Items and Services for the Nuclear Operating Unit
[73]	240-98789276	CAMP Manual for Low Voltage (LV) Cables and Cable Systems
[74]	240-98789629	CAMP Manual for I&C Cables
[75]	32-T-PE-006	One-Time Inspection Ageing Management Programme Manual
[76]	32-T-PE-007	One-Time Inspection of Class 1 Small-Bore Piping Ageing Management Programme Manual
[77]	32-T-PE-010	Internal Surfaces, Coatings and Linings Ageing Management Programme Manual
[78]	331-143	Equivalency Study Process to Change the Plant
[79]	331-144	Standard for the Preparation of an Equivalency Study
[80]	331-146	Obsolescence Management Process
[81]	331-148	Programme Engineers' Guide
[82]	331-175	Corrosion Management Programme
[83]	331-260	Reactor Pressure Vessel – Cracking of the Core Barrel Bolts
[84]	331-268	Corrosion Under Lagging in the Containment Building
[85]	331-275	Process for the Development and Implementation of Ageing Management at Koeberg Nuclear Power Station
[86]	331-311	Cable Ageing Management Manual for Medium Voltage Power Cables and Cable System
[87]	331-511	Boric Acid Corrosion Control Programme
[88]	331-610	Main Coolant Piping Ageing Management
[89]	331-618	Safety Case for Long-Term Operation of Koeberg Nuclear Power Station
[90]	331-627	Report – Evaluation and Rectification of SALTO Anomalies
[91]	331-665	Re-assessment of the Qualified Cables TLAA Revalidation Limitations

[92] 331-687 Qualification Revalidation of Pressuriser Fixed Heaters RCP 005 RS and RCP 006 RS

[93] 331-688 Reassessment of the Electrical Penetration Assemblies EQ TLAA Revalidation Limitations

[94] 331-691 Containment Structures – Re-Analysis for LTO and Overview of On-Line Monitoring

[95] 331-696 Time-Limited Ageing Analyses Based on Initial Environmental Qualification for RIC Thermocouple Cables and Connectors

[96] 331-86 Design Changes to Plant Structures or Operating Parameters’

[97] 331-91 Control of Equipment and Software Classifications

[98] 331-93 Guide for Classification of Plant Components, Structures, and Parts

[99] 331-94 Importance Category Classification Listing

[100] 36-197 Koeberg Licensing Basis Manual

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

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

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

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

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

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

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

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

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

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

[111] D02-ARV-01-176-728 Time-Limited Ageing Analysis (TLAA) – Re-Analysis of Environmentally Qualified Equipment – Valcor Solenoid Valves

[112] D02-ARV-01-177-328 TLAA-RPV-PWSCC of Alloy 182 Repairs

[113] D02-ARV-01-177-459 RPVI – Identification of RPVI Components Sensitive to Flaws

[114] D02-ARV-01-178-200 Pressurizer – Environmental Assisted Fatigue – Screening

[115] D02-ARV-01-178-201 Main Coolant Lines – Environmental Assisted Fatigue – Screening

[116] D02-ARV-01-178-202 Reactor Pressure Vessel Internals – Environmental Assisted Fatigue – Screening

[117] D02-ARV-01-178-203 Environmental Assisted Fatigue – Screening

[118] D02-ARV-01-180-957 PZR-Heater Sleeves – Fatigue Analysis

[119] D02-ARV-01-181-189 Time-Limited Ageing Analysis (TLAA) for Qualified Equipment – Rotork Valve Actuators

[120] D02-ARV-01-181-583 Time-Limited Ageing Analysis (TLAA), Re-Analysis of Qualified Equipment – Jeumont-Schneider Residual Heat Removal (RRA) Medium Voltage Motors

[121] D02-ARV-01-181-612 TLAA Re-Analysis of Components Important to Safety – In-Core Thermocouples of the RIC System

[122] D02-ARV-01-182-258 Time-Limited Ageing Analysis (TLAA) for Qualified Equipment – Containment Sweeping Ventilation System (EBA) AMRI Containment Isolation Valves

[123] D02-ARV-01-183-091 TLAA 108 Re-Analysis Crane

[124] D02-ARV-01-183-095 TLAA 301 Containment Re-Analysis

[125] D02-ARV-01-212-366 Environmentally Assisted Fatigue – Main Coolant Line – Pressurizer Surge Line Stress Report

[126] D02-ARV-01-212-368 Main Coolant Line – Environmental Assisted Fatigue-Downstream SG By-Pass Nozzles [Item 8] Stress Report

[127] D02-ARV-01-212-369 Main Coolant Line – Environmental Assisted Fatigue – Charging Line Nozzle [Item 7] Stress Report

[128] D02-ARV-01-212-371 Main Coolant Line – Environmental Assisted Fatigue – Cold leg Safety Injection Nozzle [Item 5]

[129]	D02-ARV-01-212-372	Main Coolant Line – Environmental Assisted Fatigue – Residual Heat Removal System (RRA) Nozzle [Item 2] Stress Report
[130]	D02-ARV-01-212-373	Auxiliary Line – Environmental Assisted Fatigue – Pressurizer Discharge Line by Relief Valves of Koeberg Unit 1 (KB1) Analysis
[131]	D02-ARV-01-212-374	Auxiliary Line – Environmental Assisted Fatigue – Resistance Temperature Detector (RTD) By-Pass Lines of Koeberg Unit 1 (KB1) Analysis
[132]	D02-ARV-01-212-375	Auxiliary Line – Environmental Assisted Fatigue – Resistance Temperature Detector (RTD) By-Pass Lines of Koeberg Unit 2 (KB2) Analysis
[133]	D02-ARV-01-212-376	Auxiliary Line – Environmental Assisted Fatigue – Reactor Chemical and Volume Control System (RCV) Discharge Lines of Koeberg Unit 1 (KB1) Analysis’
[134]	D02-ARV-01-212-378	Auxiliary Line – Environmental Assisted Fatigue – Reactor Chemical and Volume Control System (RCV) Discharge Lines of Koeberg Unit 2 (KB2) Analysis’
[135]	D02-ARV-01-212-379	Auxiliary Line – Environmental Assisted Fatigue – Reactor Safety Injection System (RIS) and Accumulator 1 Lines of Koeberg Unit 2 (KB2) analysis’
[136]	D02-ARV-01-212-382	Auxiliary Line – Environmental Assisted Fatigue – Residual Heat Removal System (RRA), Safety Injection (RIS) and Accumulator 3 lines of Koeberg Unit 2 (KB2) analysis’
[137]	D02-ARV-01-212-383	Auxiliary Line – Environmental Assisted Fatigue – RPE lines (loop 2) of Koeberg Unit 1 (KB1) analysis
[138]	D02-ARV-01-212-385	Auxiliary Line – Environmental Assisted Fatigue – Spray line of Koeberg Unit 1 (KB1) analysis’
[139]	D02-ARV-01-212-661	Reactor Pressure Vessel Internals – Environmental Assisted Fatigue – Mechanical Analysis
[140]	D02-ARV-01-213-179	Pressurizer – Spray Nozzle Mechanical Analyses
[141]	D02-ARV-01-217-289	RPVI-Thermal Ageing and Neutron Embrittlement – CRGA Behaviour in Case of Weld Failure During LOCA Event
[142]	D02-ARV-01-219-088	RPVI – Thermal Ageing and Neutron Embrittlement – Fast Fracture Analysis of Core Barrel Welds

[143] D02-ARV-01-221-375 RPVI – Thermal Ageing and Neutron Embrittlement – Fast Fracture Analysis of Flange/Core Barrel Weld

[144] EA-19-080 Inspections of Panels, Distribution Cabinets & Local Control Boxes (Pd.Bs.) to Identify Age-Related Degradation as Described in AMP 212

[145] EA-20-075 Inspections of Electrical Cabinets to Identify Age-Related Degradation

[146] EA-20-080 SE 35189-021 SE: On-time inspections on selected printed circuit boards and other components of electronic equipment to identify the presence of whiskers

[147] EA-20-108 Ageing Evaluation of the 6.6kv/380v Dry-Type Transformers of Units 1 and 2 for the Purpose of Sustaining the Long-Term Operation of KNPS

[148] EA-20-174 CR 117514-004 CA Review of the Existing LOPP, KBA 0022 N NEPO LOPP 045 - Batteries (Rev 16)

[149] EA-20-184 CR 117514-003 CA (Output Deliverables 00_7.108): Electrical Penetration Assemblies

[150] EA-22-087 Notification 25942220 - Installation of the Westinghouse Equipment Lifetime Monitors in Outage 225 for Unit 2

[151] EA-22-141 Review of the completed Electrical One-time inspections Results (OD_7.11C, OD_7.11D, 00_7.188 and GA 41999)

[152] EA-23-013 Installation of the Westinghouse Equipment Lifetime Monitors and the Alanine Dosimeters in Outage 126 for Unit 1

[153] EA-23-057 Strategy for the Requalification of Qualified Cables in Harsh Environments for Long-Term Operation

[154] EA-23-064 Assessment of Service Life for Viton O-Rings Installed in Valcor Solenoid Valves

[155] EA-23-070 Review of 1 LGD001AR, 1 LHA001AR, 1 LHB001TB, 1 LLC001AR, 1 LGA001AR Switchboards Maintenance completed in Outage 121

[156] EA-23-102 Review of the Mechanical One-time inspections completed in Outages 125, 225, 126, and 226

[157] EA-23-119 CR 140513-002 CA: Assessment of Viton O-Ring installed in Valcor Solenoid Valves model V70900-65-31

[158]	EA-23-128	Evaluation of The Residual Heat Removal (RRA) System Temperature Sensors RRA 005 MT and RRA 007 MT
[159]	EA-23-143	Assessment of IGALL TLAA 120 Reactor Pressure Vessel (RPV) Internals Vibrations
[160]	EA-23-148	Review of 2LHA001TB, 2LHB001TB and 2LGA001TB Switchboards Maintenance completed in Outage 221
[161]	EA-23-150	CR 115457-021 CA, CR 115457-022 CA, CR 115457-023 CA, CR 115457-024 CA, CR 115457-025 CA and CR 121535-004 CA - SALTO Civil One-Time Inspections
[162]	EA-23-170	Engineering Assessment of Auxiliary Piping Sentinel Locations with CUFen Exceeding Design Code Requirements
[163]	EA-23-175	SAP Imp 42586 and SAP Imp 41471 : Create a service note to overhaul the RRA 001 MO and RRA 002 MO every 5 years and replacement of the motors at the end of the Qualified life
[164]	EA-24-001	Engineering Assessment of Pressuriser Heater Sleeves with CUFen Exceeding Code Requirements
[165]	EERT-11-015	Seismic Hazard Report
[166]	EERT-11-019	The Explosion Hazard Report
[167]	ISIPRM AUG 13	Main Steam Piping
[168]	JIC-NC-00130	Control Rod Drive Mechanism Pressure Housing Assembly-CRDM Impacted by Thermal Sleeve Wear Phenomenon-Stress Report
[169]	JIC-NC-00138	Reactor Coolant Pumps – Environmental Assisted Fatigue – Screening
[170]	JIC-NC-00140	Control Rod Drive Mechanism – Environmental Assisted Fatigue – Screening
[171]	JIC-NC-00143	TLAA Reactor Coolant Pump – Mechanical Behaviour of the Flywheel – TLAA 112
[172]	JIC-NC-00253	Reactor Coolant Pumps – Environmental Assisted Fatigue – Fatigue Analysis
[173]	JIC-NC-00260	Control Rod Drive Mechanism – Environmental Assisted Fatigue – Fatigue Analysis

[174]	JN195/NCI/ESKOM/J2/365	Koeberg Nuclear Power Station Internal Flooding Analysis
[175]	JN377/AMEC/NCI/TR/6393	Seismic Event Fall-Down Hazard Report
[176]	JN850/NSE/ESKB/R/8613	Civil Structure Inspection Summary Report – Containment Building Unit 2: SALTO – One Time Inspection
[177]	K08016VAR	Koeberg Plant Life Extension
[178]	KAA-501	Project Management Process for Koeberg Nuclear Power Station Modifications
[179]	KAA-688	Authorisation of Staff to Perform Safety-Related Functions
[180]	KAA-913	Integrated Equipment Reliability Process
[181]	KBA0022CHEMJUSTIF2	Chemistry Justification
[182]	KBA0022NNEPOLOPP007	Plant Engineering Life of Plant Plan - RIC System Maintenance Regime
[183]	KBA0022NNEPOLOPP023	Fire Detection and Suppression Systems Life-of-Plant Plan
[184]	KBA0022NNEPOLOPP045	Plant Engineering Life of Plant Plan - Koeberg Nuclear Power Station Batteries
[185]	KBA0022NNEPOLOPP162	Plant Engineering Life of Plant Plan - The 380 Vac System (LLX-Electrical) System Maintenance Regime
[186]	KBA0022NNEPONEPP034	Thermal Stratification and Thermal Fatigue of the Dead End and Interspace Piping
[187]	KBA0022NNEPONEPP134	Thermal Fatigue in the Mixing Zones on NSSS and BNI Piping
[188]	KBA0022SRSM000	Safety Related Surveillance Manual
[189]	KBA1207E00002	Equipment Specification – Pressuriser
[190]	KGU-033	Failure Investigation of Plant Equipment and Evaluation of Experience
[191]	KNC-001	Chemistry Operating Specifications for Safety Related Systems
[192]	KNC-002	Chemistry Operating Specifications for Availability Related Systems
[193]	KSM-LIC-001	Requirements for the Control of Maintenance
[194]	KWM-EM-MAC-010	Working Procedure 380 V Switchboards, Including Plug-In Units: Contactor CF-Range and Breaker D-Range

[195] KWM-EM-MAC-011 Working Procedure 6,6 kV Switchboards

[196] KWM-EM-MDC-004 Working Procedure dc Switchboards

[197] KWM-IN-RIC-008 Insulation Resistance and Millivolt Measurements of the RIC Thermocouples

[198] KWR-IP-CIV-025 Working Procedures - Condition Assessment of the Low-Level Waste Complex and Cask Storage Building

[199] KWR-IP-CIV-026 Working Procedures - Condition Assessment of the Containment Building External Facades

[200] KWR-IP-CIV-027 Working Procedures - Conditional Assessment of the Diesel Buildings

[201] KWR-IP-CIV-028 Working Procedures - Condition Assessment of the Nuclear Auxiliary Building

[202] KWR-IP-CIV-029 Working Procedures - Condition Assessment of the Electrical Building – Unit 2

[203] KWR-IP-CIV-030 Working Procedures - Condition Assessment of the Electrical Building – Unit 9

[204] KWR-IP-CIV-031 Working Procedures - Condition Assessment of the Low-Level Waste Complex and Cask Storage Building

[205] KWR-IP-CIV-032 Working Procedures - Visual Inspection of the Electrical Building – Unit 1

[206] KWR-IP-CIV-036 Working Procedures - Condition Assessment of the Fuel Buildings and PTR Tank Rooms

[207] KWR-IP-CIV-044 Working Procedures - Long-Term Monitoring of Aseismic Bearings

[208] KWR-IP-CIV-045 Working Procedures - Visual Inspections of the Aseismic Vault

[209] KWR-IP-CIV-046 Working Procedures - Conditional Assessment of the Essential Services Water Pumping Station and Galleries

[210] L1124-CV-RPT-001 New Civil Components Report

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

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

[213] L1124-DE-GDL-004 Engineered Master Table Guide

[214]	L1124-DE-MNL-001	SALTO Overall Concept Manual
[215]	L1124-DE-PCD-001	SALTO Scoping – SSC Verification Control Procedure
[216]	L1124-DE-PCD-002	SALTO Screening/Commodity Grouping Control Procedure
[217]	L1124-DE-PCD-003	SALTO AME Control Procedure
[218]	L1124-DE-PCD-004	Time-Limited Ageing Analysis Evaluation Control Procedure
[219]	L1124-DE-RPT-001	Scoping Data Verification Method
[220]	L1124-DE-RPT-002	SALTO Commodity Grouping Methodology
[221]	L1124-DE-RPT-003	Ageing Management Evaluation Methodology
[222]	L1124-DE-RPT-004	Time-Limited Ageing Analysis Evaluation Methodology
[223]	L1124-EL-LIS-001	List of In-Scope Items for SALTO EQ TLAA
[224]	L1124-EL-LIS-002	SALTO TLAA Result List
[225]	L1124-EL-LIS-003	Cable List
[226]	L1124-EL-LIS-004	EQ Cable List
[227]	L1124-GN-LIS-002	The Engineered Master Table
[228]	L1124-GN-LIS-006A	IGALL Commodity Group Matrix Linking Table – Commodity Group
[229]	L1124-GN-LIS-009A	IGALL AMP – Task Requirements – Mechanical
[230]	L1124-GN-LIS-009B	IGALL AMP – Task Requirements – Electrical
[231]	L1124-GN-LIS-009C	IGALL AMP – Task Requirements – Civil
[232]	L1124-GN-LIS-010	Comprehensive List of Koeberg TLAAs
[233]	L1124-GN-LIS-016	SALTO Room Master and Environmental Zones List
[234]	L1124-GN-LIS-017	Component Failure List
[235]	L1124-GN-LIS-020	Comprehensive List of all SSCs Reviewed for SALTO Requirements
[236]	L1124-GN-LIS-027	AMR Data Tables for Commodity Groups
[237]	L1124-GN-RPT-002	SALTO Koeberg Classification Master Table
[238]	L1124-GN-RPT-018	Time-Limited Ageing Analysis Based on Initial Environmental Qualification
[239]	L1124-GN-RPT-019	Validity of KNPS Containment Civil TLAA 301
[240]	L1124-GN-RPT-020	Validity of Polar Crane

[241]	L1124-GN-RPT-022	Report on Verified List of Existing Koeberg Time-Limited Ageing Analyses
[242]	L1124-GN-RPT-023	AME Degradation Assessment Results Mechanical
[243]	L1124-GN-RPT-024	AME Degradation Assessment Results Civil
[244]	L1124-GN-RPT-025	AME Degradation Assessment Results Electrical
[245]	L1124-GN-RPT-027	Report on Operational Experience for the Review of Existing Koeberg TLAAs
[246]	L1124-GN-RPT-030	Comparison Report Existing KNPS Plant Programmes with IGALL AMP Requirements
[247]	L1124-GN-RPT-039	Component Failure Report
[248]	L1124-GN-RPT-040	SALTO Room Master and Environmental Zones Report
[249]	L1124-GN-RPT-041	SALTO Scoping Report
[250]	L1124-GN-RPT-044	Containment Liner – SALTO Civil Assessment Report TLAA 303
[251]	L1124-GN-RPT-045	Koeberg Containment Settlement – SALTO Civil Assessment Report TLAA 304
[252]	L1124-PM-PLN-004	SALTO Consortium Documentation Management Plan
[253]	RD-0034	Quality and Safety Management Requirements for Nuclear Installations

2.4 Definitions

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

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

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

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

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

Pericles Database: A database for electrical and C&I cables.

Qualified Condition: Condition of equipment before 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.

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

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.

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.

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

[1] 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 Abbreviations

Abbreviation	Explanation
AK	Valve Actuator – Pneumatic
ALARA	As low as reasonably achievable
AM	Ageing Management
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
BNI	Balance of Nuclear Island
CAMP	Cable Ageing Management Programme
CASS	Cast Austenitic Stainless Steel
CCCW	Closed-Cycle Cooling Water
CE-Civil	Component Engineering - Civil
CF	Component Failure
COMSY	Condition-Oriented Ageing Management System
CR	Condition Report
CRDM	Control Rod Drive Mechanism
CRGA	Control Rod Guide Assembly
CSE	Conventional System Engineering
CSR	Critically Safety Related
CUF	Cumulative Usage Factor (from conventional fatigue analysis)
CUF_{en}	Environmentally Corrected Cumulative Usage Factor
DCRF	Document Control Resolution Form
DDR	Document Drawing Change Request
DEC	Design Extension Condition
DER	Design Extension Related
DVK	Fuel Building Ventilation System
EAF	Environmentally Assisted Fatigue
EBA	Containment Sweeping Ventilation System

Abbreviation	Explanation
EDF	Électricité de France
EERT	External Events Review Team
ECMP	Environmental Condition Monitoring Programme
EI&C	Electrical, Instrumentation and Control
EL	Solenoid Pilot Valve
EQ	Environmental Qualification
EPA	Electrical Penetration Assembly
ETY	Containment Atmosphere Control System
GALL	Generic Ageing Lessons Learned
HQB	Low-Level Waste Building and Survey
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
I&T	Inspection and Test Group
IEEE	Institute for Electrical and Electronic Engineers
IGALL	International Generic Ageing Lessons Learned
IQ Review	Module of Equipment Reliability Software
IR	Insulation Resistance
ISI	In-Service Inspection
ISIPRM	In-Service Inspection Programme Requirements Manual
IST	In-Service Test
KLBM	Koeberg Licensing Basis Manual
KNPS	Koeberg Nuclear Power Station
KRT	Plant Radiation Monitoring System
LOPP	Life-of-Plant Plan
LS	Linked to Safety
LTO	Long-Term Operation
LV	Low Voltage
MA	Nuclear Measurement
MOVPRM	Motor-Operated Valve Programme Requirements Manual
MP	Pressure Measurement
MRG	Materials reliability Group
MV	Medium Voltage

Abbreviation	Explanation
NDE	Non-destructive Examination
NEPP	Nuclear Engineering Position Paper
NNR	National Nuclear Regulator
NPP	Nuclear Power Plant
NS	(Lesedi) Nuclear Services
NSA	Non-Safety or Availability-Related
NSAS	Non-Safety Affecting Safety
NSE	Nuclear System Engineering
NSF	No Safety Function
NSSS	Nuclear Steam Supply System
ODCOF	Output Deliverable Close-Out Form
OE	Operating Experience
OTS	Operating Technical Specification
P&ID	Piping and Instrumentation Diagram
PLCM	Project Life Cycle Management
PLEX	Plant Life Extension
PM	Preventive Maintenance
PO	Pump
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
PWSCC	Primary Water Stress Corrosion Cracking
PZR	Pressuriser
QA	Quality Assurance
QL	Qualified Life
RCP	Reactor Coolant System
RCV	Reactor Chemical and Volume Control System
RIC	In-Core Instrumentation System
RG	(NNR) Regulatory Guide
RIS	Reactor Safety Injection System
ROD	Record of Decision
RPE	Vent and Drain System
RPN	Nuclear Instrumentation System

Abbreviation	Explanation
RPV	Reactor Pressure Vessel
RPVI	Reactor Pressure Vessel Internals
RRA	Residual Heat Removal System
RS	Resistor (Electric Heater)
RTD	Resistance Temperature Detector
SALTO	Safety Aspects of Long-Term Operation
SAP	Systems, Applications, and Products (Business Management Software)
SAR	Safety Analysis Report
SGR	Steam Generator Replacement
SR	Safety-Related
SRSM	Safety-Related Surveillance Manual
SSC	System, Structure and Component
TLAA	Time-Limited Ageing Analysis
TOP	Technological Obsolescence Programme
UT	Ultrasonic Test
VVP	Main Steam System
WBS	Work Breakdown Structure
WT	Wall Thickness

3.0 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 to support the KNPS LTO initiative. For context to the background of LTO at KNPS, refer to* *Appendix B**.*

3.1 Evolution of Ageing Management at KNPS

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

Historically, the KNPS arrangements for ageing management were aligned with the plant condition management requirements in Annexure E of the KLBM. The ageing management activities consisted of general asset management processes and programmes (such as ISI, 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, and 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 adopted the EDF ageing management approach, including the AMM. An assumption was made that for the initial matrix, the ageing concerns of EDF and KNPS are similar enough to adopt and allow for adaptation to the KNPS specifics. EDF ageing mechanisms that were not applicable to KNPS were also identified on the AMM and dispositioned. The AMM identifies the ageing degradation, ageing effects, and the SSCs affected by ageing. The ageing management matrix was populated with KNPS-specific equipment, ageing management programmes and processes, maintenance activities, and associated reference documents.

