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Compiled by	Functional Responsibility	Authorised by
K Moroka	N Ryland	A Kamroodien
Senior Engineer	Manager	Middle Manager
Materials Reliability Group	Materials Reliability Group	Programmes Engineering
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CONTENTS

1. Introduction

Ageing management for nuclear power plants is implemented to ensure that the effects of ageing will not prevent structures, systems and components (SSCs) from being able to accomplish their required safety functions throughout the lifetime of the nuclear power plant (including its decommissioning). This requires addressing both the effects of physical ageing of SSCs, resulting in degradation of their performance characteristics, and the non-physical ageing (obsolescence) of SSCs (i.e. their becoming out of date in comparison with current knowledge, codes, standards and regulations, and technology).

Effective ageing management of SSCs is a key element of the safe and reliable operation of nuclear power plants. This requires the use of a systematic approach to managing the effects of ageing that provides a framework for coordinating all activities relating to the understanding, prevention, detection, monitoring and mitigation of ageing effects on the plant's SSCs.

In addition, the safety of nuclear power plants during long term operation (LTO) has become more important owing to the steady increase in the number of operating organizations giving high priority to continuing the operation of nuclear power plants beyond the time frame originally anticipated for their operation.

2. Supporting Clauses

2.1 Scope

The scope of the Ageing Management Matrix (AMM) covers all mechanical, civil, electrical, instrumentation & control SSCs important to safety. SSCs important to safety are items that are part of a safety group and/or whose malfunction or failure could lead to radiation exposure of the site personnel or members of the public [17]. The scope further includes ageing affects and ageing degradations relevant to the in-scope SSCs and their treatment.

2.1.1 Purpose

This document describes the Ageing Management Matrix, its location and how it interfaces with other existing ageing management processes.

2.1.2 Applicability

This document applies to the Nuclear Operating Unit (NOU).

2.1.3 Effective Date

The document is effective from the authorisation date.

2.2 Normative/Informative References

2.2.1 Normative

Parties using this document shall apply the most recent edition of the following documents:

[1] ISO 9001 Quality Management Systems

[2] 240-149139512: Ageing Management Requirements for Koeberg Nuclear Power Station

[3] 240-150483693: Ageing Management Programmes List

[4] 331-3: Nuclear Engineering Documentation and Records Management Work Instruction

[5] 331-275: Process for the Development and Control of Ageing Management Matrix at KOU

[6] 331-94: Importance Category Classification Listing

[7] 331-148: Programmes Engineer's Guide

2.2.2 Informative

[8] 240-125839632: Koeberg Safety Aspects of Long-Term Operation (SALTO) Scoping Methodology

[9] 240-125122792: Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses

[10] 331 83: Standard for Plant Changes affecting the Design of Koeberg Nuclear Power Station

[11] 331-144: Standard for the preparation of an Equivalency Study

[12] Koeberg Nuclear Power Station: Safety Analysis Report

[13] IAEA Specific Safety Guide Reports No. SSG 48: Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants

[14] IAEA Safety Reports Series No. 82: Ageing Management for Nuclear Power Plants - International Generic Ageing Lessons Learned (IGALL)

[15] Interim Regulatory Guide RG-0027: Interim Regulatory Guide Ageing Management and Long Term Operations Of Nuclear Power Plants

[16] IAEA Technical Document 1736: Approaches to Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)

[17] IAEA Safety Glossary: Terminology used in Nuclear Safety And Radiation Protection 2018 Edition

[18] KGU-002: Guide for System Engineers

[19] KGU-031: System Health Reporting guide

[20] KGU-023: Guide for Component Engineers

[21] KGU-011: Preparation of Life of Plant Plants (LOPPs)

[22] KGU-033: Failure Investigation of Plant Equipment and Evaluation of Experience

[23] NUREG-1801: US NRC Generic Ageing Lessons Learned (GALL) Report

[24] KAA-913: Integrated Equipment Reliability Process

2.3 Definitions

2.3.1 Ageing: General process in which characteristics of a structure, system or component gradually change with time or use.

2.3.2 Ageing Degradation: Ageing effects that could impair the ability of a structure, system or component to function within its acceptance criteria.

2.3.3 Ageing Management: Engineering, operations and maintenance actions to control within acceptable limits the ageing degradation of structures, systems and components.

