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Content

1. Introduction

This guide is based on the requirements and guidance set out in the regulatory guide RG-0027, “Ageing Management and Long Term Operations of Nuclear Power Plants”, ageing management standard 240-149139512, “Ageing management requirements for Koeberg nuclear Power Station”, and in the Institute of Nuclear Power Operations (INPO) document INPO 15-003, “Conduct of Engineering Programmes at Nuclear Power Stations”. It provides guidance to programme engineers within the Materials Reliability Group (MRG) who develop, implement, maintain, optimise, and provide programme oversight on plant programmes allocated to them.

Engineering programmes are established to:

- implement relevant regulatory requirements;
- manage ageing concerns;
- effectively manage plant efficiency and plant integrity; and
- implement safety improvements;

This is done to ensure reliability, safety and integrity of Structures, Systems and Components throughout the life of the plant including the period of Long Term Operation (LTO).

An engineering programme is a set of plant activities relating to the following:

- Understanding, preventing, detecting, monitoring and mitigating a specific ageing effect or degradation mechanism identified on Systems, Structures and Components (SSCs);
- Managing specific safety and integrity related issues; or
- Managing specific aspects of plant performance.

Plant activities required by an engineering programme include maintenance, in-service inspection, condition monitoring, testing and surveillance, visual inspections, plant walk-downs as well as controlling operational and design conditions.

Operating Experience (OE) and lessons learned from the nuclear industry as well as Nuclear Operating Unit (NOU) plant specific OE that affected or could affect plant safety or operation are reviewed for applicability and incorporated into the existing engineering programme. If no relevant programme exists, a new programme is initiated.

Properly implemented engineering programmes are an important tool in managing ageing and can be used to support managements’ objective of safely operating the plant in the future, beyond its originally intended design life.

All programmes developed should comply with relevant national nuclear regulatory requirements, if applicable, and relevant codes and standards.

2. Supporting Clauses

2.1 Scope

This document provide guidance to all programme engineers and their respective programmes.

2.1.1 Purpose

To provide generally accepted methods for developing, implementing and managing engineering programmes effectively.

2.1.2 Applicability

This document shall apply throughout Nuclear Engineering.

2.1.3 Effective date

This document is effective from the authorisation date.

2.2 Normative/Informative References

The following documents are the normative and informative references applicable to this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

2.2.1 Normative

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application.

[1] 238-6 - Nuclear document and records management requirement.

[2] 238-8 - Nuclear Safety and Quality Manual.

[3] 240-149139512: Ageing management requirements for Koeberg nuclear Power Station

[4] 240-150384693: Ageing Management Programmes List

[5] 331-2 - Nuclear Engineering Management Manual.

[6] 331-3 - Nuclear Engineering Documentation and Records Management Work Instruction.

[7] ISO 9001 Quality Management Systems

[8] RG-0027: Ageing Management and Long Term Operations of Nuclear Power Plants

2.2.2 Informative

The following documents are further sources of information cited in this document, e.g. laws, standards, codes and procedures.

[9] 240-139089079: Programme Oversight Committee (POC)

[10] 240-143604773 (KAA-709): Safety Evaluation Process

[11] 331-102: Engineering Technical Management Meeting

[12] 331-23: Processing of Industry Operating Experience in Nuclear Engineering

[13] 331-275: Process for the Development and Control of Ageing Management Matrix at KOU

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

[15] INPO 15-003: Conduct of Engineering Programmes at Nuclear Power Stations

[16] INPO IER L1-14-20, Integrated Risk – Healthy Technical Conscience

[17] EA-13-027 - Engineering Training and Authorisation Programme

[18] KAA-500: The Process for Controlled Documents

[19] KAA-690: Operability Determinations

[20] KAA-688: The Corrective Action Process

[21] KAA-826: Plant Health Committee Constitution

[22] KAD-025: Processing of Operating Experience

[23] KGA-053: Self-Assessment At Koeberg Nuclear Power Station

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

[25] NEI 14-12: Ageing Management Programme Effectiveness

2.3 Definitions

2.3.1 **Ageing**: Ageing is the process by which the physical characteristics of SSCs change with time when subjected to a specific ambient environment and operating regime.

2.3.2 **Ageing Management**: These are engineering, operations and maintenance actions performed to control ageing degradation of SSCs to within acceptable limits.

2.3.3 **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 design basis for the period of planned operation.

2.3.4 **Can**: indicates a possibility or a capability.

2.3.5 **Engineering Programme**: Is an administratively controlled and on-going set of engineering activities that implement regulatory requirements, Institute of Nuclear Power Operations (INPO) and World Association of Nuclear Operators (WANO) recommendations, industry wide and plant specific OE and best practices, as well as management requirements, in order to improve plant reliability, efficiency and safety.

2.3.6 **May**: indicates a permission.

2.3.7 **Programme Engineer**: A specific person tasked with the development, implementation, management, optimisation and oversight of a programme.

2.3.8 **Self-Assessment**: A line owned process that follows a structured approach in assessing the effectiveness of programmes, processes or performance against specific criteria and identifying areas for improvements.