As part of the Koeberg SALTO assessment project, scoping and ageing management evaluation exercises were performed to ensure that all ageing-related aspects of all plant systems, structures, and components (SCCs) important to safety are identified and assessed. Due to the complexity of the ageing management evaluation process, this activity is more time and cost-effectively supported by a dedicated software system for:

- The management of ageing relevant data (approximately 90 000 SSCs)

- Functions for the periodic assessment of degradation effects resembling the state of science and technology.

Considering the aforementioned, the COMSY database was adopted and customised in accordance with the AME document 240-125122792 [2]. For this purpose, the COMSY database is now utilised as the Koeberg SALTO ageing management database and has now superseded the previous AMM 240-101650256 (*Ageing Management Matrix*). The ageing management platform COMSY is designed to provide a degradation assessment and degradation surveillance for the technical equipment of power plants of different designs. It is designed to support the commodity grouping process based on the input data regarding design, materials, operating conditions, and environmental data. The IAEA IGALL master table was used as the primary source for the commodity grouping process. Therefore, the commodity groups are based on the pre-defined groups from the IGALL master table linked to the SSCs stored in the ageing management database with categories, commodity groups, and sub-commodity groups.

Ongoing updates of the Koeberg AMM in accordance with procedure 331-275 [85] have continued to date, based on local and international operating experience (OE), including a review of proven practice from the IAEA IGALL.

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's scope of work was developed based on the requirements in the IAEA's SALTO guidance and 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. The project followed the Project Life Cycle Management (PLCM) structure defined in KAA-501 [178].

The project had two approaches to execute the work scope to achieve the required output deliverables:

- The project included once-off initiatives (such as the SALTO scope setting and 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 KNPS organisational line groups to implement and address the gaps identified in the assessments. To control the scope of work in the KNPS organisational line groups, the line group actions linked to the project

[2] The self-assessment results are documented in 240-106374672 [37] and in 240-102103854 [36].

were loaded on the DevonWay action tracking system for each line group. Over 400 actions were raised through the SALTO project. All of those required for completion prior to LTO are closed. The few remaining open actions are either enhancements that are treated as business-as-usual or post-LTO activities.

The Koeberg SALTO assessment project is managed in accordance with 08016-S-PMP (*SALTO Project Management Plan*) [35].

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

3.3 SALTO Ageing Management Assessment Process Overview

The SALTO ageing management assessment process was developed to comprehensively verify the adequacy of the KNPS ageing management processes for LTO. It was 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*) [7], and is supported by the IAEA IGALL report, SRS-82 (*International Generic Ageing Lessons Learned*) [6]. The process was adjusted to be specific for KNPS and to meet the regulatory requirements in accordance with RG-0027 [8]. 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 [219];
  - Procedure – L1124-DE-PCD-001 [215].
- **Commodity Grouping:**
  - Methodology – L1124-DE-RPT-002 [220];
  - Procedure – L1124-DE-PCD-002 [216].

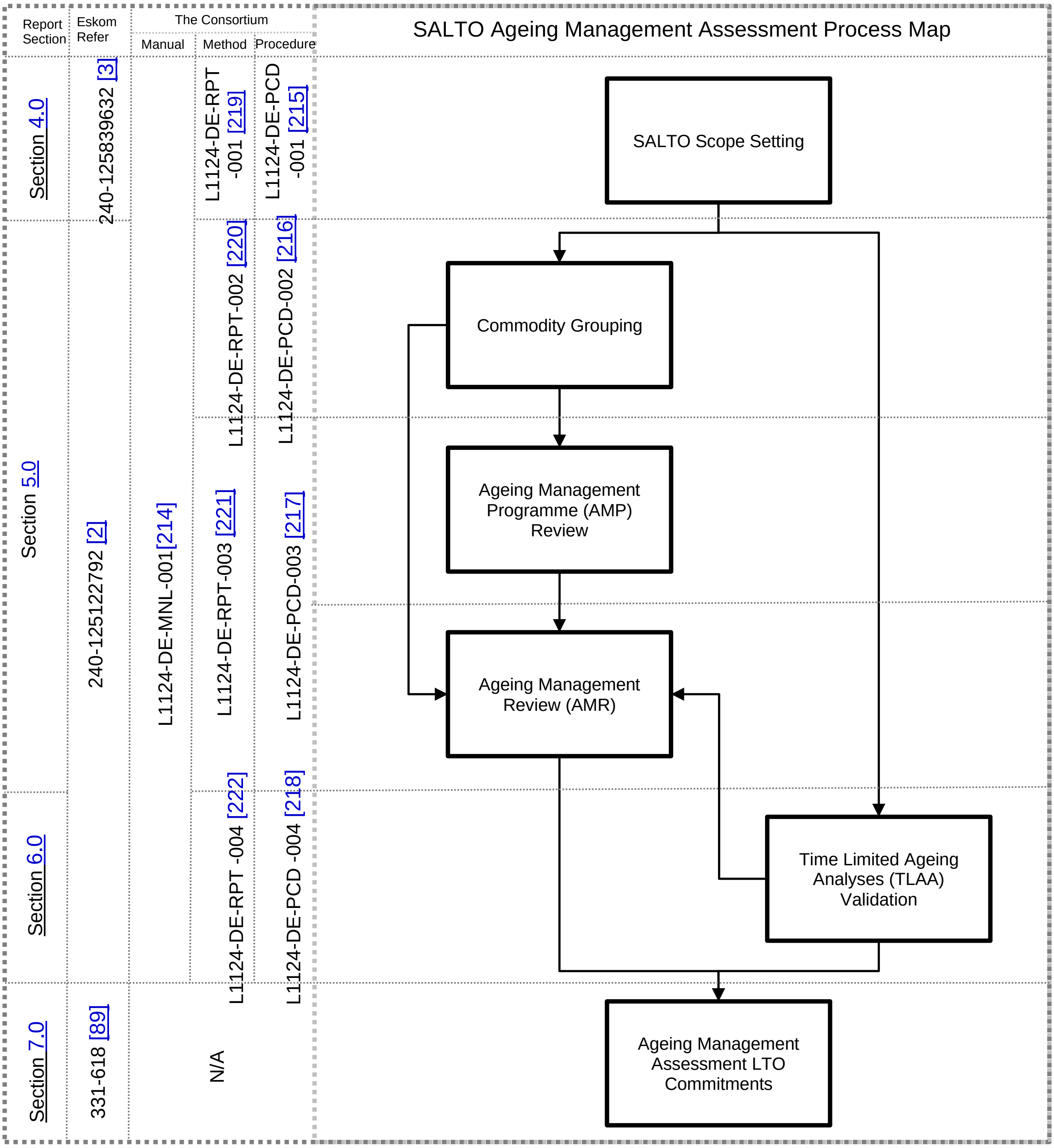
- **Ageing Management Evaluation[3]:**
  * Methodology – L1124-DE-RPT-003 [221];
  * Procedure – L1124-DE-PCD-003 [217].
- **Time Limited Ageing Analysis:**
  * Methodology – L1124-DE-RPT-004 [222];
  * Procedure – L1124-DE-PCD-004 [218].

The mapping of the assessment process to the final report sections, Eskom and Consortium governance documents is provided in Figure 2.

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 [214] provides an overview of the processes followed and the quality steps taken throughout the assessment.

The main steps of the process will be discussed in § 4.0, § 5.0, and § 6.0. These sections include the process steps' requirements, methods, processes, and outputs, as illustrated in Figure 2.

[3] The Consortium's 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.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240-125839632 [3]
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L1124-DE-PCD-001 [215]
SALTO Scope Setting
Section 5.0
240-125122792 [2]
L1124-DE-MNL-001[214]
L1124-DE-RPT-002 [220]
L1124-DE-PCD-002 [216]
Commodity Grouping
Ageing Management Programme (AMP) Review
L1124-DE-RPT-003 [221]
L1124-DE-PCD-003 [217]
Ageing Management Review (AMR)
Section 6.0
L1124-DE-RPT -004 [222]
L1124-DE-PCD -004 [218]
Time Limited Ageing Analyses (TLAA) Validation
Section 7.0
331-618 [89]
N/A
Ageing Management Assessment LTO Commitments

Figure 2: SALTO Ageing Management Assessment Process Map

4.0 SALTO SCOPE SETTING

The first step in the SALTO ageing management assessment was to determine the scope of SSCs important to nuclear safety that are to be subjected to 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 an actively managed safety classification system that aligns with the requirements for identifying SSCs needing to be subjected to an AME. KNPS utilised this unique classification system that was established and maintained at KNPS 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, identifying the scope for ageing management at KNPS was informed by the various requirements of KNPS's safety-related programmes. Each programme had its scope of SSCs to which the programmes were applied. The individual scope of applicable SSCs was comprehensive in accordance with the specific programme requirements. Therefore, multiple KNPS equipment information sources exist for specific applications and programmes. Examples of such sources include SAP, IQ Review (for preventive maintenance strategies), the importance classification listing (expanded later), ISI and IST list of equipment, and the SRSM lists for Operating Technical Specification (OTS) equipment, etc. Each list was created for a specific purpose and is maintained appropriately to achieve its programme requirements to maintain plant safety. No integrated list of all safety-related plant SSCs indicating which programmes apply to the SSCs existed.

Between 2008 and 2011, KNPS undertook its second periodic safety review (PSR) (also referred to as SRA II). As a result of the findings of SRA II, a comprehensive AMM was developed. The development of the AMM is discussed in detail in § 3.1.

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 on which the design and manufacture of plant SSCs were based were inadequate for defining levels of control to be applied to operational plant processes. This deficiency led to the establishment of importance categories at KNPS and the related importance classification category listing. The term 'Importance Category' refers to the importance of functions, processes, services, software, and SSCs as they relate to nuclear safety and plant availability. Following several developments, the document KLA-001 was established and accepted by the NNR in 2006. KLA-001 was subsequently re-referenced to 331-94 [99].

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 (previously KSA-010) [71], establishes the classifications used at KNPS. These classifications are described below. Guidance for classifications is provided in 331-93 [98].

4.1.2.2.1 Design Safety Classes

The design safety classification is in accordance with the adopted ANSI 18.2 [101]. These nuclear safety classes are the basis for the classification of seismic, environmental, and safety management system levels. 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 (introduced in § 4.1.2.1) is a classification that defines the nuclear safety importance of functions, systems, processes, components, structures, services, and software. It also provides for boundaries and 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 the potential dispersion of radioactive materials from the plant.
- ∗ Components subject to fire protection requirements necessary to protect areas where CSR and SR equipment are 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 fuel or to cool spent fuel.
- ∗ Components on the environmental qualification (EQ) list.
- ∗ Components essential for OTS requirements.
- ∗ Components required by emergency operating procedures.

- **Design Extension Related (DER)**

  A category assigned to systems, functions, components, structures, software, services, or processes not designated CSR or SR designed for or required for the prevention or mitigation of a design extension condition (DEC) that exceeds 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 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 an 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 ensure that certain systems, components, structures, parts, software, and services remain functional in environmentally hostile environments, particularly in the containment building in post-loss of coolant accident 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 the containment and required to operate in a normal external environment.
- **Category 0A**: Components located outside the containment required to operate near a line that conveys reactor coolant or is subjected to similar radiation levels.

- **Category 0B**: Components located outside containment required to operate in a steam environment during an accident.
- **Category 1**: Components located inside containment not required to withstand an accident – or post-accident environment.
- **Category 2**: Components located inside the containment that are required to operate only in the initial period following an accident.
- **Category 3**: Components located inside the containment that are required to operate during and after an accident.
- **Category 4**: Components located inside the containment that are required to operate after an accident.
- **Non-Environmental**: Components not required to conform to any EQ 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.

> ***NOTE:*** *Quality Q5 has been discontinued; the updated classification standard, 240-89294359 [71] defines that quality Q1 to Q4. Q5 was removed from the SAR II-1.2.2.1.5 under change notification CN-296.*

4.1.2.2.6 Management System Level

Management system levels are assigned to suppliers and sub-suppliers in a tiered approach based on their importance to nuclear safety of the structures, components, parts, and software as prescribed by the NNR requirements document RD-0034 [253]. The management system levels and their respective requirements are levels 1, 2, or 3.

4.1.3 Classifications Relevant to SALTO Scope Setting

The relevant KNPS classifications used for SALTO scoping are shown below and summarised in Table 4-1:

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

4.2 Requirements

In accordance with section 6.6 of RG-0027 [8], KNPS should implement a scope-setting process for the identification of scope to be included in the ageing management assessment to meet the following requirements:

1) A systematic scope setting (scoping) process should be developed and implemented to identify SSCs subject to ageing management.
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 SSCs.
3) A list or database of all SSCs at the nuclear power plant (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 based on predefined rules (based on a manufacturer's recommendation or other basis and not on an assessment of the condition of the structure or component, which would comprise the implementation of ageing management for the structure or component) within the period of LTO.
   b) Structures and components accepted by the NNR that are not to be included in the scope. Any adjustment to revise the agreed-upon frequency 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 walkdowns 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 AMR should be documented, including:

   a) A description and justification of the methods used to determine the structures or components that are subject to an AMR.

   b) An identification and listing of structures or components subject to an AMR 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 and outside of the scope should be evident.

4.3 Methodology

The Eskom SALTO scoping methodology (defined in 240-125839632 [3]) documents the KNPS scope setting methodology required to meet the regulatory scope setting expectations. The methodology was initially developed based on the IAEA SALTO guidance and reviewed and updated to ensure all requirements of the RG-0027 [8] were catered for. This document was submitted and approved by the NNR via NNR letter k26204N.

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 below.

4.3.1 Requirement Interpretation

Clauses 4 and 5 of section 6.6 in RG-0027 [8] 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.

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

Interpretation of Clause 6.6.4.a

Regulatory requirement 6.6.4.a is expanded in the IAEA guide, SSG-48 [7], as follows:

> *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 [101]. For KNPS, SSCs required to fulfil the fundamental safety functions 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 [7] 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 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 [7] 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 DECs 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 above were identified and included in the SALTO scope in the following way:

- SSCs in emergency operating procedures 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 identified by the external events risk assessment is 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 provides requirements for the exclusion of scope due to periodic replacement or a scheduled refurbishment plan according to the equipment 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

Further to the section above, Table 4-1 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 are 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 SSCs within the scope and those outside 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 defined in section 4.3.2 are, by default, excluded from the scope list. These may 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. Historically, these SSCs have not been assigned a classification in accordance with the classification standard 240-89294359 [71].

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

From a comprehensive review of the NNR regulatory requirements and the functional areas in the KLBM, SSCs from the following functional areas were identified where the SSCs are used in the execution of a licence-binding programme:

- 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 best managed under their specific licence-binding programmes. These SSCs are still covered by their maintenance activities, obsolescence related to long-lead items included in the obsolescence management programme and the reporting of the reliability of these SSCs to the NNR are still included in the annual reports to the NNR in accordance with RG-0027 [8]. The approach still seeks to maintain a high degree of reliability for these SSCs that have many off-the-shelf components that can readily be replaced without long-lead times.

This approach to dealing with these types of excluded SSCs has been benchmarked through engagements with IAEA scoping SMEs, and this approach was found to be consistent with other plants that follow the IAEA SSG-48 [7] SALTO process. The governing documents for the programmes and their SSCs are therefore considered adequate for ensuring reliability during the LTO period. The ageing management of these SSCs is discussed in the scoping methodology procedure, 240-125839632 [3].

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 for scoping. Document 240-128716554 [4], which lists multiple input information sources available for scoping, was developed. The input information sources collated for the scoping process fall under one or more of the following categories (non-exhaustive examples for each category are provided):

- Digital SSC sources: 331-94 [99], design engineering classifications catalogue, SAP equipment listing, IQ Review (preventive 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 documents – Scoping sources: system design files (DSEs), plant drawings such as P&IDs (process and instrumentation drawings) and isometric drawings, the Koeberg SAR, etc.
- Plant documents – Ageing management sources: working procedures, operating procedures, operator training manuals, DevonWay, SAP history, IQ Review strategies, etc.

4.3.5 High-Level Approach

The SALTO scoping methodology 240-125839632 [3] provides a high-level approach for executing the scope-setting process, which includes:

- The extraction of equipment information from the various equipment lists;
- The linking of identified equipment with their classifications;
- Documenting the criteria for SSC scope inclusion or 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 3 depicts the process followed during the scoping activities. The following section briefly describes the scoping process elements as depicted in the flow diagram.

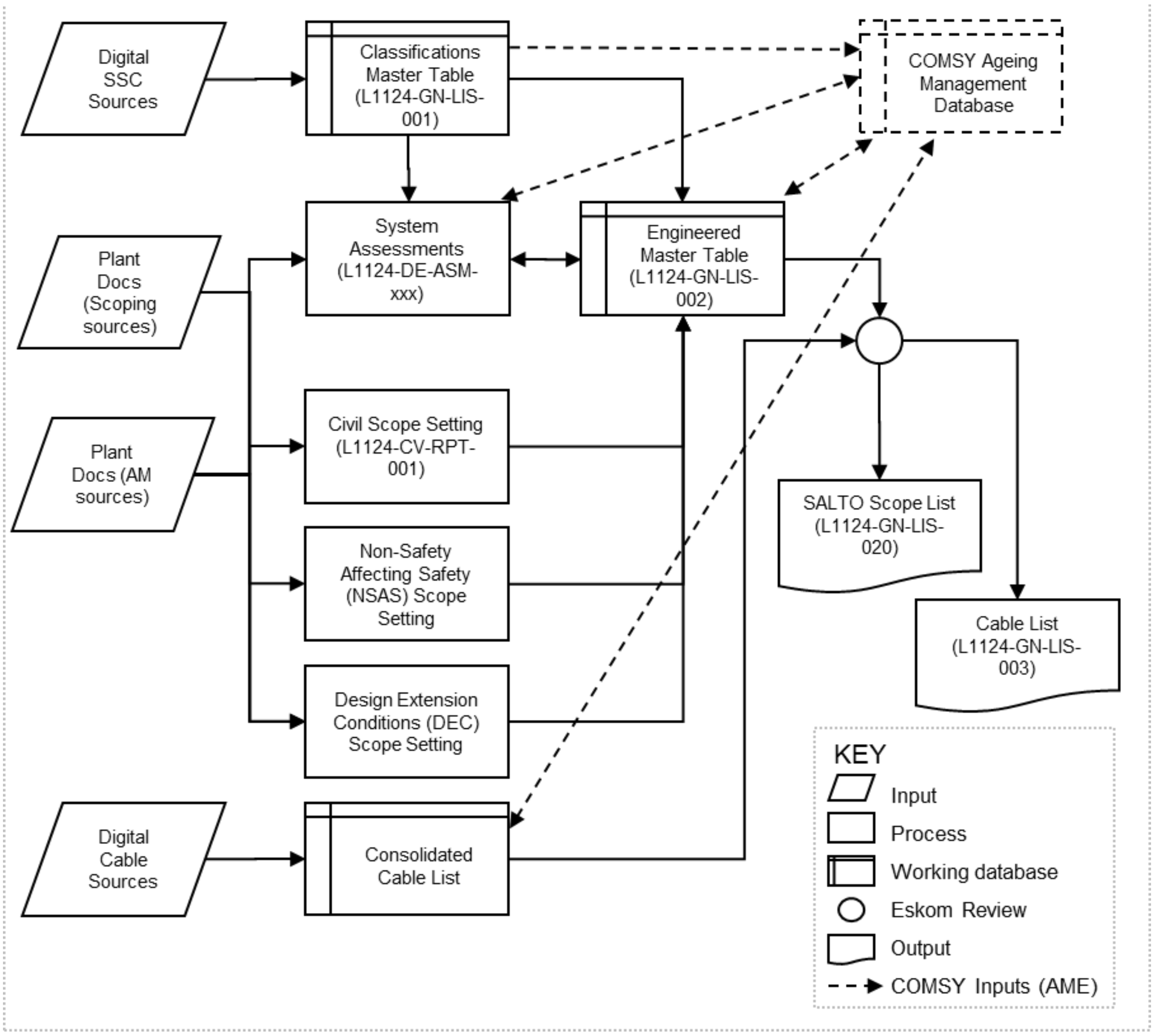

Figure 3: The Consortium Scoping Process Flow Diagram

4.4.1 KNPS Information Inputs

International guidelines recommend that a list or database of all SSCs (master list) be available before scope setting is commenced. In the absence of such a verified plant configuration for KNPS, the actual process of scoping utilised various input sources (as mentioned previously). Refer to § 4.3.4 on input information sources used for scoping.

The formal exchange of input source documents and deliverable documents distributed or transmitted across interfaces was properly documented and controlled in accordance with L1124-PM-PLN-004 [252].

4.4.2 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. SSC information in digital sources, such as component identifiers, descriptions, 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 [220]. The classification master table is documented in L1124-GN-LIS-002 [227].

4.4.3 System Assessment Sheets

System assessment sheets were created from the input information sources and the classification master table mentioned above to capture the scoping information. The 173 system assessment sheets (one worksheet per plant system, numbered '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 a 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. Refer to § 5.2.4.1 for further details.

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

4.4.4 Civil Scoping

Structures and buildings housing SSCs important to safety are included in the scope as primarily identified in 331-94 [99] 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 identifiable, 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 broken down 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:	1 HKA 000 BG
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 HKA 000 BG, room K113 of the Unit 1 fuel building is, therefore:	1 HKA 000 BG-K113-0S

The detailed methodology for creating new civil component Trigrammes is documented in L1124-CV-RPT-001 [210].