2.3.4 Ageing Management Programme (AMP): A programme that manages the effects of ageing on SSCs so that the intended functions will be maintained in accordance with the current licensing basis (CLB) for the period of planned operation.

2.3.5 Ageing Management Evaluation: A process to perform an ageing evaluation for all LTO in-scope SSCs, the performance of ageing management review and the revalidation of the TLAAs.

2.3.6 Ageing Management Review (AMR): The process whereby SSCs are evaluated for ageing effects based on their materials of construction, operating environments, and operating experience (OE) to determine those which require ageing management on an ongoing basis.

2.3.7 Ageing Couple: A combination of the degradation mechanism and the SSC to which it is applicable.

2.3.8 Ageing Effects: A change in SSCs' characteristics (due to specific processes that gradually change the characteristics of a component with time or use) that could cause the component to lose its intended function prior to the end of its operating life.

2.3.9 Commodity Group: A group of components with similar design, function and material.

2.3.10 Item important to safety: An item that is part of a safety group and/or whose malfunction or failure could lead to radiation exposure of the site personnel or members of the public.

2.3.11 Physical Ageing: Ageing of structures, systems and components due to physical, chemical and/or biological processes (ageing mechanisms).

2.3.12 Non-physical Ageing: The process of becoming out of date (i.e. obsolete) owing to the evolution of knowledge and technology and associated changes in codes and standards.

2.4 Abbreviations

Abbreviation	Description
AMM	Ageing Management Matrix
AME	Ageing Management Evaluation
AMP	Ageing Management Programme
AMR	Ageing Management Review
DAPE	Continued Operation Capability File (Dossiers d'Aptitude à la Poursuite de l'Exploitation) from EDF
EDF	Électricité de France
ER	Equipment Reliability
FAV	Ageing Analysis Sheet (Fiche D'Analyse De Vieillissement) developed by EDF
IAEA	International Atomic Energy Agency
LOPP	Life of Plant Plan
LOPP	Life of Plant Plan
SALTO	Aspects of Long Term Operation
SSC	Systems, Structures and Components
TLAAs	Time Limited Ageing Analyses

2.5 Roles and Responsibilities

Refer to 331-275 (*Process for the Development and Control of Ageing Management Matrix at KOU*).

2.6 Process for Monitoring

Refer to 331-275 (*Process for the Development and Control of Ageing Management Matrix at KOU*).

2.7 Related/Supporting Documents

Not applicable.

3. Ageing Management Matrix

The Nuclear Operating Unit (NOU) has followed international practice by developing an Ageing Management Programme (AMP) for Koeberg Nuclear Power Station. The NOU ageing management approach used the EDF ageing matrix to derive a matrix that contains a list of components and the ageing mechanisms applicable to the components. An assumption was made that for the initial matrix, the ageing concerns of EDF and Koeberg Nuclear Power Station (KNPS) are similar enough to adopt and allow for adaptation to the KNPS specifics.

The process within EDF comprises of the procedure that describes the approach adopted, the manner in which all equipment and degradation were identified, the influence of research findings, operating experience and the AMM that captures all applicable and potential degradation linked to the grouped equipment (called an ageing couple), the ageing analysis data sheets (*Fiche D'Analyse De Vieillissement (FAVs)*) prepared for each unique ageing couple to describe the ageing aspect, the implication or potential impact, the ease of component replacement and the manner whereby the ageing is managed. Lastly the major component files (*Dossier d'Aptitude à la Poursuite de l'Exploitation (DAPE)*) are files that contain a comprehensive analysis and justification for a small selection of major components that typically are considered life limiting to the plant.

The Ageing Management Matrix (AMM) identifies the ageing degradation, ageing effects, and the structures, systems and components (SSCs) that are affected by ageing. The AMM is further used to identify and track the actions needed to satisfactorily manage all ageing degradations and ageing effects. The management of ageing can be achieved via several means, inter alia repair, monitoring, inspection, testing, justification, modification, maintenance and refurbishment. Specific ageing management programmes are also implemented (typical at a component or degradation concern level) based on identified gaps in existing plant management programmes or processes, operating experience (OE) or regulatory requirements.

The unique combination of ageing mechanism and the SSCs (ageing couple) that are considered in the AMM are based on EDF's ageing management matrix that was adapted and populated with KNPS specific equipment, ageing management programmes and processes, maintenance activities and associated reference documentation addressing the Ageing Couples. EDF ageing mechanisms that are not applicable to KNPS are also identified on the AMM and they are dispositioned. The AMM intends to demonstrate that all in-scope SSCs monitoring programmes are in place and cater for all known (analysed) and potential ageing degradation. The management of ageing includes, inter alia, modification of existing plant programmes, development of new plant programmes, repair and replacement, monitoring, testing, modification, justification for continued operation, maintenance and refurbishment.

3.1 Systems, Structures and Components (SSCs) subject to ageing management

Systems, Structures and Components (SSCs) are grouped according to common characteristics, such as similar design, similar materials of construction, similar ageing management practices and similar environments in order to create commodity groups.

Commodity groups have been adopted from the original EDF Ageing Matrix and have been reviewed for applicability to KNPS. If required, new commodity groups and ageing couples specific to KNPS are added to the original EDF Ageing Matrix.

3.2 Ageing Management Matrix Information

The AMM displays as a minimum the following information:

- Commodity Groups or SSCs subject to ageing management;
- Safety classification of SSCs;
- Critical parts affected (including material and environment);
- The location or part within a given structure/component susceptible to the ageing effect/degradation mechanism;
- Relevant degradation Mechanism Code;
- Applicable ageing effects and degradation mechanism(s);
- Reference to plant programmes or plant activities.

3.3 Location of the Ageing Management Matrix

The Ageing Management Matrix (AMM) is electronically available in a Microsoft Excel format and is located on the *Koeberg Local Area Network (LAN*). Read only access to the AMM listing is available via the *Ageing Management Matrix* icon on the NAL application folder.

3.4 . Review of the AMM

The AMM is periodically reviewed to ensure that the internal and international ageing management operating experiences are incorporated. Changes to the AMM are made in accordance with 331-275.

3.5 Interface with other plant programmes/processes

The AMM interfaces with the following existing processes:

3.5.1 Plant programmes

Over the operational life of KNPS, the need for various plant programmes has been recognised and programmes established as required in accordance with the Programme Engineer's Guide, 331-148, and other plant processes. Proactive implementation of plant programmes provide the current performance characteristics and condition of the structure or component, including assessment of any ageing related failures or indications of significant material degradation within the scope of a specific programme.

3.5.2 Life of Plant Plans

The system engineers maintain life of plant plans (LOPPs) for the plant systems in accordance with KGU-011 (*Preparation of Life of Plant Plans*). These documents discuss the system conditions and specify ageing concerns, all the major maintenance, refurbishment and replacement work that will be done for the remaining operational life of the plant.

3.5.3 System Health Reporting

System health reporting (SHR), in accordance with KGU-031 (*System Health Reporting*) is used as a measurement of the general effectiveness of site programmes and processes to maintain and improve material condition and equipment reliability.

3.5.4 Component Health Reporting

In accordance with KGU-023 (*Guide for Component Engineers*), the objective of component health monitoring is to identify precursors to, and signs of deteriorating component performance such that corrective measures can be taken before any deterioration has an effect on plant production or safety.

3.5.5 Component Failures Assessment

Component failure (CF) evaluations are performed in accordance with KGU-033 (*Failure Investigation of Plant Equipment and Evaluation of Experience*). .

3.5.6 Maintenance History Records

Maintenance records are compiled after any maintenance activities are performed covering applicable procedures, drawings, diagrams, or questions in which results of work activities and related observations such as as-found conditions, measurements, answers to questions, results of calculations, and graphs and plots are recorded. It also provides a summary of the work activity or work performed which is recorded on the work order and captured on SAP.

3.5.7 Nuclear Engineering Position Papers

Nuclear Engineering Position Papers (NEPPs) is a summary of KNPS's engineering assessment of a selected, key (usually strategic) nuclear issue. It serves as a basis for technical presentations and highlights an engineering issues, status and engineering inputs.

3.6 Identification of Relevant Ageing Effects and Degradation Mechanism of SSCs

Relevant ageing effects and degradation mechanisms are identified on the basis of the understanding of ageing. The current approach to ageing management is described in the sections below, with reference to some of the various elements existing at NOU.

3.6.1 Design Stage

At the plant design stage and for licensing review, it should be demonstrated that ageing has been adequately taken into account. Appropriate measures should be taken, such as the introduction of specific features in the design stage to facilitate effective ageing management throughout the operation stage of the plant.

3.6.2 Monitoring and Inspection Results

Results of periodic monitoring and inspection results are reviewed and the AMM is updated if required. The review of the inspection and monitoring results are also used to update relevant plant programmes.