4.4.5 Non-Safety Affecting Safety (NSAS)

The process for identifying other SSCs whose 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 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 [165] and JN377/AMEC/NCI/TR/6393 [175] 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 walkdowns of the plant to identify and assess the seismic risks.
- The previously undertaken JN195/NCI/ESKOM/J2/365 [174] 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 considered the ASG, DVH, EAS, PTR, RCV, RIS, RRI, and SEC systems and the spent fuel pool overflow as sources of flooding. The SSCs of these systems 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 [166] was used to identify 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 [212]. For example, all fire systems were added to the SALTO scope.

4.4.6 Design Extension Conditions

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

- Emergency operating procedures;
- Severe accident management guidelines;
- Lists of fire risk management emergency equipment and portable equipment for design extension condition and external event accident mitigation; and
- 331-94 Importance Category Classification Listing [99].

SSCs that could be linked to the mitigation or prevention of design extension conditions were assigned or tagged as 'SALTO DER' in L1124-GN-LIS-002 [227] and L1124-GN-LIS-020 [235], which is a reference to Importance Category DER, introduced in 240-89294359 [71] and assigned to SSCs classified for use in mitigation of design extension conditions.

4.4.7 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 was imported into the engineered master table, except process parameters collected for AME, which were contained in the system assessment sheets. The engineered master table was used to improve the integrity of collected information. The engineered master table was not the final scope list but rather an input source of the 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 indicated whether components were identified in controlled and trusted sources (or not) and tracking notes for verifying the validity of components.

The engineered master table is documented in L1124-GN-LIS-002 [227], and the use and management of the engineered master table is described in L1124-DE-GDL-004 [213].

4.4.8 SALTO Scope List

The SALTO scope setting output has two main deliverables: the SALTO scope list and the SALTO cable list (described in § 4.4.9 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 [235], is described under the results § 4.5.1.

4.4.9 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.
- Koebec Cable List - A list of cables and routes installed through various plant modifications and not reflected in Pericles. The list was obtained from Koebec, an electrical and engineering service contractor for KNPS .
- MS Access cable 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 sources and included in the scope.

Due to the different formats 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; cables require origin, destination, and routing information.

The SALTO cable list is provided in L1124-EL-LIS-003 [225].

4.4.10 COMSY

As discussed in § 3.1, the COMSY software developed by Framatome is adopted and used as an ageing management database for KNPS. This database 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 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 (refer to § 5.0).

4.5 Results

The output from the scoping process provided two sets of results, namely, the SALTO scoping lists and the identified anomalies.

4.5.1 Scope Setting Results

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

The scoping process outputs (deliverables) provided by the Consortium were:

- The full SALTO SSC scope list L1124-GN-LIS-020 [235] 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 or non-existent components.*

  - Generic items, i.e. SCCs without labels or trigrams, and generic approach to certain SSCs as shown in the last worksheet of L1124-GN-LIS-020 [235].
- The full SALTO cables scope list L1124-EL-LIS-003 [225]; and
- The Consortium scope setting and verification report L1124-GN-RPT-041 [249].

4.5.2 Anomalies

During the scoping and data verification process, discrepancies, inconsistencies, and errors were discovered in plant documents. The following anomalies, inconsistencies, or document 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 input data sources: for example, description variances between SAP, IQ Review, and the SALTO scope list.
- Technical document discrepancies: These are mostly inconsistencies between various documents and apparent errors in plant documents (e.g. errors on P&IDs, or inconsistencies between the P&IDs of units 1 and 2).
- Trigram discrepancies: Several 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 found inconsistencies in the three sources used for cable information sourcing. The three sources are the Pericles database, the MS Access database, and the cable list sourced from Koebec.
- Plant layout drawings inconsistent: Plant layout inconsistencies between various document sources.

Anomalies affecting the SALTO in/out scope decision were immediately resolved between the Consortium engineers and KNPS as part of the scoping process. Document 240-153945942 [50] was developed to secure external support to evaluate and correct the identified anomalies. Design Engineering has managed the resolution of all anomalies in accordance with the appropriate KNPS configuration management process in the execution phase of the Koeberg SALTO assessment project. The assessment of discrepancies for SSCs in scope and the associated classifications was completed in January 2024. A total of 180 DDRs were completed for documentation discrepancies. Reporting and conclusions on the process and outcome of the anomaly resolution project is documented in 331-627 (Report – Evaluation and Rectification of SALTO Anomalies) [90].

4.6 Verification

This section describes the verification processes for the SALTO scope, followed by Eskom and the Consortium.

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 DSEs, logic diagrams, feeder diagrams, flow diagrams (P&ID), and SIP and SIN drawings. The system assessment sheets provided the means of capturing this information. L1124-DE-GDL-001 [211] describes this process in detail.

4.6.2 Consortium Independent Review

Each system sheet was independently reviewed. 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 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 walkdowns.

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 change review forms (DCRFs) 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 the scope and those excluded from the scope; however, with 209 774 components (and more than 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 each 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 thirty-five engineers were assigned, each reviewing forty line items.

- A detailed line-by-line review of the identified sample data of in-scope equipment was performed to confirm the SALTO scope list. This review aimed to verify the accuracy of the SALTO scope and data collected for ageing management.
- No SSCs were added or removed from the SALTO scope as a result of this review.

Scoping Review Group B – Excluded Scope Review

For this review, thirteen engineers performed an overview of all the excluded scope. The review aimed to identify any system, component, or 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 of items verified that no important-to-safety SSCs credited in the safety analysis for the two KNPS units had 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 were safety-significant SCCs used in the KNPS incident procedures that were not included in the SALTO ageing management scope. The review revealed that two safety-significant components were omitted from the SALTO scope: GCT 503 CC and

REA 411 ID. The two components were subsequently 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, or components captured in this list that should be in the excluded scope, the intention being to identify equipment that has no link to nuclear safety or with no impact on nuclear safety. The review comments by ten 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 with client requirements, etc. Where comments were noted, these were addressed and corrected by the Consortium before 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 these reviews and corrections were as follows:

- 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 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 creating a generic items list within L1124-GN-LIS-020 [235] to capture these SSCs.
- Multiple safety classes assigned to SSCs in the SALTO scope list were questioned by the reviewers. It was explained that these items were defined according to input information, and therefore, no changes were made to the SALTO scope. However, questionable classification categories found during the SALTO scope reviews were to be resolved as part of the resolution of anomalies discussed in § 4.5.2.

4.6.3.2 Scope Verification Walkdowns

During the execution phase of the Koeberg SALTO assessment project, plant walkdowns were performed to confirm and verify the completeness of the scope. For KNPS, the objective was to verify the comprehensiveness of the list of in-scope non-safety related SSCs. The plant walkdowns were performed on a sample of safety risk-significant active components identified by the Deterministic and Probabilistic Safety Analysis group. The decision and approach to plant walkdowns were recorded in 08016.ROD.012 [25]. The findings of these walk-downs, documented in report 240-160675265 [53], found that they do not significantly impact the final scope list. Actions stemming from this review were addressed in the line functions as described under § 4.7 below.

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

4.7 KNPS 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) [235] was formally submitted to the Design Engineering department via letter NPM-044-2020. The list includes SSCs in the SALTO scope as well as those excluded from the scope. It is noteworthy that the list is significantly more comprehensive when compared to the current 331-94 [99]. The list is now under the control of the Design Engineering Group. The list L1124-GN-LIS-020 [235] has been incorporated into the Design Engineering Access classification database (located on the G-drive), and it is managed through 331-91/KAA-562 Control of Equipment and Software Classifications [97] and 331-93 Guide for Classification of Plant Components, Structures, and Parts [98].

5.0 AGEING MANAGEMENT EVALUATION

RG-0027 [8] requires that the AMR address the categorisation of SSCs with regard to degradation and ageing processes and the review of ageing management programmes in accordance with current NNR or international safety standards and operating practices. To achieve this, KNPS performed an AME for all the SALTO in-scope SSCs as defined in § 4.5.1.

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

The validation of TLAAs is described separately in § 6.0 of this report.

5.1 Requirements

In 2019, the NNR issued RG-0027 [8], which provides the requirements for ageing management and LTO for NPPs. Section 6 of RG-0027 [8] requires an AMR for in-scope SSCs to ensure and demonstrate that ageing will be effectively managed and that all identified TLAAs will remain valid for the planned period of LTO.

The AME activities to meet the requirements of RG-0027 [8] can be categorised into the following main activities:

- Commodity grouping;
- Review of ageing management programmes;
- Equipment AMR;
- TLAA.

To ensure that the requirements and activities mentioned above are achieved, KNPS developed the SALTO AME procedure 240-125122792 [2], which provides a high-level process for performing the AME. This is to demonstrate that ageing will be effectively managed and monitored for the planned period of LTO for the in-scope SSCs. This procedure further provides the process for identification and validation of the TLAAs applicable to KNPS for LTO. This document was submitted and approved by the NNR via letter k27143N on 9 March 2021.

5.2 Process and Results

The AME process followed by the Consortium in performing the ageing management evaluation of mechanical, electrical, I&C, and civil SSCs is described below.

5.2.1 Process Overview

Figure 4 provides the AME process overview, which includes the following elements:

- Commodity grouping;
- Ageing management programme (AMP) review;
- Equipment ageing management review (AMR);
- Results of time-limited ageing analyses (TLAAs).

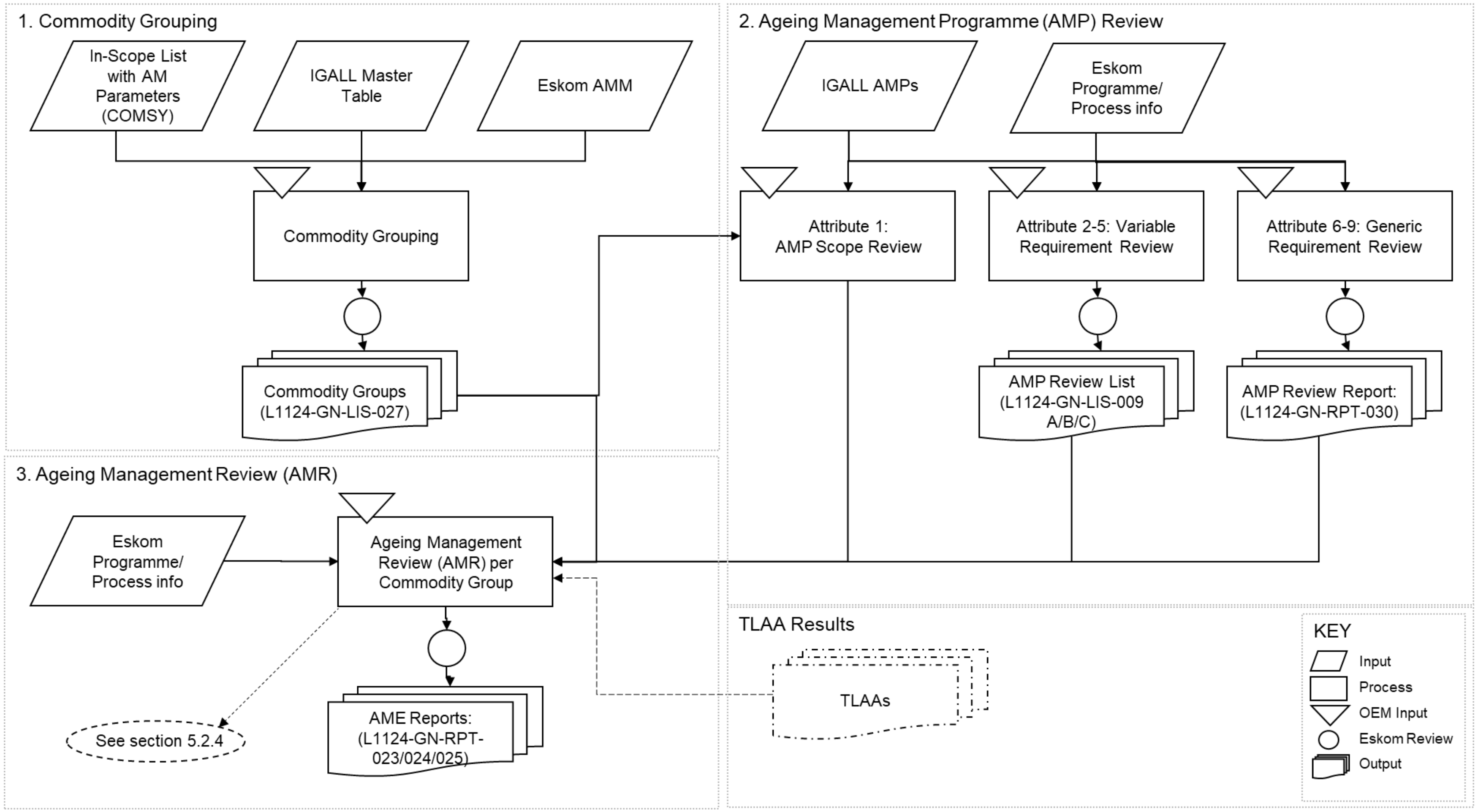

Figure 4: Ageing Management Evaluation (AME) Process Overview

5.2.2 Commodity Grouping

To ensure that the AMR is performed effectively, where applicable, the list of identified SSCs subject to ageing was grouped into commodity groups. This allowed for assessing an entire group with a single review task.

The rationale for grouping SSCs is based on characteristics such as similar design, similar materials of construction, similar ageing management practices, or similar environments. If the environment in which the structure or component operates suggests potential different environmental stressors, the commodity group determination could also consider service time, operational transients, previous failures, and any other conditions that would suggest different results. In-scope SSCs that could not be grouped into commodity groups were evaluated as stand-alone structures and components.

In accordance with requirements stipulated in the SALTO AME procedure 240-125122792 [2], the methodology developed and applied by the Consortium to perform the SALTO commodity grouping is defined in L1124-DE-RPT-002 [220]. The methodology is based on the IGALL Master Table and the Koeberg AMM.

5.2.2.1 Commodity Grouping Process

As shown in Figure 4, the following inputs were used to inform the structure of KNPS commodity groups:

- **SSCs subject to ageing management**

  The requirements stipulated in 240-125122792 [2] apply to the relevant SSCs identified during the scoping process as discussed in § 4.5.1 of this report.

- **IGALL master table**

  The IGALL master table (2018 version), which is considered an internationally acceptable and proven practice with the list of AMPs for each critical location or part of SSCs associated with an ageing effect or degradation mechanism, material, and environment was used as the primary source for the creation of the commodity groups. The IGALL master table provided a proven practice by the IAEA member states for evaluating ageing mechanisms for pressurised water reactor (PWR) plants. In addition, the IGALL master table provided links between the commodity groupings and the IGALL AMPs.

- **Koeberg ageing management matrix**

  The existing Koeberg AMM comprehensively documented 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 (refer to § 5.2.4). The use of the existing Koeberg AMM provided insights stemming from the EDF ageing management approach and extensive EDF OE, which was of additional benefit to the IGALL information.

- **Framatome adjustment (OEM OE)**

  Engineering judgement (Framatome adjustment) based on 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. The COMSY database was populated (refer to § 4.4.10) with information (such as material, temperature, medium, flow conditions, etc.) for the in-scope SSCs in accordance with document L1124-DE-RPT-002 [220].

The commodity groups were created based on the pre-defined structure of the IGALL Master Table and the Koeberg AMM. The in-scope SSCs were then linked to their respective commodity groups. In-scope items that could not be grouped into commodity groups were listed as stand-alone structures or components.

5.2.2.2 Commodity Grouping Results

The civil, electrical, and mechanical commodity groups were identified through the commodity grouping process. The Consortium deliverable L1124-GN-LIS-027 [236] and the COMSY database provide a comprehensive list of commodity groups for each discipline and the associated SSCs.

5.2.3 Ageing Management Programmes Review

RG-0027 [8] requires that if the ageing of in-scope SSCs is managed by an existing AMP, it should be verified that it is consistent with the nine attributes[6] of an effective AMP as defined in Appendix A of RG-0027 [8].

As part of the IGALL programme, 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 NPP to ensure that SSCs can perform their intended functions throughout the lifetime of the plant.

The primary objective of the AMP review was to check whether the KNPS's existing plant and ageing management programmes fulfil the requirements of the generic IGALL AMPs. The initial review was performed using the 2018 version of the IGALL AMP table, which was current at that time. The review also verified that these AMPs are consistent with the nine attributes of an effective AMP.

[6] Note that the 9 generic attributes for an effective AMP provided in RG-0027 [8] are similar to those provided in the IAEA SSG-48 [7] guidance.

A subsequent review of the 2022 version of IGALL for new AMPs was performed. None were identified, which required an additional AMR to be performed. An annual review of the IGALL website for new AMPs applicable to KNPS is being performed according to 331-275 [85].

5.2.3.1 AMP Review Process

As shown in Figure 4, the review was achieved by comparing the tasks originating from the KNPS AMPs and maintenance strategies with the generic IGALL AMPs. To facilitate the comparison, the IGALL AMP tasks were broken down into well-defined and subdivided tasks.

If all IGALL AMP tasks were covered by tasks of an AMP or maintenance strategy, the existing AMP was deemed adequate due to its conformity with IGALL AMP requirements.

The nine attributes were grouped and separately reviewed.

5.2.3.1.1 Attribute 1 – AMP Scope

Compliance of the existing AMPs with Attribute 1 was checked as part of the AMR process. The outcome of the AMR was reported in the COMSY database, data sheets L1124-GN-LIS-027 [236], and the following AME reports:

- L1124-GN-RPT-023 [242];
- L1124-GN-RPT-024 [243]; and
- L1124-GN-RPT-025 [244].

5.2.3.1.2 Attributes 2 to 5 – AMP Variable Requirements

IGALL AMP Attributes 2 to 5 cover activities such as maintenance, inspection, mitigation, and monitoring. The existing KNPS AMPs were checked for consistency against these attributes. The results of this assessment are documented in the following:

- L1124-GN-LIS-009A [229];
- L1124-GN-LIS-009B [230]; and
- L1124-GN-LIS-009C [231].

The existing maintenance activities were also reviewed for adequacy and results provided in the AME reports.

5.2.3.1.3 Attributes 6 to 9 – AMP Generic Requirements

Attributes 6 to 9 are generic programme requirements that apply to all the existing KNPS AMPs. The Consortium reviewed the existing KNPS AMPs for compliance with these attributes.

Based on the review outcome, several suggested gaps with proposed corrective actions were documented in Consortium report L1124-GN-RPT-030 [246] and reported in the AME reports.

5.2.3.2 Ageing Management Programme Review Results

The results of the AMP review for each discipline are expanded in the sections below and were considered in the AMR process.

5.2.3.2.1 Civil

The civil AMP review is documented in report L1124-GN-RPT-030 [246] and the AME report L1124-GN-RPT-024 [243]. The comparison review resulted in the following:

- The requirements of five IGALL AMPs were found to be adequately covered by the existing Koeberg AMPs.
- The requirements of the seven IGALL AMPs were found to be partially covered by the Koeberg existing AMPs.
- The requirements of one IGALL AMP (AMP 309) were not adequately covered by the Koeberg AMPs and needed to be developed.

5.2.3.2.2 Electrical and I&C

The review of electrical, instrumentation and control (EI&C) AMPs is documented in report L1124-GN-RPT-030 [246] and the AME report L1124-GN-RPT-025 [244]. The review resulted in the following:

- The requirements of the twelve IGALL AMPs were found to be fully covered by the existing Koeberg AMPs.
- The requirements of three IGALL AMPs were partially covered by the existing KNPS AMPs.
- The requirements of two IGALL AMPs were not covered by any existing AMPs and needed to be developed.
- Three of the IGALL AMPs were considered as not applicable to KNPS.

5.2.3.2.3 Mechanical

The mechanical review is documented in report L1124-GN-RPT-030 [246] and the AME report L1124-GN-RPT-023 [242]. The review resulted in the following:

- The requirements of twenty-five IGALL AMPs are fully covered by existing AMPs.
- The requirements of eight IGALL AMPs were found to be partially met by the requirements of the existing AMPs.
- Seven IGALL AMPs needed to be developed to meet the IGALL requirements.

Eskom reviewed the above AMP comparison results and recommendations and the AMR results. This was used to establish the KNPS position for all recommendations, documented decisions with appropriate justifications, and captured corrective actions in the AME recommendation review reports for mechanical, civil, and EI&C as discussed in the AME results section of this report (refer to § 5.3).

5.2.4 Ageing Management Review

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

In accordance with the requirements stipulated in the 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 [221]. The document provides a process whereby SSCs were evaluated for ageing effects based on their construction materials, operating environments, and OE.

For specific commodity groups and SSCs, the AMR systematically assessed the ageing effects and their related degradation mechanisms that are experienced or anticipated. This was to assure the ability of the SSCs to perform their intended function(s) throughout the extended plant life.

The AMR process, shown in Figure 5, consists of the following essential elements:

- Gathering of relevant equipment data (i.e. materials, the environment, and stressors);
- Assessment of the current condition of the structure or component (including component failure assessment);
- Identification of ageing effects and degradation mechanisms based on fundamental knowledge for understanding ageing;
- Identification of the appropriate programme for ageing management; and
- Reporting of the AMR to demonstrate that the ageing effects and degradation mechanisms are being managed effectively.

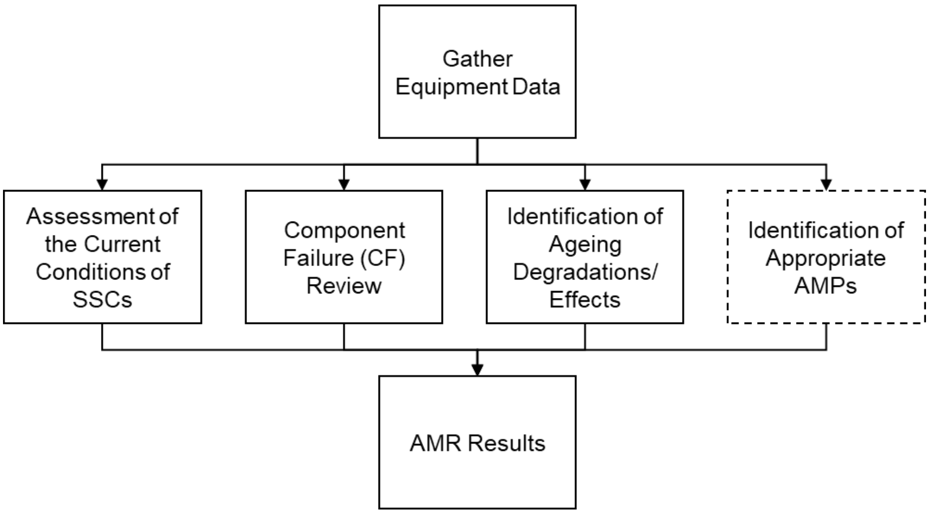

Figure 5: Ageing Management Review (AMR) Process

The AMR essential elements are discussed in the subsections below.

5.2.4.1 Gathering Equipment Data

The relevant equipment data was collected during the scoping process as input into the AMR process. The data collected consisted of the following:

- Material information for in-scope SSCs:
  - 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, material specification, ageing sensitive materials of component and component datasheets to identify service limits of the SSC.
- Data required for the ageing assessment, such as the ageing of susceptible parts and materials, temperature, radiation, electrical voltage, humidity, rated current, and rated power.
- Installation information and position (defined in terms of room 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 Consortium report L1124-GN-RPT-040 [248] 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 [233].
- 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, 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 and IGALL AMPs;
- Koeberg AMM information;
- List of existing KNPS AMPs;
- Plant drawings (such as P&ID, isometrics, and electrical drawings), system design documents (DSEs), and maintenance manuals;
- Maintenance strategies and activities from the IQ Review database and the SAP database; and
- Information on whether the component is subject to TLAA, including its qualified life (for electrical and I&C) validity at the time of assessment.

The information was collected into the system assessment sheets (described in § 4.4.3) and included in the L1124-GN-LIS-002 [227], and later uploaded into the COMSY database. The engineered master table was used as a database of SSCs. The relevant information applicable to the SSCs was obtained from Eskom technical input sources to formalise and enhance the extent and accuracy of the in-scope SSCs.

5.2.4.2 Assessment of the Current Conditions of SSCs

KNPS has developed and implemented several plant programmes and processes to monitor and maintain SSCs in good condition. Implementing 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 and 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 CF review (discussed in § 5.2.4.3).

The position on the approach KNPS has adopted for assessing the current physical status of relevant SSCs for SALTO AME has been documented in the output deliverable close-out form, 08016.ODCOF.049 [9]. It provides the justification for taking credit for the existing programmes and processes at KNPS in confirming the current conditions of the relevant SSCs, which is in accordance with the requirements stipulated in the SALTO AME procedure 240-125122792 [2].

5.2.4.3 Review of Component Failures

During the AMR process, CFs reported at KNPS were reviewed. This review included all CFs reviewed under procedure KGU-033 [190], which provides guidance for investigating plant CFs, including consideration of the OE to prevent recurrence and to improve the current maintenance strategies. The guidance in this document is applied to all CFs.

The review of CFs compared international failure rates with those of Koeberg. This review further provided information on the physical condition of SCCs.

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

L1124-GN-RPT-039 [247] and L1124-GN-LIS-017 [234] were compiled to report on the review of these CFs.

The review of the CFs indicated that where failures occur, these were dealt with sufficiently and affected components were restored to good health, consistent with the guidance for investigating plant CFs provided in KGU-033 [190]. The review also confirmed that the AMPs 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

The AMR systematically assessed ageing effects and their related degradation mechanisms experienced or anticipated. The AMR process included identifying 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 [refer to § 5.2.3]). The AMR included an assessment of the impact of the ageing effect on the in-scope SSCs' ability to perform their intended function(s), including consideration of the current condition of the SSC.

Potential ageing mechanisms and subsequent applicable ageing effects were identified and assigned to a commodity group or SSCs within COMSY. This was to obtain the comprehensive link of all potential ageing mechanisms to the commodity group or SSC, based on the IGALL master table as an international reference and the Koeberg AMM, which provides KNPS-specific experience. Through the AMR process, the applicable lessons relating to ageing-based industry OE, KNPS-specific OE, and the Framatome experience were applied.

5.2.4.5 Identification of Appropriate Ageing Management Programmes

For ageing effects requiring management, the process defined in L1124-DE-RPT-003 [221] also determined 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 review of the AMPs as part of the AME is covered in § 5.2.3.

5.2.4.6 Ageing Management Review Results

The results of the AMR are documented in the COMSY data sets L1124-GN-LIS-027 [236] and in the discipline-specific AME reports L1124-GN-RPT-023 [242], L1124-GN-RPT-024 [243], and L1124-GN-RPT-025 [244].

Each AME report provides information on the following:

- List of SSCs and commodity groups evaluated;
- Assessment of the ageing effects and degradation mechanisms using the IGALL master table, the Koeberg AMM and Framatome experience;
- Relevant AMPs or activities to manage the ageing effects and degradation mechanisms for each commodity grouping or SSC; and
- Recommendations to include updates to existing programmes or the need for new plant programmes.

The AME reports provided the Consortium with identified potential ageing management gaps and recommended actions. These AME results and the actions recommended by the Consortium were reviewed by the Eskom technical team and subject matter experts, as discussed below.

5.2.5 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 deliverables:

- **Interface with the KNPS SALTO technical team**

  During the AME, there were continuous interfacing and engagements between the Consortium and the KNPS SALTO technical team to confirm understanding and interpretation of the KNPS situation, implementation, and application.

  The formal exchange of input source documents and deliverable documents distributed or transmitted across interfaces was properly documented and controlled in accordance with the Consortium L1124-PM-PLN-004 [252].

- **Interface with KNPS SMEs and programme engineers**

  During the AME process, the Consortium engaged directly with the KNPS SMEs, system engineers, and programme engineers as required.

- **Consortium/Eskom technical meetings**

  In addition to the ongoing Consortium and Koeberg SALTO assessment project technical team direct engagements, there were specific 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 for review and acceptance. The SALTO project team utilised the Koeberg SALTO assessment project technical team and Eskom SMEs to review and accept the final AME deliverables. A formal process was followed for the review and acceptance of the AME deliverables tracked through the DCRFs to ensure resolution before acceptance.

5.3 Recommendations Verification

After review and acceptance of the AME deliverables, verification (review, evaluation, and consideration) of the recommendations was performed to decide on the appropriate actions required to address the Consortium recommendations. The status of identified actions are also described below.

Figure 6 depicts the final AME deliverables by the Consortium and the verification review process by the KNPS technical team and plant SMEs. As shown in Figure 6, the recommendations made by the Consortium were submitted to Eskom that utilised the KNPS technical team (which included the SALTO technical team, plant SMEs, system engineers and programme engineers) to:

- Technically review the recommendations to determine what is required;
- Formulate KNPS's position 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 included any of the following actions:
  - No further action required by providing sufficient justification;
  - One-time inspections to determine further potential actions, if any;
  - Updates to existing AMPs or maintenance strategies;
  - New AMPs required; and
  - Further engineering assessment required to develop an engineering position.

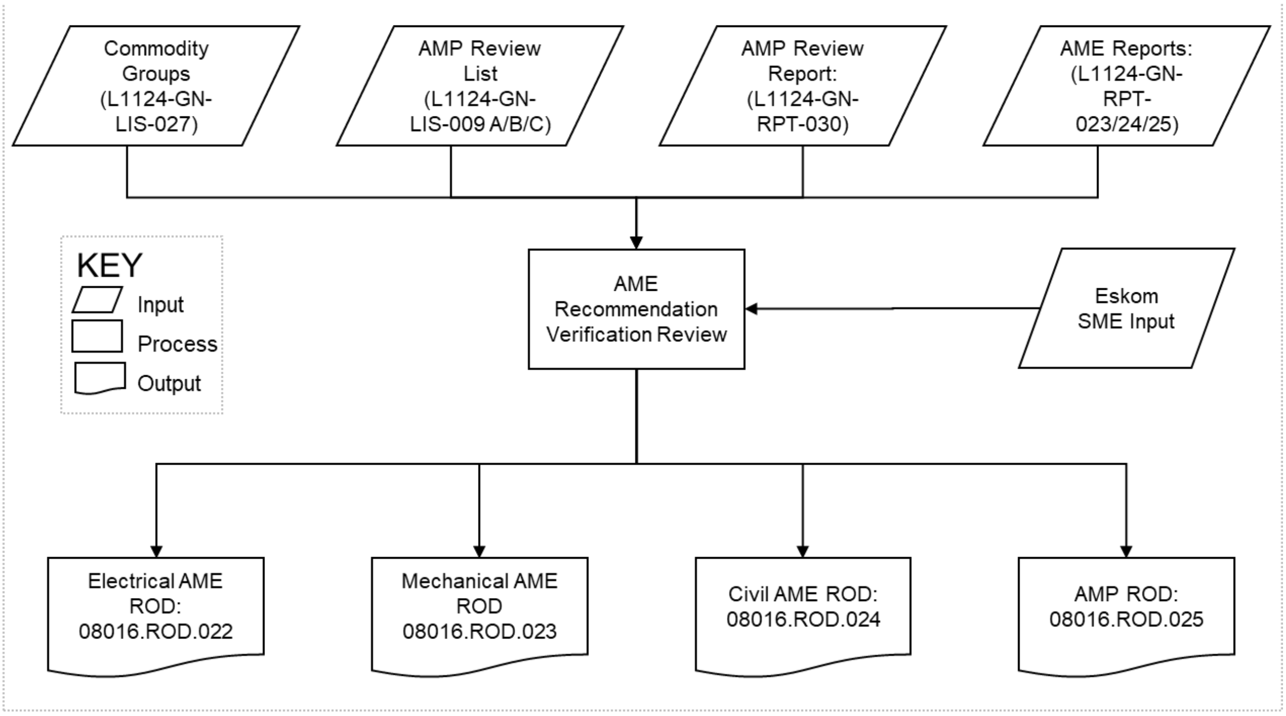

Figure 6: Eskom AME Verification Process

For each discipline, a record of decision (ROD) was compiled comprising the technical review considerations and decisions, the confirmation of the gaps, and the corrective actions required to address the identified gaps. The following RODs were then submitted and presented to the Programmes Engineering Department technical review meeting for review and to the SALTO management oversight committee for endorsement and inclusion into the scope of the Koeberg SALTO assessment project.

- 08016.ROD.022 [29];
- 08016.ROD.023 [30]; and
- 08016.ROD.024 [31].

The actions identified were captured as corrective actions on DevonWay and actioned for implementation by the various responsible line groups.

For each discipline, the results of the review, the verification of the recommendations conducted by the KNPS technical team, and the status of these corrective actions are briefly discussed below.

5.3.1 Civil

The review of the civil AME deliverables and associated corrective actions were captured in 08016.ROD.024 [31]. Condition Report 115457 was raised in DevonWay, and thirty-nine corrective actions were initiated.

A summary of the corrective actions raised and their status are as follows:

- **New AMPs to be developed**

  Two new AMPs were required (CR 115457-020 CA and CR109937-001 GA/SE 38545-025 GA) to address the gaps identified in 08016.ROD.024 [31]:

  * **AMP 306:** A new civil ageing management programme requirements manual 240-165425812 [60], was developed to address the partial gaps relating to IGALL AMP 306 (inclusive of AMP 301, 305, 307, 308, 311, and 313) and to ensure consistency with the nine attributes (to augment the existing civil monitoring programme).

  * **AMP 309:** A new liner monitoring programme manual 240-166959159 [68] was required to address the ageing management gap with respect to IGALL AMP-309. In terms of implementation, Appendix B of 240-166959159 [68] provides a summary of actions and requirements which are performed or catered for as part of the existing programmes, system engineering, chemistry, plant operating processes, and maintenance activities. GA 42427 (due 2023-11-30) was raised to the Material Reliability group to investigate possible leak paths from the spent fuel pool. The close-out of OD 6.12 NEW and OD 7.47 was captured in 08016.ODCOF.263 [22].

- **Updates to Existing Programmes**

  * The existing civil programme (higher tier) documents were reviewed to address the shortcomings tracked by CR 115457-011 CA OD 6.1A-003j and CR 115457-019 CA OD 6.1A-019 (including SE 38545-025 GA/OD 7.55). Updates to the procedures below included the inclusion of HQB, addressing the programmatic gaps identified (to comply with RG-0027 [8], to ensure consistency with the nine attributes of an effective AMP) and incorporating the improvements stemming from the new civil ageing management programme manual, 240-165425812 [60].

    - 240-166151023 (KSA-128) [65]
    - 240-166150229 (KAA-671) [63]
    - 240-166150507 (KAA-672) [64]
    - 240-166149425 (KAU-029) [62]; and
    - 240-166148961 (KAU-030) [61].

    SAP IMPs were raised for the additional surveillances incorporated in KAU-029 [62] and KAU-030 [61] to the respective implementation groups, as follows:

    - I&T SAP IMPs from KAU-030 [61] and KAU-029 [62] 42532, 42537, 42538, 42539, 42540, 42541, and 42308, 42309, 42310, 42311, and 42312.
    - IMS SAP IMP from KAU-030 [61] – SAP IMP 42529.

- E&S SAP IMP from Life-of-Plant Plan (LOPP) 164 – SAP IMP 42621.

* Updates to the existing civil inspection/monitoring procedures (lower tier) were completed and are contained in the procedures listed below (and close-out documented in 08016.ODCOF.269 [23]). These updates included the incorporation of the requirements/improvements from the high-tier civil programme procedure suite and the AME gaps related to IGALL AMP 301, 305, 306, 307, 308, 311 and 313 (OD 6.1A-001; OD 6.1A-001a; OD 6.1A-001b; OD 6.1A-001c; OD 6.1A-001d; OD 6.1A-001e; OD 6.1A-001f; OD 6.1A-001g; OD 6.1A-002a; OD 6.1A-002b; OD 6.1A-003i, and OD 6.1A-011a) related to the civil monitoring surveillances of different ageing and deterioration mechanisms that civil SSCs are or potentially exposed to during their service life.

NOTE: *Due to the withdrawal of the previous civil inspection procedures and new ones raised under CR 130513, the procedure references could not be maintained, and new ones were allocated as follows:*

- KWR-IP-CIV-025 [198] for HQB,
- KWR-IP-CIV-026 [199] replaced KWR-IP-CIV-005 (HRX–External),
- KWR-IP-CIV-027 [200] replaced KWR-IP-CIV-010 (I, HDB, HDC),
- KWR-IP-CIV-028 [201] replaced KWR-IP-CIV-011(HNA),
- KWR-IP-CIV-029 [202] replaced KWR-IP-CIV-021 (2HLX),
- KWR-IP-CIV-030 [203] replaced KWR-IP-CIV-022 (9HLX),
- KWR-IP-CIV-031 [204] replaced KWR-IP-CIV-024 (HRX-Internal),
- KWR-IP-CIV-032 [205] replaced KWR-IP-CIV-020 (1HLX),
- KWR-IP-CIV-036 [206] replaced KWR-IP-CIV-009 (HKA),
- KWR-IP-CIV-044 [207] replaced KWR-DE-020 (Aseismic Bearings-HNI),
- KWR-IP-CIV-045 [208] replaced KWR-IP-CIV-014 (Aseismic Vault – HNI), and
- KWR-IP-CIV-046 [209] replaced KWR-IP-CIV-012 (HPA and HUG).

* 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 (CR 115457-015 CA, CR 115457-017 CA, and CR 115457-018 CA).

  The existing corrosion monitoring programme was reviewed. Compliance with AMP 308 for the ageing effects due to irradiation was confirmed and documented in the close-out document 08016.ODCOF.085 [11].

* 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 (CR 115457-016 CA).

  The existing ISI programme was reviewed, and compliance with AMP 306 for the ageing of paints, vibration fatigue and the thermal cracking of steel liners was confirmed and documented in the close-out document 08016.ODCOF.202 [19].

- **One-Time Inspections**

  In accordance with ROD 08016.ROD.024 [31], a one-time inspection of selected civil commodities was identified as one of the corrective actions to address the identified gaps. This one-time inspection was selected where, during the AMR, there was insufficient data relating to the specific ageing degradations and insufficient maintenance history to confirm the absence of degradation and current conditions.

* The one-time inspection scope was selected based on the susceptibility of the commodity group to potential ageing degradations (based on partial applicability and no previous KNPS history or documented failures), locations, and accessibility. This was done to ensure a good representation of the total population. The sampled one-time inspection scope included the vent stack and chimney, joints, penetrations, containment joints, and containment structural concrete commodity groups to confirm the current state of condition.

* SAP Notifications were raised to I&T for the execution of civil one-time inspections as required by CR 115457-021 CA, CR 115457-022 CA, CR 115457-023 CA, CR 115457-024 CA and CR 115457-025 CA (OD 6.1B-001, OD 6.1B-002, OD 6.1B-003, OD 6.1B-004, and OD 6.1B-005). The inspections were completed and close-out was captured in 08016.ODCOF.119 [14].

* The one-time inspection results were found to be acceptable, with no need for future ongoing repeat inspections or a specific AMP. For the minor defects that were noted during the inspections, notifications were raised on SAP. One specific item was the deformation of some lifting lugs on the precast slabs in rooms R751, R761, R771, and R788-2HRX, JN850-NSE-ESKB-R-8613 [176], which was raised as an issue for CE-Civil to perform a structural analysis (tracked under SAP Notification 26395715). The responsible civil engineer and civil system engineer confirmed the recommendations in a previous, related memo DB2019-0016, attached to 08016.ODCOF.279 [24], to the Rigging department, remains valid in ensuring operations continue safely. The structural analysis, tracked under SAP notification 26395715, will inform any additional action.

* The inspection findings did not reveal any new plant programmes to be developed. Civil inspection procedures (referenced in 08016.ODCOF.269 [23]), as applicable, were updated to incorporate the ageing mechanisms observed on these commodity groups to be inspected as part of the periodic civil surveillances.

- ∗ The review of the civil one-time inspection results and the follow-on actions raised as SAP notifications for implementation, are documented in memo EA-23-150 [161] attached to the close-out document 08016.ODCOF.279 [24] (for OD 7.18C). Hence, no significant age-related challenges prevent continued operation into the LTO period.

- **Engineering Assessments Performed**

  System Engineering was to assess and document 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 (tracked by CR 115457-026 CA and CR 115457-027 CA).

- ∗ The System Engineering assessments are documented in close-out 08016.ODCOF.107 [13] and 08016.ODCOF.153 [18], which concluded a low likelihood of flooding of the conventional systems in the electrical buildings, ASG tank room area, and low-level waste area, with no additional actions required for the conventional island floor drains.

  However, blockages are common in the RPE lines associated with the nuclear island drains. The possibility of blockages that may result in flooding cannot be neglected on the nuclear island. To minimise this possibility, the following GAs were raised for the nuclear island floor drains:

  - GA 41049: To investigate the feasibility of replacing RPE drain and vent lines with corrosion resistant pipes to eliminate internal corrosion and minimise blockages and flooding.
  - GA 41048: To include a 1RO task for cleaning all floor drain channels and floor traps.
  - GA 41061: To include a planned maintenance task for all floor drain channels and floor traps to be regularly cleaned.

5.3.2 Electrical

The review of the AME deliverables and associated corrective actions were captured in 08016.ROD.022 [29], CR 117514 was raised in DevonWay, and corrective actions were initiated to track progress.

A summary of the actions and status are as follows:

- **Development of New AMPs**

- ∗ AMP 212 and AMP 215: Electrical enclosures, switchgear, and other active components not subject to EQ requirements (CR 102826-032 GA & SE 35189-022 SE).

The new AMPs were developed, and their requirements captured in the AMP manual 240-164966115 [56]. Actions to track the implementation and integrate the requirements of the AMPs are captured in CR 128539. The status of these actions is provided below:

- CR 128539-002 CA, CR 128539-005 CA and CR 128539-006 CA: The maintenance procedures KWM-EM-MAC-011 [195] (6,6 kV switchboards), KWM-EM-MAC-010 [194] (380V switchboards) and KWM-EM-MDC-004 [196] (DC switchboards) were updated to revision 15 to make reference to the AMP manual 240-164966115 [56] and to include more detailed instructions for the inspection of the switchboards and insulators.
- CR 128539-001 GA and CR 128539-003 GA: An assessment to initiate updates of the IQReview to align with the AMP requirements. During the implementation workshop for this programme, it was found that certain requirements are not required as they are adequately covered by other activities of the programme and that the current existing frequencies for existing tasks are adequate and no revision to the frequencies is necessary. The AMP manual was updated accordingly.
- CR 128539-004 GA: Initiate a once off phased replacement of the critical MCCBs and for MCCBs that have been involved in a fault interruption event. This action is still open.

∗ AMP 213 and AMP 218: Electronic equipment not subject to EQ requirements, whiskers, and capacitors with liquid electrolyte (CR 117514-002 CA).

A new AMP was developed, combining the guidance from IGALL AMP 213 and AMP 218. The requirements for the new AMP documented in the AMP manual 240-165424554 [59]. Actions to implement the requirements of the AMPs are tracked by the SAP implementation actions under GA 41728 and the creation of the required service notifications to implement periodic tasks is in progress, including updates to the relevant maintenance working procedures.

∗ AMP 220: Lightning protection and grounding grid not subject to EQ requirements (CR 117514-010 CA).

A new AMP was developed, and the requirements were captured in the AMP Manual 240-166957253 [67]. Actions to implement and integrate the requirements of the AMPs are tracked by SAP implementation actions under GA 41716.

∗ Environmental condition monitoring of electrical and I&C cables subject to EQ requirements (CR 121535-013 CA).

The environmental condition monitoring programme (ECMP) was developed using guidance from IGALL AMP 210. The AMP provides requirements for monitoring environmental conditions external to the equipment, such as temperature, radiation, and externally induced vibration from mounting points or earthquakes. Other adverse environmental conditions, such as increased service or ambient temperature, radiation, submergence, local vibration, electromagnetic interference and compatibility, radio frequency interference, toxic chemical exposure, moisture/humidity, or a combination thereof, may be monitored ad hoc as required. The programme requirements are documented in the ECMP manual, 240-165386950 [58]. The implementation of the ECMP is tracked in SAP under GA 41665.

The temperature and radiation monitoring devices (equipment lifetime monitors) were installed in Unit 2 as per letter EA 22-087 [150] (outage 225- SAP notification 25942220) and in Unit 1 as per EA 23-013 [152] (outage 126 - SAP notification 26068533). Data will be retrieved in outages 226 and 127 for analysis. This is tracked under GA 41665-001 GA and GA 41665-002 GA.

- **Updates to existing plant programmes/maintenance activities**
  - Cable Ageing Management Programme (CAMP)

The following CAMP documents had to be updated to address the gaps identified during the SALTO definition phase and the IAEA pre-SALTO support mission (CR 117514.

- 240-166828385 [66].
- 331-311 [86].
- 240-98789276, Rev. 2 [73].
- 240-98789629 [74].

The updates included the following:

- Include all cables important to safety identified in the SALTO cable listing into the scope of the CAMP.
- Ensure the requirements of IGALL AMP 201, AMP 202, and AMP 203 are fully covered for Medium, Low, and I&C voltages.
- Ensure ageing factors, mechanisms, and effects are fully consistent with the AMM and that the AMM is referenced in the AMP.
- Add criteria for the sample selection of cables for testing to the MV, LV, and I&C CAMP manuals.