3.6.3 Walkdowns and failure Assessment Results

Component failures (CFs) and Engineering Problem Reports (EPRs) are reviewed to identify any ageing/degradation mechanism that has occurred to SSCs.

Reports from plant walkdowns should be reviewed to identify ageing effects and degradation mechanisms. Any new concerns need to be included in the AMM.

3.6.4 Operating Experience

The operating experience (OE) programme improves safety and reliability by providing lessons learned from the OE of the world community of nuclear plants. Experience has shown that severe events were usually preceded by less consequential precursor problems or events that occurred at the same plant or at other plants. When the root causes of these precursors are left uncorrected, events can be repeated and, in unanticipated circumstances, can lead to events of safety significance.

Where the OE (both internal and external) includes equipment ageing and degradation, these should be included in the AMM.

3.6.5 International Generic Ageing Lessons Learned (IGALL)

IAEA Safety Reports Series No.82, “Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)”, provide a technical basis and practical guidance on ageing of mechanical, electrical and instrumentation and control (I&C) components and civil structures of nuclear power plants important to safety. IGALL provides a common, internationally agreed basis on what constitutes an acceptable ageing management programme (AMP), as well as a knowledge base on ageing management for design of new plants, design reviews, safety reviews (such as periodic safety review (PSR)), etc., and serves as a roadmap to available information on ageing management.

The IGALL Ageing Management Review (AMR) tables are used as an internationally agreed upon basis for what constitutes an acceptable AMP and/or Time Limited Ageing Analyses (TLAA) for each critical location/part of SSCs, ageing effect/degradation mechanism, material and environment.

3.7 Data collection and record keeping

As part of the implementation of the plant programmes or processes, and the AMM activities, appropriate data should be collected and recorded to provide a basis for decisions on the type and timing of ageing management actions. Data collection and record keeping form part of the individual plant programmes or processes, as a necessary base for the support of ageing management. The data collection and record keeping exist in order to provide information for the following activities:

- Identification of fabrication/manufacturing, construction and environmental conditions that could adversely affect the ageing of SSCs, including any periods of delayed construction or suspended operation;
- Identification of relevant fabrication records, such as heat treatment history and certified reports on material tests;
- Identification and evaluation of degradation, failures and malfunctions of components caused by ageing effects;

- Decisions on the type and timing of maintenance actions, including calibration, repair, refurbishment and replacement;
- Optimization of operating conditions and practices that avoid or minimize ageing effects;
- Identification of all ageing effects before they jeopardize plant safety or reduce service lives of SSCs;
- Records of configuration and modification management, maintenance, surveillance and in-service inspection results and chemistry control records.

3.8 Management of obsolescence

Technological obsolescence of the SSCs in the plant should be proactively managed through a dedicated plant programme with foresight and anticipation, and should be resolved before any associated decrease in reliability and availability occur. Obsolescence is managed through the implementation of the process defined in 331-146 (*The Obsolescence Process*).

3.9 Ageing Management Evaluation

Procedure 240-125122792 (*Koeberg Safety Aspects of Long Term Operation (SALTO) Ageing Management Evaluation Process and Revalidation of the Time Limited Ageing Analyses*) describes the process for assessing the SSCs identified for LTO evaluation, for which ageing management review (AMR) need to be performed. This is to demonstrate that ageing will be effectively managed and monitored for the planned period of LTO for the in-scope SSCs. The document further provides the process for identification and revalidation of the time limited ageing analyses (TLAAs) applicable to KNPS.

As part of the SALTO assessment project the Koeberg AMM will be reviewed for comprehensiveness based on the latest IAEA IGALL Master Table and updated as required.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
A Jakoet	Programme Engineer - Materials Reliability Group
M Matthews	Senior Advisor - Material Reliability Group
N Ryland	Manager - Materials Reliability Group Manager
S Cyster	Senior Advisor – Programmes Engineering Department

5. Revisions

Date	Rev.	Compiler	Remarks
November 2019	3	K Moroka	Full Cycle Review
May 2016	2	K Moroka	Document reviewed to correct the document title on the page header and to align with 32-4.
November 2015	1	KI Moroka	New document to describe the Ageing Management Matrix, its location and the process to be followed for updating the AMM.

6. Development Team

Not applicable

7. Acknowledgements

Not applicable