- Grouping of cables based on the selection criteria for cables to be tested or inspected.
- Justifying why the 132 kV cables from the 132 kV switchyard to the standby transformers are not included in the CAMP.

* Review and update the scope of the current maintenance procedures and service notifications for the inspections of electrical penetrations to include additional scope (CR 117514-003 CA).
    - A compressive review of the maintenance practices implemented for electrical penetrations was conducted and summarised in engineering assessment EA-20-184 [149] (*CR 117514-003 CA [OD 7.108]: Electrical Penetration Assemblies*). The review concluded that the ageing management (that includes the detection of the ageing effects) of electrical penetrations at KNPS is considered adequate, and no further action was required. The review further concluded that the inspection of the commodity group “Electrical Penetration”, as represented by the sample scope was already covered by the existing programmes. Therefore, no modification was required in the scope of the existing plant programmes.
    - Additionally, CR 142807 for 1 EPP 223 WD for through wall leaks due to corrosion propagated from external surface, recently noted at KNPS, was reviewed to check if the conclusion of the review presented in EA-20-184 [149] was comprehensive. It must be noted that this penetration is a mechanical spare penetration that is opened most outages to pass cables into containment. A portion of this penetration is therefore opened to atmosphere, external to containment. These environmental conditions are different to the electrical penetrations which are housed in the NAB. The extent of condition was performed in the assessment report, CR 142700. The extent of condition applies to 2 EPP 223 WD, and 1/2 EPP 224 WD which have a similar configuration. Notifications 26654367, 26654369, 26054370 were raised for I&T to perform an examination during outages 226 and 127. Actions were also raised to assess the inspection results of penetrations 1/2 EPP 223 WD and 1/2 EPP 224 WD and to monitor any possible further degradation on these, to determine if any further actions need to be taken.
    - KIT Request 9143 states negligible OE on the electrical penetrations for the lifetime of the EDF fleets.
* Review the life of plant plan KBA 0022 N NEPO LOPP 162 [185] for 6.6 kV/380 V dry-type transformers (CR 117514-009 CA) and identified required updates to the LOPP.
    - The life of plant plan KBA 0022 N NEPO LOPP 162 [185] was reviewed for the adequacy of the ageing management of the 6.6 kV/380 V dry-type transformers, based on IAEA IGALL AMP 21. The review was captured in engineering

assessment, EA-20-108 [147] (*Ageing Evaluation of the 6.6 kV/380 V Dry-Type Transformers Housed Inside the 380 V Switchboards of Units 1, 2, and 9 for the Purpose of Sustaining the LTO of KNPS*). No significant ageing concerns associated with the dry-type transformers were identified in EA-20-108 [147].

- Based on this review, a recommendation was raised to update KBA 0022 N NEPO LOPP 162 [185] (GA 39926) to include thermal monitoring of the dry-type transformers due to the elevated temperature and the ORT impact, post SGR. This action is still open and due in April 2024.
- Additionally, a recommendation was raised to verify that the maintenance procedure KWM-EM-MAC-010 [194] includes a visual examination of the transformer iron core for signs of coating damage and an instruction to apply Glyptal coating to any damaged coating area to prevent future corrosion of the transformer iron core (GA 39870). This action is still open and due in March 2024.

* Review the existing life of plant plan, KBA 0022 N NEPO LOPP 045 [184] on batteries (CR 117514-004 CA, 08016.ODCOF.081 [10]).
  - KBA 0022 N NEPO LOPP 045 [184] was reviewed to confirm the adequacy of existing ageing management strategies for batteries. The review results are documented in engineering assessment, EA-20-174 [148] (*CR 117514-004 CA – Review of the Existing LOPP, KBA 0022 N NEPO LOPP 045* [184] *– Batteries*).
  - The periodic replacement of the batteries ensures that important-to-safety systems (that use lead acid batteries) can perform their function when required to do so, and KBA 0022 N NEPO LOPP 045 [184] confirms that this replacement strategy will continue until the end of LTO. The degradation mechanisms and detection of ageing effects for batteries, as specified by AMP 216, are adequately covered by the KNPS PM strategy for lead-acid batteries.

- **Engineering position on the current maintenance strategy**

  In accordance with ROD 08016.ROD.022 [29], an engineering position was required based on a further review of the existing maintenance practices, equipment history, and OE relating to solenoid valve actuators, motor actuators, motors, and transformers (CR 117514-001 CA and CR 117514-008 CA).

  Based on the current maintenance strategy, OE, and the applicable IGALL AMP requirements, the current maintenance strategies for electrical motors, motor actuators, solenoids, valve actuators, and oil-filled transformers were reviewed, and the position was documented in the Nuclear Engineering Position Papers. A summary of the assessment and conclusions is provided below:

* A review of the maintenance history and OE relating to solenoid valve actuators, motor actuators and motors, and the necessary measures required based on the review of IAEA IGALL AMP 214 (CR 117514-001 CA).

  - A review of the maintenance practices, history, and OE relating to the solenoid valve actuators was conducted, and the review results were documented in the Nuclear Engineering Position Paper (NEPP) 240-163295286 [54]. The assessment concluded that there is no need for a formal AMP for the solenoid valves as these are adequately covered in the existing PM programme.

  - A review of the maintenance practices, history, and OE relating to the MV motors (6.6 kV) was performed and documented in engineering assessment, EA-21-200 (*Ageing Management Evaluation of the 6,6 kV Motors of Units 1 and 2 for the Purpose of Sustaining the LTO of KNPS*). All 6.6 kV motors identified as items important to safety and listed in scoping list L1124-GN-LIS-020 [235] are covered in the PM programme (as reflected in IQ Review). This assessment found that the preventive maintenance strategy for 6.6 kV motors in IQ Review considers all the 6.6 kV motors and adequately addresses the requirements of AMP 214.

  - The maintenance practices, history, and OE relating to the LV motors were reviewed and documented in the close-out document 08016.ODCOF.146 [16]. The ageing management of the LV motors is addressed in the PM programme (as reflected in IQ Review). The existing preventive maintenance strategies specified in the IQ Review database for LV motors were found to be adequate.

  - A review of the maintenance practices, history, and OE relating to the LV motor-operated actuators was performed and documented in the close-out document 08016.ODCOF.146 [16]. The motor-operated valves are covered in the scope of 240-149053169 [45] and the PM programme. The existing preventive maintenance strategies specified in the IQ Review database for motor-operated actuators were found to be adequate. In addition, the motor-operated valve programme requirements manual (MOVPRM), 240-149053169 [45] covers MOVs required to perform a specific function in shutting down the reactor to the safe shut-down condition, in maintaining the safe shut-down condition and in mitigating the consequences of an accident. The programme establishes the periodic testing requirements to confirm that MOVs will continue to fulfil their intended design functions.

* Establish the adequacy of the management of the GEX, GEV and LGR transformers, considering the guidance provided in the IGALL AMP 211 (CR 117514-008 CA).

  - The existing preventive maintenance philosophy, maintenance procedures, recorded CFs, and OE were reviewed for oil-filled type transformers. Based on the review, it was concluded that the existing PM programme adequately addresses the transformer preventive maintenance and surveillance interventions, which intends to manage the ageing of the transformers and their components. The review results are documented in the nuclear engineering position paper 240-160477589 [52].

- **One-time inspections on EI&C**

  In accordance with ROD 08016.ROD.022 [29], one-time inspection of selected EI&C components was deemed a corrective action to address identified gaps. The one-time inspections were applied where, during the AMR, there was insufficient data relating to the specific ageing degradations and insufficient maintenance history to confirm the absence of degradation and the current conditions.

  The one-time inspection scope was selected based on the design classification, susceptibility of the commodity group to the applicable ageing degradations, locations, and accessibility. This was done to ensure a good representation of the total population.

  The sampled one-time inspection scope included the following commodity groups:

  - Electrical enclosures (i.e. panels, distribution cabinets and control boxes)

    Visual inspections (internal and external) of electrical enclosures for signs of mechanical damage, corrosion, conditions conducive to future corrosion, damage to the cabinet coating, damage to any of the cabinet supports, damage to cabinets covers, doors and locking or closing mechanisms, and water dripping on surfaces that can lead to future surface degradation. Refer to engineering assessments EA-19-080 [144] (*One-Time Inspections of Selected Transmitters and Other Electronic Components*) and EA-20-075 [145] (*One-Time Inspections of Electrical Cabinets to Identify Age-Related Degradation*).

  - Electronic components

    Visual inspections of the selected electronic components, which included sensors, transmitters, and an electrical card, were required to identify the presence of whiskers according to the engineering assessment, EA-20-080 [146]. The growth of whiskers is a monocrystalline metallurgical phenomenon which occurs on printed circuit boards and other components of electronic equipment.

  Most of the one-time sections were completed in outage 125, outage 225, and outage 126, and the inspection results were captured in the equipment history records. The engineering evaluation of the inspection results is documented in assessment, EA-22-141 Rev 1 [151] (*Review of the Completed Electrical One-Time Inspection Results (OD 7.11C, OD 7.11D, OD 7.18B and GA 41999*). The inspections did not reveal any age-related degradations on electrical enclosures or the presence of whiskers in the electronic components. The cabinets were found to be in good condition, with no signs of corrosion or mechanical damage, no damage to the cabinet coating, no water deposits on cabinet surfaces or water dripping on surfaces noted and supports were reported during the inspections. All the covers and locking mechanisms are in good condition. The one-time inspection results were found to be acceptable, with no need for future ongoing repeat inspections or a specific AMP.

The following one-time inspections are still outstanding and are scheduled for outage 226.

Table 5-1: Outstanding One-Time Inspections

Order	Notification	FLOC	Description
729395960	26469645	38-2GRE003AR	PDBs Inspections sample scope
729395959	26469646	38-2GRE004AR	PDBs Inspections sample scope

An engineering review of the one-time inspection results planned for outage 226 is tracked under GA 42911.

The switchboard maintenance and inspections conducted in outages 121 and 221 were assessed to confirm whether they covered the scope of the one-time inspection of these switchboards. This review is documented in letters EA-23-070 [155] (*Review of 1 LGD 001 AR, 1 LHA 001 AR, 1 LHB 001 TB, 1 LLC 001 AR, and 1 LGA 001 AR Switchboards Maintenance and Inspections History*) and EA-23-148 [160] (*Review of 2 LHA 001 TB, 2 LHB 001 TB, 2 LGA 001 TB Switchboards Maintenance completed in outage 221*).

The assessment concluded inspections performed in outage 121 and outage 221 were more detailed than the visual inspections required by the one-time inspection task. The inspection requirements in procedure KWM-EM-MAC-011 [195] satisfy the intent of the one-time inspections raised for outages 126 and 226 on these switchboards. According to the equipment history records (EHRs) and SAP history, all the switchboards and cabinets were in good condition, and no additional work was required. According to the letter EA-22-141 Rev. 1 [151], credit is taken for these inspections, and therefore, no further one-time inspections are required on these boards.

5.3.3 Mechanical

The review of the AME deliverables and associated corrective actions were captured in 08016.ROD.023 Rev. 1 [30], CR 116340 was raised in DevonWay, and corrective actions were initiated to track progress.

A summary of the actions are as follows:

- Development of the new AMPs:

  Six new AMPs were developed to address the gaps identified in 08016.ROD.023 Rev. 1 [30]:

  * AMP 112 – Thermal ageing embrittlement of cast austenitic stainless steel (CASS) and AMP 161 – High-cycle fatigue monitoring.

    The new AMP was developed to meet the IGALL intent of AMP 112 and AMP 161. The requirements captured in the AMP programme manual 240-141494955 [42] covers three main thermal fatigue issues: the thermal embrittlement of CASS components installed in the RCP system when subjected to the operating temperature of the system; the occurrence of thermal stratification in specific NSSS and BNI piping systems; and the occurrence of thermal fatigue due to temperature fluctuations in specific NSSS and BNI piping systems. There are no new actions raised as the majority of the AMP inspections forms part of the existing Augmented ISI modules. The rest of the scope is replaced or inspected, based on the need, such as the CASS hot leg elbows which were replaced on Unit 1 during outage 126 (CR 121535-035 CA) while Unit 2 is planned for replacement in outage 226 (CR 121535-069 CA). A SAP notification 25656678, was raised for an inspection of the Unit 2 RRA mixing tee during outage 226, while the cold leg elbows were justified for continued operation in 240-141494955 [42].

  * AMP 119 - One-time inspections

    The new AMP was developed for the one-time inspection (OTI) programme is documented in 32-T-PE-006 [75]. GA 42404 was raised for the implementation of the one-time inspection requirements on SAP.

  * AMP 120 - Selective leaching

    The new AMP document 240-166959251 [69] was developed to manage the integrity of components manufactured from alloys potentially susceptible to selective leaching. GA 42384 was raised for the implementation of the selective leaching requirements on SAP.

  * AMP 121 – One-time inspections Class 1 small-bore piping

    The new AMP was developed, and the requirements are provided in document 32-T-PE-007 [76]. GA 42405 was raised for implementation of the one–time inspections class 1 small-bore piping requirements on SAP.

  * AMP 135 – Inspection of internal surfaces in miscellaneous piping and ducting components and AMP 157 – Internal coatings and linings.

A new AMP was developed, combining the guidance from IGALL AMP 135 and AMP 157. The requirements for the new AMP is documented 32-T-PE-010 [77] which provides the requirements for the management of the ageing mechanisms which potentially affect the integrity of internal surfaces of piping, piping components, and ducting in the scope of IGALL AMP 135 and all the internal coatings and linings installed on the in-scope piping, piping components, heat exchangers, and the tanks of IGALL AMP 157. SAP notifications were raised for baseline inspections, scheduled for outages X26 and X27. The results thereof, will be evaluated to establish if periodic inspections are required.

∗ AMP 154 – PWR pressuriser

A new AMP was developed to manage the integrity of the Unit 1 and 2 pressurisers. The programme requirements are documented in 240-165295505 [57]. Once–off notifications were raised for inspections of different pressurisers subcomponents on both units.

- **Engineering position on the current maintenance strategy**

The output deliverables (OD_7.93, AMP 157 Ageing Management for Main Coolant Piping) and (OD_7.20B Corrective Action Implementation (Neutron Absorbing Material Other Than Boraflex)) were raised to develop new AMPs or to review the adequacy of the current maintenance strategies to conclude on the KNPS position.

Based on the current maintenance strategy, OE, and the applicable IGALL AMP requirements, the current maintenance strategies for ageing management were assessed, credited, and documented in an engineering position paper. A summary of the assessment and conclusions is provided below:

∗ AMP 156 – PWR main coolant piping

A review of the maintenance practices, history and OE relating to AMP 156 was conducted as documented in the nuclear engineering position paper 331-610 [88]. The assessment concluded that there is no need for a formal AMP for the main coolant piping since related ageing mechanisms such as fatigue, thermal embrittlement, boric acid corrosion, stress corrosion cracking, pitting, and crevice corrosion are already managed through existing programmes at KNPS as follows:

- Low-cycle fatigue is currently managed according to 240-149867926 [47].
- Thermal fatigue is managed according to 240-141494955 [42].
- Boric acid corrosion is managed according to 331-511 [87].

- Stress corrosion cracking inside the primary coolant piping, particularly inside the main (large bore) coolant piping, is not considered a likely ageing mechanism at Koeberg. The reason for this is the fact that none of the piping welds used nickel-based alloys such as Alloy 82/182. The primary circulating water is maintained within specification in accordance with KNC-001 [191].
- Pitting, which is associated with contamination of the external surface of piping, normally under insulation, is managed according to the NEPP 331-268 [84].
- Crevice corrosion, which occurs mainly in sockets, is managed according to the ISIPRM Module E-RA and the scope is defined in the ISIPRM Module E-A.

∗ AMP 137 – Monitoring of neutron absorbers other than Boraflex.

A review of the maintenance practices, history, and OE relating to AMP 137 was conducted as documented in the NEPP 240-167231099 Rev. 1 [70]. The assessment concluded that there is no need for a formal AMP for the spent fuel pool as there are no postulated plausible ageing mechanisms that will threaten or diminish the neutron absorbing capacity as provided by the borated stainless steel shielding plates. Furthermore, the one-time inspections described lower down revealed no signs of corrosion, cracking, or gross deformation of the spent fuel pool racks, detailed in EA-23-102 Rev. 1 [156].

- **Updates required to existing programmes and maintenance activities:**

∗ **Chemistry Programme**

The action that resulted in an update to the chemistry programme was due to an identified gap on the OD_7.77 – Add IGALL AMP 103 as a reference in the chemistry justification for the plant's chemistry operating specification document. IGALL reference AMP 103 was added to KBA0022CHEMJUSTIF2 [181].

∗ **Fire water system**

The requested review of KBA0022NNEPOLOPP023 [183] concluded that current Koeberg practices with regards to the management of the fire systems are generally comprehensive and satisfactory; that is, there are no major gaps between current Koeberg practices and the IAEA recommended ageing management strategies for fire systems. Thus, no formal AMP for fire systems is required.

∗ **Preventive maintenance programme**

Through a comparison of the SSCs relating to ageing management programmes and the preventive maintenance programme (as captured in IQ Review), the mechanical AME review identified a scope of PM strategies to be reviewed. The reviews and relevant revisions of the PM strategies were completed under CR 116340-016 CA and are currently being implemented in SAP.

* **AMP 117 – Closed treated water systems**

  The mechanical AME review identified a scope to be evaluated for applicability to AMP 117 (*Monitoring Water Chemistry Closed Treated Water Systems*). The main applicable systems at Koeberg corresponding to AMP 117 scope are parts of the component cooling system (RRI), high- and low-temperature emergency diesel cooling water systems (LHP, LHQ, and LHS), and the chilled water system (DEG). The evaluation concluded that the bulk chemistry in all systems is strictly controlled and monitored according to chemistry procedures KNC-001 [191] and KNC-002 [192]. In the case of RRI, the water is dosed with trisodium phosphate as a corrosion inhibitor. However, based on OE during activities such as local leak rate testing or IST of the containment isolation valves, specifically the RRI system, there have been reports of corrosion and fouling affecting the leak tightness of certain valves. This has been ascribed to dead legs where the water chemistry differs significantly from the bulk system and the effects from frequent air ingress (as a result of breaching of the system for maintenance activities). This resulted in defining a sample scope randomly selected for one-time wall thickness testing of system piping. SAP notifications were raised to perform these inspections on line. The results of these inspections had the objective of indicating the current risk of process-related corrosion on closed treated water circuits at Koeberg. The inspection results have since been reviewed and are summarised under the one-time inspections bullet below. No further monitoring or management action is required.

* **AMP 134 – Monitoring external surfaces of mechanical components**

  The mechanical AME review identified the scope required to be evaluated for applicability to AMP 134 (*External Surfaces Monitoring of Mechanical Components*). The results of the assessment are documented in 08016.ODCOF.139 [15]. The assessment concludes that the full scope of commodities identified apply to AMP 134, and credit is taken for existing inspection programmes at Koeberg, especially 331-175 [82] and 240-166151023 (ex KSA-128) [65]. An additional action (CR 133538-005 CA) was initiated to update the position paper 331-268 [84] to include the requirement to inspect insulated external surfaces of components exposed to condensation, as prescribed in AMP 134, to inspect every ten years beyond the LTO period periodically. Therefore, the KNPS assessment and position regarding the inspection requirement was added to 331-268 [84], GA 43571 was raised to track the 10 yearly post LTO inspection work scope.

* **Heat Exchanger Programme**

  The mechanical AME review identified additional scope of the heat exchangers that required inclusion into 240-154215724 [51]. The reviews and relevant revisions of the heat exchanger management programme were completed under 08016.ODCOF.105 [12].

- **One Time Inspections**

  The AMR identified a number of recommendations for mechanical components as documented in the ageing assessment report L1124-GN-RPT-023 [242].

  An in-depth review of the mechanical AME results was conducted to determine the appropriate actions to address the gaps. These results were documented in ROD 08016.ROD.023 Rev. 1 [30]. Based on the review of the AME, a number of one-time inspections were identified to determine any further potential actions. The one-time inspection scope was determined based on the following:

  * SSCs, where the assessment and the review indicated insufficient ageing data to confirm the adequacy of the current physical condition.
  * No previous maintenance history or documented failures exist.
  * An ageing effect is not expected to occur, but the data is insufficient to rule it out with reasonable confidence.
  * An ageing effect is expected to progress very slowly in the specified environment, but the local environment may be more adverse than generally expected.

For all the above cases, confirmation by means of inspection could demonstrate that the theoretical ageing effect is either not occurring or is occurring so slowly that it is not expected to prevent the component, structure, or system from performing its intended function during the period of extended operation.

The inspection scope was selected on a sample basis, and the sample size was informed by the guidance provided in the IGALL AMP 119 (*One-time inspections*). SAP notifications were raised for inspections on the identified sample scope during on line periods and outages 125, 225, 126, and 226.

The results of the mechanical one-time inspections completed during outages 125, 225, and 126 were reviewed and documented in engineering assessment EA-23-102 Rev. 1 [156]. The review results are summarised below.

- Cabinet bolting inspections on Units 1 and 9

  The intent of prescribing tension verification on the bolting scope anchoring the electrical cabinets to rails or civil structure was solely to verify that the mechanical connection integrity was maintained. To date, all the selected cabinet inspections have been performed. Most cabinets were reportedly tightly secured with no fault conditions and no signs of corrosion. However, the bolts and nuts of the support brackets for cabinet 1 SEC 900 AR were badly corroded. Notification 26372476 was raised for a corrosion assessment, and work order 728927341/1/23-171635 was issued to replace the corroded brackets. A missing bolt was noted inside cabinet 1 EPP 301 AR, which was replaced and torqued to the correct loading. All the cabinet bolting inspection results were captured in the EHRs and the SAP database. In future the bolting inspections will be managed under 331-175 [82].

- One-time inspections of mechanical components sampled from various commodity groups according to SALTO AME

  These one-time inspections were performed to ascertain plant conditions and confirm whether degradation had occurred. The inspections performed in outages 125, 126, and 225 revealed no significant ageing-related degradation other than superficial degradation, e.g. surface oxidation, coating breakdown, light surface corrosion, etc. Corrective action was taken to restore the plant by cleaning the surfaces and recoating the affected areas.

- AMP 117 Closed-cycle cooling water (CCCW) systems inspections

  AMP 117 addresses the ageing effects (material erosion and corrosion) on CCCW systems. Such systems include the nuclear island component cooling water (RRI), the nuclear chilled water system (DEG), the electrical building chilled water system (DEL), and the emergency diesel generator cooling water (LHJ) circuits. Since these systems are difficult to access internally, once-off ultrasonic wall thickness inspections were performed at susceptible locations on a randomly selected scope. All inspection results have not shown any significant evidence of erosion and corrosion of inspected components (after approximately 40 years of service). There is, therefore, currently little or no likelihood of ageing degradation on the CCCW systems. In addition, the chemistry of CCCW systems is closely monitored, and it is envisaged that should the corrosive state of these systems deteriorate, the effects will be detected via chemistry excursions, and suitable corrective actions can be implemented.

- AMP 120 Selective Leaching Inspection

  The objective of the selective leaching inspections was to detect thinning of the effective wall thickness by porous pitting. This was done by means of ultrasonic testing (UT) and secondary reflections of the signal, that will indicate a layer of porous material.

  The ultrasonic (UT) wall thickness (WT) measurements were performed on three RRI and two JPP pump casings to ascertain whether there is any wall loss or pitting on the internal surfaces due to selective leaching and to establish baseline wall thickness readings. No evidence of WT loss or pitting was found on the inspected pump casings. The internal surfaces had uniform WT with no pitting or double reflection caused by the difference in densities between potentially sound material and corroded porous material. The base metal for the JPP and RRI pump casings and the SEC valve bodies is ductile cast iron with nodular graphite. Graphitic corrosion is less aggressive on ductile cast iron when compared with grey cast iron, which has "flaky graphite" networks in its graphite-iron matrix grain structure; nevertheless, ductile cast iron is potentially susceptible to graphitic corrosion. Thus, the absence of pits and sponginess near surface graphite does not mean the degradation mechanism is inactive, as this can only be confirmed by visual examination that includes surface scrape test.

The outer surface of the SEC valve bodies is irregular and has grooves that make it impractical to interpret the UT WT results. For this reason, the UT WT examinations of the SEC valve bodies could not be performed as planned.

Based on the results of the one-time inspections performed on the JPP and RRI pump casings, it is recommended that the next set of inspections be visual examinations that include the internal surface scrape tests of the pump casings and the SEC valves. These inspections will be performed during the maintenance overhauls, as stated in the AMP manual 120. SAP notifications have been raised for these inspections.

- AMP 137 Monitoring of Neutron Absorbers other than Boraflex Inspections

  The once-off inspection of the spent fuel pool (SFP) racks for both KNPS units, as dictated by the position paper NEPP 240-167231099 [70] (*Assessment of the Spent Fuel Pool for LTO*), was performed in outage 126. Engineering evaluated the inspection reports and found the results satisfactory, as there were no signs of corrosion, cracking, or gross deformation of the SFP racks.

  A review of the results for the inspections completed to date did not find any signs of significant age-related degradations. Therefore, there are no significant age-related challenges preventing continued operation into the LTO period.

  - The outstanding one-time inspection scope for the Unit 9 diesels and outage 226 will be performed as they become available, and memo EA-23-102 Rev. 1 [156] will then be updated accordingly.

5.3.4 Generic AMP Programmatic Updates

The Consortium recommendations of generic AMP reviews and updates, were evaluated and accepted for updates to existing programmes to address programmatic gaps as defined in § 5.2.3.1.3, documented in L1124-GN-RPT-030 [246] and provided in 08016.ROD.025 [32]. All AMPs listed as part of the self-evaluation report SE 38545 were reviewed under SE 38545-007 CA on DevonWay for consistency with the nine attributes of an effective AMP and the gaps were adequately addressed.

5.4 Management of Technological Obsolescence and Spare Parts

5.4.1 Technological Obsolescence Programme

KNPS developed and implemented a technological obsolescence programme (TOP) to proactively identify, prioritise, and resolve obsolescence issues. Procedure 331-146 [80] describes the process for the development and implementation of a proactive TOP at KNPS. The TOP scope covers all SSCs important to safety, including civil and fire protection systems. KNPS used mechanisms that ensure timely feedback on OE, research, and development results (if applicable), e.g. IGALL, TOP401, EPRI, and internal OE. The TOP is continually being improved using internal OE; the programme owner expects this trend to continue as the programme matures.

An obsolescence management service contract has also been placed to facilitate the programme's proactive aspect. This will allow KNPS to establish, via this contract, contacts with vendors to establish equipment obsolescence status before a demand for the equipment on the plant arises. The obsolescence steering committee, a subcommittee of the plant health committee, provides oversight of obsolescence issues at KNPS.

According to 331-146 [80], obsolescence issues are logged as CRs and tracked using DevonWay and the CAP process to (among other benefits) promote accountability and enable a systematic approach to tracking and monitoring obsolescence. Initial investigations of the CRs are done by Specification Engineering to determine whether an equivalency study is an appropriate obsolescence solution strategy. If an equivalency study is not an appropriate strategy, the obsolescence issue is referred to the steering committee for further investigation of other obsolescence solution pathways.

In accordance with the interim regulatory guide RG-0027 [8], procedure 331-146 [80] was submitted for the NNR's acceptance via K-25890-E. The NNR has reviewed the submission. The procedure meets the minimum guidance stipulated in RG-0027 [8], IAEA SSG-48 [7], and recommendations from international research organisations (refer to NNR letter k25890N, dated 21 November 2021).

The latest revision of 331-146 Rev. 4 [80] was submitted to the NNR as required by RG-0027 [8] via Eskom letter K-29489-E.

5.4.2 Spare Parts

KNPS has developed procedures to procure, inspect, and test replacement or spare parts for equipment. These include, amongst others, 240-95405347 [72], 240-129867163 [40], 240-164732871 [55], 240-129883544 [41], 240-127002040 [39], and 240-112278820 [38].

The need for a spare is defined through automatic stock replenishment, where the stock parameters are pre-defined, maintenance (online and outage), and critical spares replenishment. Component receipt inspection is a key quality hold point where non-conforming items can be detected, which may include the verification of documented factory acceptance tests and warehouse receipt inspection.

Station management of critical components and associated spares which may affect or are classified as important to plant availability is monitored by various forums and committees such as the production meeting, both operational and strategic plant health committees (PHC), including the obsolescence steering committee which deals with identified spares obsolescence.

5.5 KNPS Organisational Responsibility for the AME Deliverables

The AME deliverables completed during the Koeberg SALTO assessment project definition phase have been provided to the 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, and the preventive maintenance aspect is managed by the Reliability Engineering group. Engineers of the ageing management programme have been appointed to oversee the plant-level ageing management process, including the implementation thereof. Programmes Engineering is responsible for continuously reviewing plant programmes and creating new AMPs, as required.

The following processes exist for effective ageing management at KNPS:

- **Ageing management standard**

  240-149139512 [46] 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 [8]. 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 for the life of the plant, that is, design, construction, manufacturing, commissioning, operating, LTO, suspended operation, and decommissioning. This document was submitted and approved by the NNR via k27142N on 11 February 2021.

- **Process for the development and control of AM at KNPS**

  331-275 [85] describes the process used to manage (develop, control, and update) the Koeberg AMM. 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.

- **Equipment Reliability Process**

  KAA-913 [180] describes the process and establishes the responsibilities for the integrated equipment reliability process to maintain high levels of safe and reliable plant operation. It also identifies, organises, and integrates equipment reliability activities into a single efficient and effective process.

- **Programme Engineers' Guide**

  331-148 [81] provides guidance for programme engineers to develop, maintain, optimise, and perform programme oversight on the AM programmes allocated to them.

- **AM Database**

  The COMSY database identifies the ageing mechanisms relevant to KNPS and the SSCs affected by ageing mechanisms or degradations that can affect equipment life or capability. ROD 08016.ROD.017 [26] captured Eskom's decision to use commodity groups from the IAEA IGALL master table for AM at KNPS and adopted the COMSY software tool to support this. COMSY will replace the original Koeberg AMM.

- **Plant Change Documents**

  Reference to AM of the SALTO scope has been introduced in the following Design Engineering Processes/Procedures:

  * 240-143890978 [44]: A new section within the design template requires the identification of SSCs within the SALTO scope that are affected by any modification, including non-safety-related SSCs that could affect safety. Furthermore, design reviews by the AM database custodian are instituted to ensure AM for the SALTO scope SSCs.
  * 331-93 [98]: The AM scope list is now updated following the approval of new or revised classifications, as it is now managed through the classification process.
  * 331-143 [78]: This facilitates the updating of the KNPS ageing management database as new components, ageing mechanisms, or classification changes are introduced by plant modifications.

- **Alignment with RG-0027**

  In addition to the above, RG-0027 [8] was reviewed against the current ageing management programme and processes established at KNPS. The review aimed to confirm the alignment of all current processes and programmes that fall within the scope of AM according to the regulatory requirements of RG-0027 [8]. When gaps were found, actions were raised to the responsible line groups or departments to review the finding and develop a resolution to fill the gap and comply with RG-0027 [8]. The self-evaluation report SE 38545 was compiled with actions: ROD 08016.ROD.021 [28] was compiled to include the tracking of the actions raised under the scope of the Koeberg SALTO assessment project.

  This SE resulted in the review and update of the following plant documents and processes:

* The Koeberg SAR was updated with reference to AM. The SAR change has been processed under CN-312, UR 2466.
* 36-197 [100] was updated with reference to requirements for AM submitted to NNR for approval via Eskom letter K-26558-E.
* All existing ageing management programmes (including chemistry and fire programmes) were reviewed for alignment with the nine attributes and updated accordingly.
* 331-148 [81] was updated to include the nine attributes according to RG-0027 [8].
* The integrated ER process was reviewed, considering the guidelines stipulated in RG-0027 [8]. The outcome of the review resulted in an update of KAA-913 [180], which was tracked under GA 38167.
* The preventive maintenance (PM) programme was reviewed against the IAEA's nine attributes of an effective AMP (CR 102827-001 GA). Furthermore, the PM programme is governed by KSM-LIC-001 [193] and KAA-913 [180].
* The document KSM-LIC-001 [193], which provides requirements for the control of maintenance according to RG-0027 [8] and preventive maintenance programmes related to LTO, also requires that plant life extension PMs and AMPs be implemented within specified approved PM strategies.
* SRSM KBA 0022 SRSM 000 [188] was reviewed against the nine attributes, and the review report demonstrates compliance with the nine attributes. This action was closed under SE 38545-014 CA.
* The plant modification processes were reviewed by Design Engineering to demonstrate the design process alignment and compliance with RG-0027 [8] requirements. The result of the review is documented in memorandum DA2021-0051. Updates to plant modification documents were made where shortfalls were identified (e.g. updates to the design template) and where compliance with the requirements already exists; refer to close-out form 08016.ODCOF.152 [17].
* Equivalency study processes in 331-143 [78] and 331-144 [79] were updated to include the AM consideration.
* The current corrective action process described in KAA-688 [179] covers the CAP requirements stipulated in RG-0027 [8].

6.0 TIME-LIMITED AGEING ANALYSES

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

This section provides the requirements for TLAAs, describes the methods and processes used by KNPS to meet these requirements, provides descriptions of relevant TLAAs, and presents the verifications performed to conclude their adequacy for LTO. Furthermore, this section provides an overview of the TLAA results performed as part of the SALTO project and further work required to update or complete some TLAAs for LTO. The section concludes with the TLAA organisational responsibilities beyond the scope of the Koeberg SALTO assessment project.

6.1 Requirements

In accordance with RG-0027 [8], for in-scope SSCs, KNPS should identify all TLAAs and should demonstrate that all 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 [8], TLAAs should meet all six of the following criteria:

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

b) TLAAs should consider ageing effects. Ageing effects include, but are not limited to, the loss of material, changes in dimension, changes in material properties, loss of toughness, loss of pre-stress, settlement, cracking, and the 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 insufficient. 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 deemed 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 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 because 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 criterion f) above and that have been developed to demonstrate preparedness for the intended period of operation should also be considered TLAAs.

The validity of TLAAs over the intended period of operation should also be assessed by demonstrating satisfaction against one of the following three 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 criteria (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; and
- 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 KNPS 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 of 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 [2].

Regulatory review and approval is required for updated, validated, and re-analysed new TLAAs, changes to the SAR, other associated licensing basis documents, and the supporting safety evaluations and safety justifications as required by 240-143604773 [43].

6.3 Process

This section describes the steps taken by the Consortium for the process used in identifying and evaluating TLAAs. This methodology, as defined in L1124-DE-RPT-003 [221], requires the following steps:

- Identify and verify existing KNPS TLAAs.
- Review international OE and internal experience to ensure that all relevant TLAAs have been identified. Document the sources/references used to identify the relevant TLAAs.
- Compile a comprehensive list of TLAAs that include reference documents.
- Compare the KNPS TLAAs identified with the IGALL TLAAs.
- Compile a list of IGALL TLAAs that do not apply to KNPS with justification.
- Validate existing TLAAs for a 60-year life of the plant.
- Compile a list of TLAAs that require re-analysis.

6.3.1 Identification and Verification of Existing Plant TLAAs

The Consortium identified existing KNPS TLAAs by studying various input sources, including the Koeberg SAR, DSEs, and other design basis documents, using keywords as documented in L1124-GN-RPT-022 [241].

The review of international experience is documented in L1124-GN-RPT-027 [245].

6.3.2 References Not Considered as TLAAs

During the TLAA search of the input sources, the following references 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 [241].

- 331-260 [83];
- KBA0022NNEPONEPP134 [187];
- KBA0022NNEPONEPP034 [186];
- ISIPRM AUG 13 [167]

Despite the documents mentioned above not being TLAAs, the SSCs referred to above are still included in the in-scope SALTO list and subject to the AME described in § 5.0.

6.3.3 Comparison with the IGALL TLAAs

The IAEA IGALL document, SRS-82 [6], provides a list of typical TLAAs based on input from participating member states. The KNPS-identified TLAAs were compared with a version of the IGALL list valid in 2018 of applicable PWR TLAAs and tabled below as documented in L1124-GN-RPT-027 [245]. The 2018 list was the one that was current at the time of this phase in the project.

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

TLAA title	Existing KNPS TLAAs	Additional IGALL TLAAs required by KNPS
TLAA109 PWR RPV Internals Swelling		X
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 EQ 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 included in L1124-GN-LIS-010 [232].

Each TLAA was researched and evaluated, and a report was 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 according to 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 and possible thermal power uprate was analysed. These analyses covered several TLAAs identified during the Koeberg SALTO assessment project and justified for 60 years as part of the SGR project.

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

6.4 Verification

This section describes the processes for verifying the SALTO TLAA scope followed by the Consortium and Eskom.

6.4.1 Consortium Verification

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

L1124-DE-RPT-004 [222] describes in detail the methodology used for this process.

6.4.2 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, which 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 identifying additional work required under the execution phase of the Koeberg SALTO assessment project.

6.5 Results

As indicated in § 6.3.4, reports were generated per component, stating which TLAAs were revalidated and listed for further studies to be performed. A list of these Consortium documents is presented below. Where Framatome later updated documents, their document number is listed with the original Consortium number shown in parentheses.

Table 6-2: TLAA Reports

Document Number	Title
D02-ARV-01-138-106 [102] (L1124-GN-RPT-031)	Reactor Coolant Pump
D02-ARV-01-142-242 [103] (L1124-GN-RPT-032)	RPV Internals
D02-ARV-01-143-003 [104] (L1124-GN-RPT-037)	Control Rod Drive Mechanism
D02-ARV-01-144-513 [105] (L1124-GN-RPT-033)	RPV
D02-ARV-01-144-514 [106] (L1124-GN-RPT-034)	Pressuriser
D02-ARV-01-144-861 [107] (L1124-GN-RPT-038)	Steam Generators
D02-ARV-01-145-030 [108] (L1124-GN-RPT-035)	Main Coolant and Surge Lines
D02-ARV-01-146-690 [109] (L1124-GN-RPT-036)	RPV In-Core Instrumentation
D02-ARV-01-149-074 [110] (L1124-GN-RPT-046)	Auxiliary and Secondary Lines
L1124-GN-RPT-018 [238]	EQ
L1124-GN-RPT-019	KNPS Containment Civil TLAA 301
L1124-GN-RPT-020	Polar Crane
L1124-GN-RPT-044	Containment Liner
L1124-GN-RPT-045	Containment Settlement Civil

A comprehensive list of the TLAAs is provided in L1124-GN-LIS-010 [232].

The mechanical and civil TLAA results are summarised in Table 6-3.

Table 6-3: Mechanical and Civil TLAA Result Summary

TLAAs	Mechanical	Civil
Existing TLAAs validated for 60 years of operation	66	0
Newly identified TLAAs validated for 60 years of operation	32	2
Components that required analyses to validate them for 60 years of operation by the SALTO project (refer to Table 6-4).	8	2

6.5.1 Mechanical TLAAs

6.5.1.1 TLAAs Validated for 60 Years

The SALTO project took credit for the existing 66 and 32 newly identified mechanical TLAAs validated for 60 years by the SGR project, as listed in Table 6-3 above and mentioned in § 6.3.4.

6.5.1.2 New TLAAs Requiring Analysis to be Validated for 60 Years

The components identified for analyses to validate them for 60 years by the SALTO project are discussed below.

6.5.1.2.1 IGALL TLAA 106: Environmentally Assisted Fatigue

For the environmentally assisted fatigue (EAF) associated TLAAs, screenings were completed on all major primary components to identify the locations potentially affected by environmental fatigue for which the cumulative usage factor (CUF), considering the EAF conditions, may be greater than 1 (the ASME Section III NB design code requires the CUF to be less than 1). The objective was to determine a list of sentinel locations for which further detailed EAF and CUF analyses were required, as described in the screening documents mentioned below for each of the components. This approach aligns with NUREG / CR-6909, RCC-M and IGALL TLAA 106 for plants requesting extensions to their operating life.

A detailed analysis for most of the equipment with sentinel locations were performed as a second step by:

- Creating 2D or 3D finite element models of the sentinel locations;
- Calculating the thermal and mechanical loads to perform fatigue analysis according to ASME Section III NB-3200 and with the fatigue curve of the RCC-M code (the RCC-M fatigue curve has been specifically derived for French-designed and manufactured nuclear reactors with their associated materials, which includes the Koeberg plant);
- Calculating the environmentally adjusted cumulative usage factor (CUF_{en}) according to the rule in probationary phase n°3 (RPP3) from the RCC-M code; and
- Documenting the results. The objective is to document code-acceptable fatigue results for 60 years of operation.

The following components were identified with sentinel locations and for EAF analysis:

- **Reactor Coolant Pumps** – After the initial screening in JIC-NC-00138 [169] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation, some sentinel locations were retained for detailed CUF_{en} analysis. The mechanical, thermal, and thermomechanical calculations were performed on a 3D finite element model of the reactor coolant pump casing. The results of the analysis justified the absence of the risk of fatigue damage during LTO based on the IGALL criteria within JIC-NC-00253 [172].

- **Reactor Pressure Vessel Internals** – After the initial screening in D02-ARV-01-178-202 [116] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation, some sentinel locations were retained for a detailed CUF_{en} analysis. These consisted of the core baffle and formers as well as the bolts of the core baffle and formers assembly. The mechanical analysis in D02-ARV-01-212-661 [139] justified the absence of a safety risk due to EAF on the reactor pressure vessel internals (RPVI) components for LTO.
- **Pressuriser** – After the initial screening of D02-ARV-01-178-200 [114] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation, only the pressuriser heater sleeves were identified for a detailed CUF_{en} analysis. The fatigue analysis found that the code's progressive deformation and fatigue (CUF<1) criteria are met for normal and upset conditions and, therefore, protected against the risk of progressive deformation and fatigue risks for LTO. The CUF_{en}, however, is not met (CUF_{en}>1) for normal and upset conditions. Based on the original plant fatigue studies, all these sentinel locations were known to have elevated CUF values. They required several original analysis optimisations to meet the original design code requirements with margin. According to D02-ARV-01-180-957 [118], this location will require further CUF_{en} analysis optimisation by Framatome to meet the code requirements. An interim assessment EA-24-001 [164] was performed by KNPS, and it concluded that based on the previously shown technical justification, this location is acceptable for continued service until the optimised analysis can be completed by Framatome. This acceptability is based on the following main arguments:
  - The original design optimised CUF values show that there is fatigue margin existing in the sentinel location;
  - The low actual transient usage versus actual design transient numbers for LTO results in a minimal risk of fatigue initiation occurring in the sentinel location;
  - NDE carried out demonstrates that no through-wall crack defects have occurred.
- **Main Coolant Lines** – After the initial screening in D02-ARV-01-178-201 [115] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation, some sentinel locations were retained for a detailed CUF_{en} analysis. The mechanical, thermal, and thermomechanical calculations were performed on 3D finite element models in D02-ARV-01-212-366 [125], D02-ARV-01-212-368 [126], D02-ARV-01-212-369 [127], D02-ARV-01-212-371 [128], and D02-ARV-01-212-372 [129]. All studied sections respected the criterion CUF_{en}<1, resulting in the absence of fatigue and EAF damage for the main coolant lines during the LTO period.
- **Auxiliary Lines** - After the initial screening in D02-ARV-01-178-203 [117] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation by using

the EAF screening method, some sentinel locations were retained for a detailed CUF_{en} analysis. The mechanical loads considered in the fatigue analysis were evaluated through piping stress analyses and the local thermal stresses were calculated in D02-ARV-01-212-373 [130], D02-ARV-01-212-374 [131], D02-ARV-01-212-375 [132], D02-ARV-01-212-376 [133], D02-ARV-01-212-378 [134], D02-ARV-01-212-379 [135], D02-ARV-01-212-382 [136], D02-ARV-01-212-383 [137], and D02-ARV-01-212-385 [138] using the finite element method.

Following the detailed EAF analysis, four of the nine sentinel locations were identified where either the CUF or the CUF_{en} were above the ASME Section III Code allowable value of 1. The locations are as follows:

* ALF1: Pressuriser discharge line by relief valves of Koeberg Unit 1;
* ALF4: Reactor chemical and volume control system (RCV) discharge lines of Koeberg Unit 1;
* ALF5: Reactor chemical and volume control system (RCV) discharge lines of Koeberg Unit 2;
* ALF9: Spray line of Koeberg Unit 1.

The original plant fatigue studies of these sentinel locations were known to have high CUF values. They required several iterative analyses with optimisation to meet the design code requirements (CUF<1) and confirm fatigue would not be an expected degradation effect. Similarly, these four locations require further CUF_{en} analysis and optimisation to confirm that they meet the code requirements.

An interim assessment EA-23-170 [162] was performed by KNPS and it concluded that the low actual transient usage versus actual design transient numbers for LTO results in a minimal risk of fatigue initiation occurring in the sentinel piping locations. The weld A11 (ALF9) is inspected as part of the ISIPRM, and no recordable indications have been found. NDE for ALF1 and ALF4 is planned for outage 127, with NDE for ALF5 for outage 227 (subject to cancellation should the Framatome analyses, planned for 2024, indicate CUF_{en} code acceptability). Locations are acceptable for continued service until the optimised analysis is completed.

The remaining five sentinel locations respected the criterion CUF_{en}<1, resulting in the absence of fatigue and EAF damage for the main coolant lines during the LTO period.

- **Control Rod Drive Mechanism** – After the initial screening in JIC-NC-00140 [170] to identify and select the sentinel locations that serve as a leading indicator for EAF damage accumulation, some sentinel locations were retained for a detailed CUF_{en} analysis. The mechanical, thermal, and thermo-mechanical calculations were performed on a 2D axisymmetric finite element model. All studied segments in JIC-NC-00260 [173] were found to respect the criterion of CUF_{en}<1, resulting in the absence of fatigue and EAF damage for the control rod drive mechanism (CRDM) during the LTO period.

6.5.1.2.2 IGALL TLAA 103 and 105: Pressuriser Spray Nozzles – Crack Growth Analysis of Flaws Detected in Service and Fatigue and Thermal Ageing Analysis of Manufacturing Flaws and Flaw Tolerance

The purpose of the mechanical analysis D02-ARV-01-213-179 [140] was to perform a crack initiation and growth analysis followed by a stability analysis of the four defects located in the pressuriser spray nozzle. The analysis showed that only two of the defects would potentially grow. However, the stability analysis concluded that, for the selected transients and defects, all the criteria for each category are respected for the LTO period.

6.5.1.2.3 Additional TLAA: RPV – Primary Water Stress Corrosion Cracking

This TLAA was identified by Framatome as the KNPS OEM as one that should be available. The TLAA aims to ascertain whether the alloy 182 construction weld repairs in the RPV nozzles and the upper keyways are potentially at risk during the extended design lifetime of 60 years due to the initiation of primary water stress corrosion cracking (PWSCC). Somel EDF plants have had the same repairs performed during construction. Due to KNPS operation at reduced temperature for several cycles, the expected crack initiation time lags the EDF units significantly. To date, no PWSCC indication has been detected in any of the EDF units (currently under 10 yearly inspections). Also, at KNPS these are inspected during the 10 yearly RPV internal inspections. Thus, unless EDF units report indications, the expected PWSCC initiation at KNPS is largely acceptable.

During manufacturing, a defect was detected on the keyways cladding on Unit 1, which required an alloy 182 repair. Since the keyway repairs are operating at a lower temperature than the RPV outlet nozzle repairs, the absence of PWSCC initiation in these areas on Unit 1 is readily justified in D02-ARV-01-177-328 [112] for 60 years of operation, similarly for the nozzle repairs done with alloy 182.

6.5.1.2.4 Additional TLAA: RPV Adaptor Flanges

This TLAA was identified by Framatome as the KNPS OEM as one that should be available. This TLAA aims to verify that the wear phenomenon observed in the Unit 1 RPV adaptor flanges does not affect the mechanical strength of the CRDM according to the relevant ASME criteria. The mechanical study JIC-NC-00130 [168] concludes that all the ASME criteria are met for 60 years of operation, based on the assumption that it remains within the maximum wear allowed for the KNPS Unit 1 reactor head. This TLAA does not apply to Unit 2, as it was previously validated as part of the replacement of Unit 2 reactor head project as referenced in D02-ARV-01-144-513 [105].

6.5.1.2.5 IGALL TLAA 110, 122 and Additional TLAA: RPVI Thermal Ageing and Neutron Embrittlement

This TLAA aims to evaluate the risk for the different RPVI components potentially sensitive to fast fracture. During operation, the components are affected by thermal ageing and neutron embrittlement that result in a decrease in ductility and fracture toughness, together with an increase in yield and tensile stress. Material ageing makes the affected RPVI components potentially sensitive to flaws with the potential for structural integrity failure. It was postulated in D02-ARV-01-177-459 [113] that there may be flaws in the welds and cast components for which the failure of ductile tearing was considered. A fast fracture analysis D02-ARV-01-221-375 [143] on the flange/core barrel weld, found that in normal, upset, emergency, and faulted conditions, there was no risk of crack initiation. For the core barrel circumferential welds, analysis D02-ARV-01-219-088 [142] confirmed there is no crack initiation in normal and upset conditions. It must be noted that no defects have been detected in the welds at KNPS or the French reactor fleet. This analysis is performed as a defence-in-depth approach.

For the control rod guide assembly (CRGA), in case of failure of one of the fillet welds between the CRGA flange and housing, it was found in D02-ARV-01-217-289 [141] that the CRGA overall bending stiffness will decrease during LOCA conditions. The results, with the failure of the fillet welds between the CRGA flange and its cover, show that the maximum deflection is respected for some LOCA breaks, i.e. R1 (area 900 cm^2) and R2 (area 750 cm^2) breaks, but not for an R3 (929 cm^2) break. This may result in not all the CRGA remaining functional. This analysis is, however, a postulated failure of the weld and concludes that there is a low probability of occurring. The failure of the weld is considered a hypothetical situation, which has never been reported to date for this component. This analysis is not a TLAA but was done to address the degradation mechanism described by IGALL TLAAs 110 and 122. The OEM has agreed that no methodology is available to perform a time-limiting ageing analysis for the thermal ageing. This analysis is retained as an additional safety study (not a TLAA) and will be included into the SAR accordingly.

6.5.1.2.6 IGALL TLAA 120: RPVI Vibration

During the definition phase of the SALTO project, in document D02-ARV-01-142-242 [103], the need for a new TLAA 120 was identified. The purpose was to determine the hydraulic loadings on the RPV and RPVI under LOCA and seismic conditions, using the SGR project analysis as a reference to determine the impact of wear of the RPVI / RPV mating surfaces.

Eskom has re-assessed the need for IGALL TLAA 120 for KNPS in engineering assessment EA.23-143 [159] and concluded that this does not meet the TLAA criteria and, therefore, is not required for LTO. No analysis model is available for calculating wear as a basis for a TLAA.

Instead, Eskom's approach is to apply an AMP for managing this wear, which is aligned with international and EDF reference plant practice and satisfies the relevant IGALL TLAA 120 criterion.

The decision and approach to the assessment are recorded in 08016.ROD.032 [34].

6.5.1.2.7 IGALL TLAA 112: Reactor Coolant Pump Flywheel

The mechanical analysis JIC-NC-00143 [171] comprises six studies, namely:

- stress determination
- fatigue analysis,
- limit load for ductile failure,
- non-ductile failure analysis,
- crack propagation, and
- limit load for the non-ductile failure analysis,

and verifies that the ASME criteria for the reactor coolant pump flywheel are met and that there is no risk of extending the operational life from 40 to 60 years. The maximum stresses, which are in the keyway, are less than 1.

6.5.2 Civil TLAAs

6.5.2.1 TLAAs Validated for 60 Years

6.5.2.1.1 IGALL TLAA 303: Cumulative Fatigue Damage of Containment Liners and Penetrations

The risk of cumulative fatigue damage of the containment liner and penetrations of KNPS containment Units 1 and 2 was assessed and found to be practically non-existent. From all events considered, only the stresses caused by pressure tests produce noteworthy differential stresses in the liner. The stresses caused by start-ups generate noteworthy differential stresses in the penetrations. However, the differential stresses and the number of load cycles are very low, and the CUFs are near zero; and fatigue damage cannot occur. As a result, it was concluded that TLAA 303 for the containment liner and penetrations in KNPS, documented in report L1124-GN-RPT-044 [250], is validated for 60 years and is one of the two listed in Table 6-3.

6.5.2.1.2 IGALL TLAA 304: Foundation Settlement due to Soil Movement

The risks associated with the residual and differential settlements were assessed and found to be negligible. The assessment was documented in report L1124-GN-RPT-045 [251], which concluded that TLAA 304 is validated for LTO and is one of the two listed in Table 6-3.

> ***NOTE:*** *IGALL TLAA 302: Effects of creep and shrinkage of concrete structures: As part of the SALTO civil AM assessment in Report L1124-GN-RPT-024 Rev. 4 [243], Framatome has provided an expert opinion stating that the stresses caused by creep and shrinkage in structures other than the containment building, which is covered in TLAA- 301, are negligible. IGALL AMP 306: Structures monitoring (version 2018) covers*

the inspection of shrinkage and creep mechanisms. Subsequently, the existing civil ageing management programme was supplemented with 240-165425812 [60], which addressed the partial gaps identified with respect to IGALL AMP 306. Hence, creep and shrinkage of concrete structures are not a concern for the period of LTO, and the civil surveillances at KNPS adequately cover the related degradation mechanisms as required in terms of IGALL AMP 306.

6.5.2.2 New TLAAs Requiring Analysis to be Validated for 60 Years

6.5.2.2.1 IGALL TLAA 108: Fatigue of Cranes

Although this is technically a mechanical TLAA, it was managed under the civil scope within SALTO. The required analysis D02-ARV-01-183-091 [123] concluded that no significant issues were found that would prevent the polar crane from operating for the duration of LTO. TLAA 108 was validated for LTO. The recommended actions to ensure a safe and reliable mode of usage and long-term operability are documented in close-out document 08016.ODCOF.262 [21].

6.5.2.2.2 IGALL TLAA 301: Concrete Containment Tendon Pre-Stress

The developed analysis D02-ARV-01-183-095 [124] concluded that TLAA 301 for the concrete containment tendon pre-stress has been revalidated for LTO. The concluding remarks re-emphasised the importance of ensuring the monitoring system's functionality and that the inspection reports' recommendations must be followed, which were captured and documented in close-out document 08016.ODCOF.252 [20].

Following the NNR reviews of TLAA 301, Eskom was requested to address the NNR comments documented in NNR letters k28880N dated 7 November 2022 and k29021N dated 22 February 2023 in response to document D02-ARV-01-183-095 [124] and L1124-GN-RPT-019 [239].

Eskom has subsequently responded to all the NNR comments related to TLAA 301 in letter K-29772-E dated 20 November 2023 with the following attachments:

- Attachment 1: Response to k29021N: General and Specific Comments
- Attachment 2: Response to k28880N: Specific Comments
- Attachment 3: 331-691 [94], 'Containment Re-Analysis for Long-Term Operation'
- Attachment 4: Reports Requested according to PSR SC-5

The purpose of document 331-691 [94] (part of K-29772-E) is to address concerns and shortcomings in the results of online monitoring equipment and gaps in the data and calibration of the initial TLAA. It compares the 1 HRX and 2 HRX structures' EAU systems as a supporting document for the application of the life extension of KNPS and in support of KNPS's LTO safety case. It is concluded that there is good confidence in the results of the strain gauges, and where required, conservative assumptions were made. Degradation of the containment structures was investigated, and the main assumption was discussed, i.e. that the tendons are not affected by chloride-induced degradation.

Furthermore, the result of the re-analysis in 331-691 [94] confirmed that the containment structures will remain in compression at a postulated LOCA at the predicted 60-years. The study verified and validated TLAA 301 for LTO.

Document 331-691 [94] (submitted to the NNR as part of letter K-29772-E) was used to support the SAR change submitted to the NNR (K-29475-E) for NNR approval.

6.5.3 Environmental Qualification TLAAs

The complete scope of electrical and I&C components to be environmentally qualified and validated is documented in list L1124-EL-LIS-001 [223]. 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 [226].

The TLAAs of environmentally qualified equipment, as required by the IAEA IGALL TLAA 201, were performed and the results documented in the report L1124-GN-RPT-018 [238], together with the associated results sheet L1124-EL-LIS-002 [224]. This report justifies extending the qualified life (QL) for some components. Identified components with a QL shorter than 60 years require re-analysis or replacement before the 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. AMP 221 was considered for the re-analysis of those items identified for re-analysis. The IAEA replaced IGALL AMP 207 and AMP 209 with IGALL AMP 221.

The results of the EQ TLAA validation and verification, as provided in L1124-EL-LIS-002 [224] and L1124-GN-RPT-018 [238], are summarised below:

- Some qualified equipment was validated for 60 years.
- Certain qualified equipment are periodically replaced, re-baselining the qualification and this strategy will be maintained; therefore, there is no need to subject these items to further re-analysis.
- The qualified transmitters located in mild environments were validated for LTO but not 60 years. They will have to be replaced or re-assessed before the end of their QL.
- Some qualified equipment was confirmed to be valid for 40 years and not suitable for LTO. These components were identified for replacement before LTO or subjected to further evaluation before the start of the LTO period.

A strategy was developed by KNPS for the EQ TLAA results and documented in 08016.ROD.018 [27]. 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 with a QL of 40 years, the strategy is to either replace the equipment, i.e. perform modifications to the plant, or re-analyse the applicable component qualification. Actions identified in 08016.ROD.018 [27] are tracked under CR 117512. Refer to Table 6-4 for a list of EQ TLAA reports.

The status of the actions to address the EQ TLAAs that are not valid for LTO is provided below.

6.5.3.1 Replacement of Components with a Qualified Life less than 60 years

The following qualified equipment was replaced as recommended in the L1124-EL-LIS-002 [224] and L1124-GN-RPT-018 [238]:

- 1, 2 VVP 007 to 015 MP
- 1, 2 ETY 201, 202 MP
- 1 VVP 127, 128, 129 EL
- 1 RPN 010 to 040 MA
- 1 RCP 001, 002, 003 PO speed sensors
- 1, 2 DVK 100, 101 MP
- 2 RCP 057, 058, 060, 061 MT
- 1 KRT 022, 023 MA

Equipment designated for replacement on Unit 2 is scheduled for replacement in outage 226.

6.5.3.2 Qualified equipment identified for further re-analysis

- **Valcor Solenoid Valves installed on SR Valves**

  A TLAA re-analysis was performed for the Valcor solenoid valve model 70900-65, installed in various safety systems, with the results documented in the EQ TLAA report D02-ARV-01-176-728 [111]. According to the EQ TLAA report, the calculated QL was demonstrated to be longer than 60 years, but this is only valid if the O-ring deemed exposed to the outside environment is successfully validated and replaced to satisfy the requirements for the integrated radiation dose requirements stipulated in the SAR II-1.11.

  The qualification of the Viton O-ring for the split in the total accident dose of Koeberg is discussed in engineering assessment EA-23-119 [157]. The assessment also evaluates the engineering implications of the Viton O-ring failure under a total accident dose of 600 kGy and how it affects the solenoid and parent valves' safety function. This is supported by calculating the gamma and beta radiation contributions to the total integrated dose, and the results are documented in the letter PSA23-0029-R00 (*Split Analysis: Calculation Method Between the Gamma and Beta Radiation Dose*), which is attached to EA-23-119 [157]. The verification of the assumed dose split carried out by Nuclear Analysis and Siting, provides assurance that the QL requirement for the Viton O-ring is met and no further requalification is needed. The assessment concluded that the Viton O-ring should not be subjected to the requalification testing for the total integrated dose of 600 kGy stated in the SAR. Additionally, in the event of failure, the consequences on the safety function of the Valcor solenoid valve are negligible.

Internal seals installed in the Valcor solenoid valves require replacement within 15 years of operation. Given that the original installation was performed in outages 119 and 219 (2010 and 2012, respectively) under CP1 modification 02262, a replacement will only be required in 2025 and 2027, respectively. This is covered in EA-23-064 [154].

SAP implementation action SAP IMP 41509 was raised to create new service notifications or to update existing ones to implement a periodic replacement of the seals to preserve the qualification of these components every 15 years.

- **Residual Heat Removal System (RRA) 6.6 kV Motors, RRA 001 and 002 MO**

  A TLAA re-analysis was performed for the residual heat removal system (RRA) motors. The results were documented in the TLAA report D02-ARV-01-181-583 [120].

  Based on calculations of the QL, the RRA motors are considered suitable for the complete LTO of 60 years. The TLAA report D02-ARV-01-181-583 [120] further concluded that there is no need to replace the complete motor or parts of it unless periodic tests reveal violation of acceptance criteria to the extent that maintenance is required. The latter point may concern the grease for the bearings on an annual basis, or the replacement of potential sealants of the housing during the required complete overhaul every 5 years.

  KNPS has implemented periodic condition monitoring tasks to preserve the qualification of the motors, which includes 1RO greasing of the motor bearings, a 2RO Tan Delta test, a 1RO PI & Ohmic test, a 1RO insulation check, a 2-monthly Monitor Vibration & Temperature, and a 2RO elastimold inspection.

  The RRA motor overhaul is not periodically required by the PM Programme. The current strategy at KNPS is to overhaul the motors or replace them based on an engineering request, and this request is generally based on the condition of the motor. Engineering assessment, EA-23-175 [163], evaluated the current strategy adopted at KNPS for the RRA motors to confirm that this strategy is adequate for LTO. The current condition monitoring regime is adequate and will be maintained throughout LTO.

- **Qualified Rotork Actuators**

  The TLAA for the Rotork valve actuators was performed, and results were documented in report D02-ARV-01-181-189 [119]. The report concluded that the results of the formal QL calculations do not cover the planned LTO period.

The insufficient calculation results are attributed to the seals (and lubricants), which, in the frame of TLAA for LTO, should be considered wear parts or material that can be replaced during maintenance works on the Rotork valve actuators, e.g. every ten years. In this case, PM, by overhauling or replacing wear parts (gears, springs, dynamic seals), can prolong the QL of the equipment.

All qualified Rotork actuators on Unit 1 were renewed in outage 126. The qualified Rotork actuators on Unit 2 are scheduled to be renewed in outage 226. SAP work orders were raised for the Unit 2 replacements.

The SAP IMP 41475 was raised to update the existing SAP service notifications or create new ones to overhaul the EQ Rotork actuators every 6RO to renew the QL of the actuators.

- **Containment Sweeping Ventilation System (EBA)**

  A TLAA was performed for the containment sweeping ventilation system (EBA) AMRI containment isolation valve actuators, 1/2 EBA 001, 003, 013, 015 AK with the results documented in D02-ARV-01-182-258 [122]. The report concluded that there is no limitation in terms of the QL of the equipment and can, therefore, be extended to cover the whole period of LTO.

- **RIC Thermocouples RIC 001 to 051 MT**

  The in-core thermocouples of the RIC system were re-assessed, and the results were documented in D02-ARV-01-181-612 [121]. The failure rate of the components during the power operation of KNPS was used to estimate the usable lifetime in service for the RIC thermocouples and justify the operation for LTO.

  The report concluded that the RIC thermocouples are suitable for the period of LTO due to the large number of installed components, the estimation of the failure rate, and the extrapolation for the period of LTO.

  Periodic monitoring activities, which includes insulation resistance measurements and temperature measurements, were recommended.

  Insulation resistance measurements and inspection of the RIC thermocouples are performed every 1RO, using procedure KWM-IN-RIC-008 [197]. This is a pre-outage (as found) as well as during start-up (as left) activity.

  The RIC temperature data is available on InSQL to compare thermocouple deviations. This will be monitored and documented in the RIC LOPP KBA 0022 N NEPO LOPP 007 [182].

  Unacceptable deviation from specified reference values and deviation between adjacent thermocouples will be evaluated. If unacceptable deviations have occurred during a fuel cycle, the root cause will be ascertained during the next outage.

- **EQ Cables with EPR Insulation**

  The EQ cables were reviewed based on the initial qualification and discussed in L1124-GN-RPT-018 [238], limiting the radiological and thermal QL to 40 years.

  To extend the QL of cables, KNPS has performed a re-assessment of the original cable qualification and documented the findings in report 331-665 [91]. As part of the on-going condition monitoring of the cables qualified condition and validation of the qualification for LTO, cable sample specimens have been removed from the plant in outage 126 for testing. Additional samples may be removed in outage 226 if required. The strategy is documented in ROD 08016.ROD.031 [33] and engineering assessment EA-23-057 [153].

- **Reassessment of 1 RRA 005 MT, 1 RRA 007 MT, 2 RRA 005 MT, and 2 RRA 007 MT**

  The existing temperature probes on RRA 005 MT and RRA 007 MT were installed during the implementation of the CP 1 modification 02261 (EQ upgrade of digital on/off sensors) with the Emerson model MW GOS KE-PE RTDs. The modification was implemented during October 2010 and March 2011 on Units 1 and 2, respectively.

  The sensors were subjected to further evaluation primarily based on material analysis and the design of the temperature sensor. Framatome performed the evaluation, and the results are documented in the letter DTICQ-G/2023/10/19/WB. The evaluation is documented in letter EA-23-128 [158], which concluded that:

  * The thermal QL was re-calculated to be > 60 years for 25°C and 35°C normal environmental exposure.
  * The radiological QL was re-calculated to be > 60 years for a dose rate of 0.1 Gy/h.

  Based on the InSQL trends and the monitoring performed in Unit 2, the environmental conditions for this this assessment period, with particular emphasis on the identification of adverse localised environments that may impact the equipment’s qualified life, did not reveal any significant anomalies or elevated temperature or radiation levels. The temperature and radiation levels remained lower that the value assumed in the calculation of the qualified life.

- **Equipment Scheduled for Replacement in Outages X27**

The following qualified items of equipment are scheduled for replacement in outages X27 and have been re-assessed to demonstrate safe operation until they are replaced.

- Electrical Penetrations

EQ TLAA revalidation of qualified electrical penetration assemblies (EPAs) was performed based on the initial qualification, and results are provided in L1124-GN-RPT-018 [238]. The revalidation results concluded the following:

* The thermal QL associated with mechanical safety functions was calculated to be greater than 60 years using 30°C and 38 years using a peak value of 35°C (30°C is the average as measured temperature in zones R2 and R3).
* The radiological QL associated with the electrical and mechanical safety functions of the EPAs is greater than 60 years, providing the maximum value of 0.1 Gy/h is not exceeded (0.1 Gy/h is the maximum radiation dose rate in zones R2 and R3 under normal conditions).
* The QL for the Weidmuller terminals that are part of the EPAs were found to be suitable for the entire period of LTO (up to 60 years) without re-analysis.

Based on the calculated thermal QL associated with mechanical safety functions, the QL of the EPAs were limited to the current licensing term, and the report recommended that the assumed temperatures that EPAs were exposed to be subjected to further re-analysis.

Report L1124-GN-RPT-018 [238] concluded that additional evaluations needed to be performed (including the evaluation of the abnormal leakage rate recorded during the initial qualification test) and therefore limited the QL of the EPAs to 40 years.

The EPAs were further evaluated, and the results were documented in report 331-688 [93]. This report demonstrates that the QL associated with the electrical and mechanical safety functions is greater than 60 years.

- **Pressuriser Heaters (RCP 005 and RCP 006 RS)**

The TLAA reassessment was performed on the installed and qualified pressuriser fixed heaters RCP 005 and 006 RS. The equipment specification document KBA1207E00002 [189] was used as the basis for the qualification requirements of the pressuriser heaters. The specification file states that the heaters shall be qualified to comply with the specifications provided in paragraphs 6.2.4.2.7 and Appendix A, paragraph 1.2 of KBA1207E00002 [189]. Although KNPS does not have the qualification file, it is assumed that the heaters meet the specifications prescribed in KBA1207E00002 [189], and these parameters are used to assess the qualification of the heaters for continued operation until outages X27 when the pressuriser heaters will be replaced.

The QL of the heaters RCP 005 RS and RCP 006 RS was re-assessed considering the following parameters:

* Thermal cycling (10 000 hours of operation with 5 000 on-off cycles), i.e. if the heaters are switched on from 0% to 100% full power and reach 5 000 cycles, they can be operated for a minimum of 10 000 hours.
* No loss of insulation shall occur when a 1 000 V potential is applied between the heater element and the heater sheath.

The minimum QL of the pressuriser fixed heaters, based on the parameters listed above, was documented in report 331-687 [92]. Based on the revalidation results, the following is concluded:

* The limit, as given in the design basis document, is 5 000 on-off cycles. It has been shown that Koeberg fixed heaters, RCP 005 and 006 RS, are well within this limit, with 28% on-off cycles calculated to be utilised after 40 years of operation. When projecting beyond X26 for one cycle of operation (until outages X27), the 5 000 on-off cycle limitation is not reached.
* The operating hours are not considered a limitation to extend the life of these components for one cycle.
* A review of the available insulation resistance (IR) results until outages X23 demonstrated that there has been minimal deterioration in the insulation resistance of the heaters since installation. To remain in compliance with in-service revalidation requirements, it is required that the IR tests be conducted at a 1RO frequency starting in outage 226 (tracked under SAP IMP 43265).
* The Thermocoax heaters are scheduled for replacement in outages 127 and 227 to eliminate the risk of failure due to SCC.

The report demonstrates that the QL of the pressuriser fixed heaters RCP 005 and 006 RS can be extended beyond the initially assumed life until outages X27 (1 cycle of operation), whereafter the heaters is scheduled to be replaced.

- **RIC Thermocouple Cables and Connectors**

  The Unit 2 RIC thermocouples cables and connectors were replaced under modification 13020 as part of the RPV vessel head replacement project. The Unit 1 RIC thermocouples cables is to be replaced in outage 127 under SAP work order 719444299. Report 331-696 [95] provides a safety demonstration based on the qualification reassessment of the installed Unit 1 RIC thermocouples cables and connectors beyond the QL of years 40 years.

6.5.3.3 Transmitters located in mild environments not valid for the entire LTO period

For the equipment located in a mild environment with a QL not valid for 60 years and with a QL expiring in 2035, the replacement or reassessment of a QL will be performed before the expiry date. Corrective action CR 117512-001 CA (with the due date of 30 September 2030) was raised to track the reassessment of QL before 2035.

6.6 Documenting of the KNPS TLAAs

In the execution phase of the Koeberg SALTO assessment project, where applicable, the TLAAs (re-analysed and analysed) are documented in a report format 240-153544432 [49].

The majority of the new TLAAs listed in Table 6-4 were compiled by Framatome as defined in the technical requirements specification 240-153477196 [48] to validate the components for 60 years of operation as identified in the documents listed in Table 6-2.

Some TLAAs were compiled by Eskom to validate the relevant components.

Table 6-4: Components that Required Analyses to Validate them for 60 Years of Operation by the SALTO Project

No.	Failure Mechanism	IGALL Reference No.	Component	Reference Document No.	Status
1a	Environmentally Assisted Fatigue	106	Reactor Coolant Pumps	JIC-NC-00138 [169] JIC-NC-00253 [172]	Complete
1b	Environmentally Assisted Fatigue	106	Reactor Pressure Vessel Internals	D02-ARV-01-178-202 [116] D02-ARV-01-212-661 [139]	Complete
1c	Environmentally Assisted Fatigue	106	Pressuriser	D02-ARV-01-178-200 [114]	Complete
1d	Environmentally Assisted Fatigue	106	Main Coolant Lines	D02-ARV-01-178-201 [115] D02-ARV-01-212-366 [125] D02-ARV-01-212-368 [126] D02-ARV-01-212-369 [127] D02-ARV-01-212-371 [128] D02-ARV-01-212-372 [129]	Complete
1e	Environmentally Assisted Fatigue	106	Auxiliary Lines	D02-ARV-01-178-203 [117] D02-ARV-01-212-373* [130] D02-ARV-01-212-374 [131] D02-ARV-01-212-375 [132] D02-ARV-01-212-376* [133] D02-ARV-01-212-378* [134] D02-ARV-01-212-379 [135] D02-ARV-01-212-382 [136] D02-ARV-01-212-383 [137] D02-ARV-01-212-385* [138] EA-23-170 [162]	Complete- *Further analysis required
1f	Environmentally Assisted Fatigue	106	Control Rod Drive Mechanism	JIC-NC-00140 [170] JIC-NC-00260 [173]	Complete
2	Environmentally Assisted Fatigue	106	Pressuriser Heater Sleeves	D02-ARV-01-180-957* [118] EA-24-001 [164]	Complete- *Further analysis required

No.	Failure Mechanism	IGALL Reference No.	Component	Reference Document No.	Status
3	Crack Growth Analyses of Flaws Detected in Service and Fatigue and Thermal Ageing Analysis of Manufacturing Flaws and Flaw Tolerance	103 115	Pressuriser Spray Nozzles	D02-ARV-01-213-179 [140]	Complete
4	PWSCC in Nickel Base Alloys	Additional TLAA	Reactor Pressure Vessel	D02-ARV-01-177-328 [112]	Complete
5	CRDM Wear of Adaptor Flanges	Additional TLAA	Reactor Pressure Vessel	JIC-NC-00130 [168]	Complete
6	Thermal Ageing of Cast Austenitic Stainless Steels, Thermal Ageing of Martensitic Stainless Steels and Neutron Embrittlement	110, 122 and Additional TLAA	Reactor Pressure Vessel Internals	D02-ARV-01-177-459 [113] D02-ARV-01-221-375 [143] D02-ARV-01-219-088 [142] D02-ARV-01-217-289 [141]	Complete
7	Vibrations	120	RPVI (Not required)	EA-23-143 [159]	De-linked from LTO
8	Fatigue	112	Reactor Coolant Pump Flywheel	JIC-NC-00143 [171]	Complete
9	Equipment Qualification	201	Qualified Components	L1124-GN-RPT-018 [238] D02-ARV-01-181-612 [121] D02-ARV-01-181-189 [119] D02-ARV-01-176-728 [111] D02-ARV-01-182-258 [122] D02-ARV-01-181-583 [120] 331-665 [91] 331-687 [92] 331-688 [93] 331-696 [95] EA-23-119 [157]	Complete
10	Fatigue	108	Polar Crane	D02-ARV-01-183-091 [123]	Complete
11	Tendon Pre-Stress	301	Containment	D02-ARV-01-183-095 [124] 331-691 [94]	Complete

6.7 KNPS Organisational Responsibility for the AME Deliverables

Upon TLAA finalisation and acceptance by the Koeberg SALTO assessment project, they are formally transferred to the responsible KNPS functional group, Design Engineering, which owns the plant design and the control thereof.

Design Engineering is also responsible for ensuring that these new TLAAs are included and referenced in the appropriate section of the SAR. A section on ageing management and LTO was incorporated into the SAR I-4.5. The SAR ageing management section includes a generic description of a TLAA in SAR I-4.5 and the full list of TLAAs in Table T-I-4.4-1 (List of Time Limited Ageing Analyses). The completed SAR updates are formally submitted to the NNR, including the associated TLAAs as a reference, for approval.

In future, all new TLAAs that may become applicable to KNPS will be considered by Programmes Engineering in accordance with 331-275 [85] and assessed/re-assessed by Design Engineering in accordance with 331-86 [96] for further processing.

7.0 SALTO AGEING MANAGEMENT ASSESSMENT COMMITMENTS

The ageing management assessment commitments are listed in Appendix A of document 331-618 [89]. All the actions raised through the SALTO project, as required by RG-0027 [8] for completion prior to LTO, are complete. The remaining open actions are scheduled and tracked accordingly.

8.0 CONCLUSION

This final SALTO AM assessment report documents the requirements for the performance of the LTO ageing assessment at KNPS. It demonstrates that the methodologies developed, and processes implemented were performed in a systematic approach aligned with international practices for achieving the requirements defined in RG-0027 [8].

The assessment results and recommendations have been reviewed, verified, and actioned to meet the regulatory expectations and assure safe operation into LTO. The result of the completed actions forms part of the justification to obtain the required nuclear installation licence variation before LTO. The SALTO ageing management assessment project has been done according to national regulations and international guidance, identified a number of improvements required to allow Eskom to claim that the ageing management processes, and situation is comprehensive and supportive of LTO.

9.0 ACCEPTANCE

This document has been seen and accepted by:

Name	Designation
A Kamroodien	Manager – Programmes Engineering
A Kotze	Manager – Design Engineering (acting)
J Kotze	Manager – LTO Programme Manager
M Rulu	Project Manager - SALTO
R Cassim	Manager – Materials Reliability

10.0 REVISIONS

Date	Rev.	Compiler	Remarks
January 2024	1	A Oosthuizen	Authorised version of the initial draft.
October 2023	0	A Oosthuizen	Initial compilation of report to inform the regulator on the status of the Koeberg SALTO assessment project.

11.0 DEVELOPMENT TEAM

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

- A Jakoet: Senior Engineer – Materials Reliability Group
- A Oosthuizen: Senior Technologist – Integrated Plant Design – Koeberg
- G Mdluli: Senior Technologist – Materials Reliability Group
- K Moroka: Senior Engineer – Materials Reliability Group
- M Koopman: Technologist – Component Engineering
- R Maapola: Engineer – Design Engineering

Appendix A
Final Report in Context to the KNPS LTO Programme

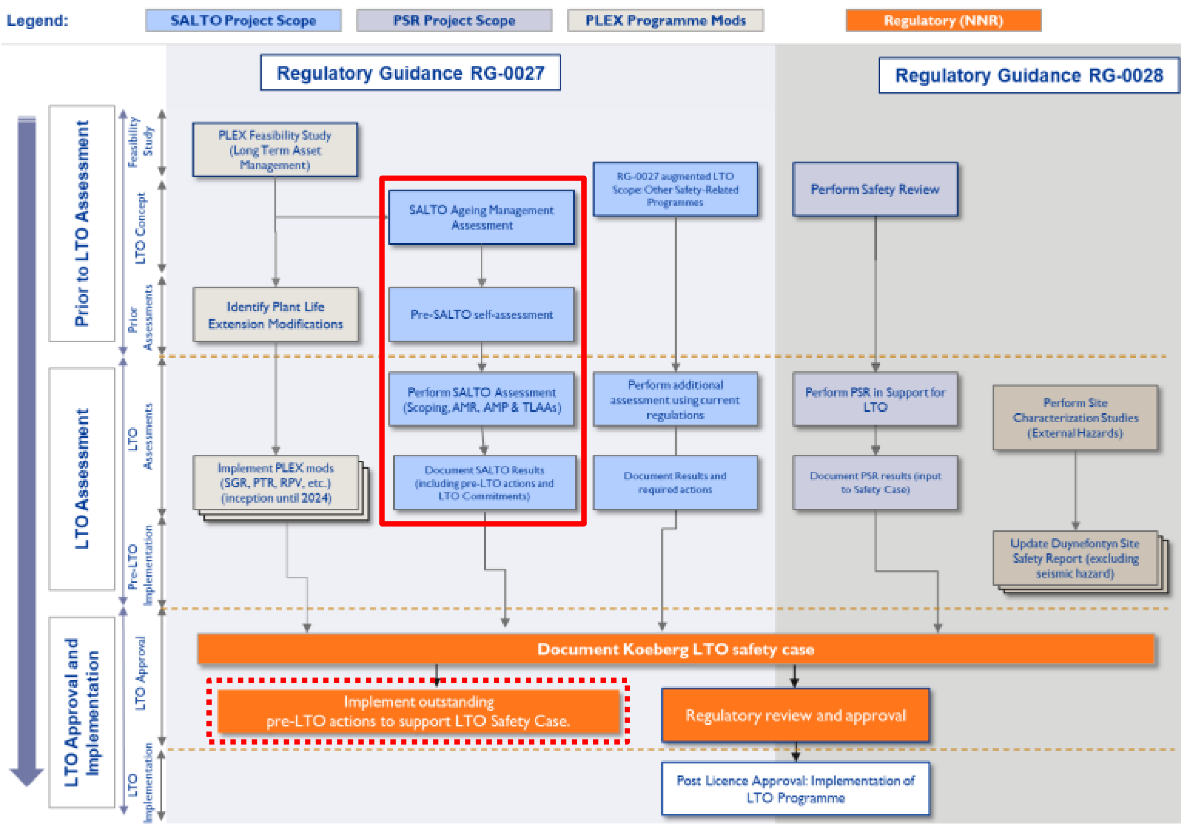

Figure A-1: LTO Assessment Activities[7]

The scope of the SALTO AM assessment report (initial) is indicated by the solid red line rectangle in Figure A-1 above. The scope of this final report now includes both the red solid and dotted line rectangles.

[7] Source: Updated from document 331-618 [89], 'Safety Case for Long-Term Operation of Koeberg Nuclear Power Station'

Appendix B
Background to LTO at Koeberg Nuclear Power Station

In 2008, due to concerns about the long-term integrity of its steam generators, KNPS solicited Eskom's 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 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 subsequent actions followed were initiating the projects to replace significant plant components that would enable PLEX and the commencement of an AM 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 LTO

Internationally, among nuclear utilities, the demonstration of safe LTO has been achieved in several ways:

- For utilities in the United States of America (USA), the United States Nuclear Regulatory Commission provides the requirements for licence renewal in 10-CFR-54, "Requirements for Renewal of Operating Licences for Nuclear Power Plants", which is supported by the GALL report and Standard Review Plan (NUREG-1800). The approach is well established, and almost all the reactors currently operational in the United States have achieved licence renewal through this process (including plants that have applied for subsequent licence renewals that extend plant life from 60 to 80 years). While the process is well documented and supported, it relies on full implementation and adherence to supporting regulations (such as the maintenance rule), making it challenging for utilities outside the United States regulatory environment.
- Many European states use the PSR process to demonstrate readiness for and justify the LTO of their nuclear power plants. In these states, the PSR is 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 cumbersome, complex, and specific to the country's regulatory and legal environment, making these approaches difficult to emulate adequately. A good example is France, where the operating licences have no life limits, but life extension

approval is obtained on a 10-year 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 IGALL workshops and publications. While the approach does not prescribe regulatory requirements, it does stipulate what should be completed to prepare for safe LTO. It provides for a peer review service to ensure that the SALTO process is adequately supported and effectively implemented.

B.2 The KNPS Approach Adopted for LTO

Since 2010, there have been several AM approaches considered by Eskom for LTO, including simplistic and limited justification in the next PSR, the use of elements of the USA licence renewal process, and the adoption of an adapted French approach. These approaches contained weaknesses, limitations, and significant financial implications that may not result in a quality, dependable outcome. 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 supported KNPS in preparing for LTO through workshops describing the SALTO process, delivering technical support missions (2018 and 2020), and conducting two pre-SALTO peer review missions in 2015 and 2019. The SALTO peer review mission was held in March 2022. All recommendations and suggestions from these missions were actioned and prioritised to ensure completion before LTO. A follow-up mission is planned for September 2024.

In 2019, the NNR published RG-0027 [8]. While similar to the IAEA requirements for the demonstration of safe LTO, RG-0027 [8] 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 licence for 60 years of operation.

B.3 LTO Regulatory Requirements

RG-0027 [8] provides the process and requirements for obtaining a licence variation to operate for the LTO period and illustrates the process and requirements for achieving LTO. The next section presents each step of the process and explains how KNPS has achieved some of the requirements and how the outstanding requirements will be achieved.

Figure B.1 illustrates how the expected benefits from LTO, as well as other regulatory requirements provided inputs into the feasibility study for LTO.

In accordance with the NNR's RG-0027 [8], 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.1 below (extracted from RG-0027 [8]).

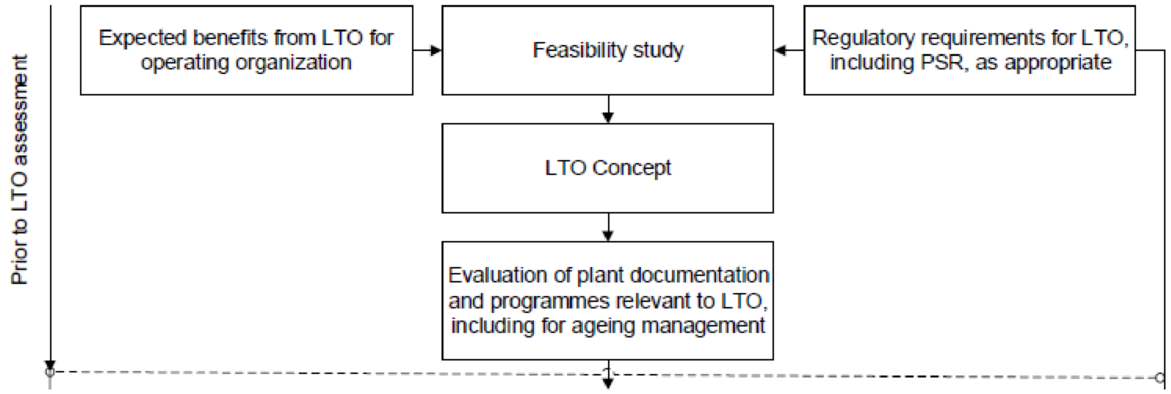

Figure B.1: Steps in a programme for LTO (before LTO Assessment) – RG-0027

KNPS's feasibility study for PLEX is documented in K08016VAR [177]. It contains the expected benefits as well as the economic justification for LTO, considering the governing regulatory requirements at the time.

Following the LTO concept (shown in Figure B.1 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. Before the NNR issued RG-0027 [8], it was considered that the SALTO approach would satisfy possible national regulations when these were published and that it would be sufficient to demonstrate safe LTO.

In 2015, KNPS assessed plant programmes relevant to LTO, including AM. This assessment was followed by an IAEA pre-SALTO review of KNPS's current plant programmes and operational readiness for LTO. From this assessment, initial actions were developed to define the scope of required AM activities in preparation for LTO. Included in these actions was establishing 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 AM 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 [8] utilising the IAEA SALTO process guidance document SSG-48 [7].

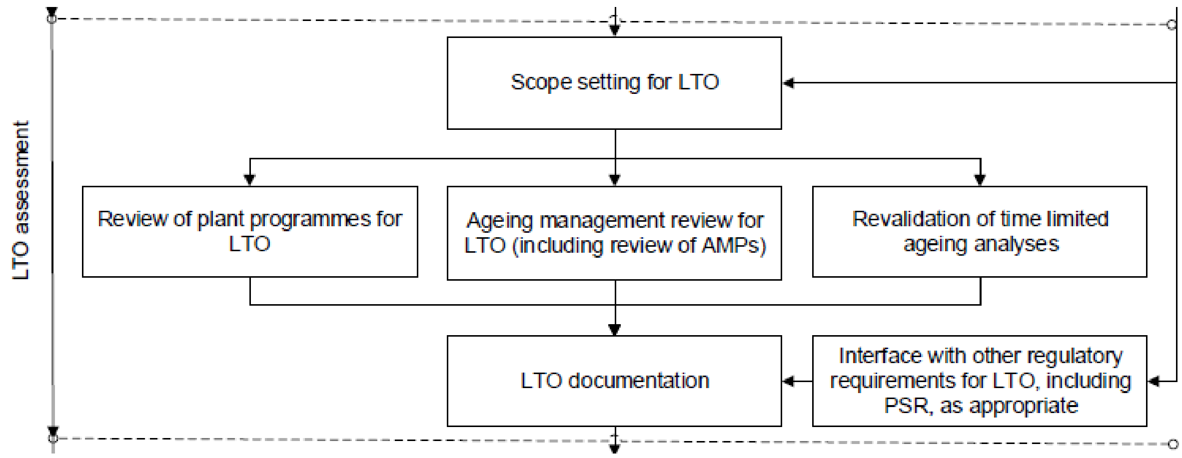

Figure B.2: Steps in a programme for LTO (LTO Assessment) – RG-0027

As shown in Figure B.2 above, the LTO assessment starts with the *scope setting of SCCs* that require further AM 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 AMR requires a review of important-to-safety SSCs, including the AM programmes that apply to these SSCs.

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

The SALTO ageing management assessment culminated in updating the plant documentation to support LTO, as shown in Figure B.2 above. This includes the Koeberg SAR, important-to-safety plant programmes, and associated operational requirements to secure safe LTO. It included a review and confirmation of plant policies, processes, and 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).

According to RG-0027 [8] requirements, a comprehensive programme for LTO was established and implemented to ensure the long-term safe operation of the plant beyond a time frame established in the current licence conditions, design limits, safety standards, or regulations.

The SALTO project organisation tracked all the activities developed for all the required implementation activities for LTO in accordance with RG-0027 [8]. The programme for LTO included additional activities that were required to be performed to achieve the LTO objectives.

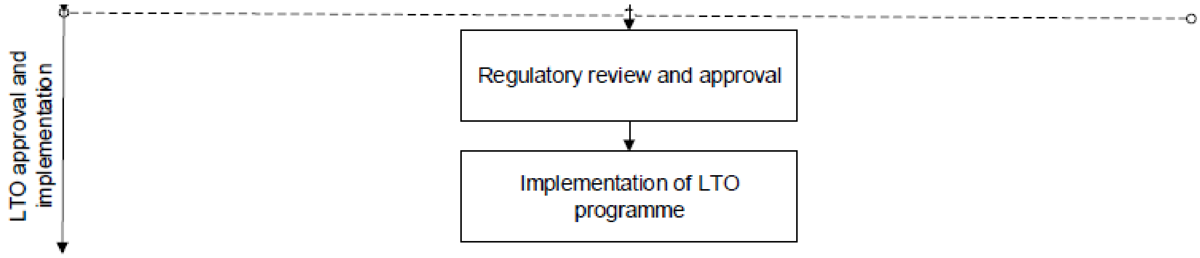

Figure B.3: Steps in a programme for LTO (Approval and Implementation) – RG-0027

In summary, RG-0027 [8] provides the regulatory requirements for achieving the AM 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 embarked on to meet these requirements with respect to AM, 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 U1
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 Unit 2
2 HRE 000 BG	Auxiliary Feedwater Tanks (ASG)