2.3.9 **Shall**: indicates a requirement.

2.3.10 **Should**: indicates a recommendation.

2.3.11 **Waiver**: A written request to deviate from a specific requirement of the programme.

2.4 Abbreviations

Abbreviation	Explanation
AMP	Ageing Management Programme
AMM	Ageing Management Matrix
CAP	Corrective Action Programme
EDF	Electric de France
EPRI	Electric Power Research Institute
ETMM	Engineering Technical Management Meeting
EWR	Engineering Work Request
FROG	Framatome Reactor Owners Group
IAEA	International Atomic Energy Agency
IER	Institute of Nuclear Power Operations (INPO) Event Report
IGALL	International Generic Ageing lessons Learned
INPO	Institute of Nuclear Power Operations
KNPS	Koeberg Nuclear Power Station
LTO	Long Term Operation
MRG	Material Reliability Group
NCR	Non Conformance Report
NEPP	Nuclear Engineering Position Paper
NOU	Nuclear Operating Unit
NRC	Nuclear Regulatory Commission
OE	Operating Experience
PHC	Plant Health Committee
PHR	Programme Health Report
TRM	Technical Review Committee
POC	Programme Oversight Committee
PWR	Pressurised Water Reactor
RG	Regulatory Guide
SSCs	Systems, Structures & Components
SOER	Significant Operating Experience Report
WANO	World Association of Nuclear Operators

2.5 Roles and Responsibilities

2.5.1 Programmes Engineering Manager

The responsibilities of the Programmes Engineering Manager include the following:

- Specify high level objectives and responsibilities;
- Approve major ageing management actions;
- Assess the effectiveness of plant programmes.

2.5.2 Material Reliability Manager

The responsibilities of the Material Reliability Group Manager include the following:

- Ensure that programmes are established in accordance with appropriate regulatory, procedural and plant requirements.
- Ensure that Programme Engineers are identified, qualified and formally appointed in writing for a specific programme or programmes.
- Ensure that Programme Engineers are properly trained in accordance with Programme Training and Authorisation Programme (EA-13-027).
- Ensure that programme health is effectively monitored and improved.
- Ensure that the programme activities are not deferred without necessary approvals, adequate technical justification, and consideration of necessary contingencies.
- Facilitate the review and implementation of actions associated with industry best practice, OE, WANO SOERs and INPO Event Reports (IERs) related to engineering programmes.
- Support Programme Engineers participation in industry organisations such as International Atomic Energy Agency (IAEA), Pressurised Water Reactor (PWR) owners' group, Framatome Reactor Owners Group (FROG), Electric Power Research Institute (EPRI) committees and users' groups.
- Provide effective communication on programmes to the senior management and oversight committees, as required.

2.5.3 Programme Engineer

The Programme Engineer:

- Has the primary responsibility of developing, implementing, managing and providing oversight for the identified engineering programme(s) in accordance with applicable industry codes and standards, regulatory requirements and OE.
- Is the primary advocate for the overall health of their assigned programmes and ensures issues are raised and understood by the appropriate level of management.
- Reviews operating experience, scientific or subject literature from industry, academia, laboratories, and professional research bodies, which have performed similar work or developed related programmes.
- Participates in meetings, industry working groups or conferences to plan co-operative activities and to devise concerted approaches to problems.
- Shares the responsibility of reporting equipment failures and lessons learnt from events or conditions that are important to nuclear, public and personnel safety and plant reliability.
- Reviews inputs provided by the various line groups (who provide a service to the Programme Engineer in the form of written recommendations, reports, test data and research data) for their validity.
- Interact with the regulatory authorities on programme related issues.
- Performed programme related activities as stipulated in this guide.

- Review changes to the EDF, WANO, INPO, EPRI and IGALL AMPs and the IGALL Master Table provided in the latest IAEA Safety Reports Series No. 82, “Ageing Management for Nuclear Power Plants - International Generic Ageing Lessons Learned (IGALL)”.
- Provide technical guidance to the plant design modification group for changes that will impact the equipment under the programme scope.
- Ensure that all changes to a programme undergo a proper review by relevant responsible groups to assess the impact on these groups.
- Compile waivers, deferments and justifications, when a deviation to the specific programme is unavoidable.

The aforementioned responsibilities are in line with the key responsibilities of the programme engineer as detailed in the Institute of Nuclear Power Operators (INPO) document INPO 15-003, “Conduct of Engineering Programmes at Nuclear Power Stations”.

2.6 Process for Monitoring

The development, implementation and the effectiveness of the programmes and impact on the plant safety and reliability are continuously monitored by the programme engineer and the following oversight committees.

2.6.1 Programme Oversight Committee (POC)

The Programme Oversight Committee (POC) has been established as a sub-committee of the Plant Health Committee (PHC) in accordance with KAA-826, “Plant Health Committee Constitution”.

In accordance with the POC term of reference 240-139089079, “Programme Oversight Committee (POC)”, POC provides management oversight (including driving sustainable excellence in order to enhance equipment and material reliability and plant performance, effectively managing plant efficiency and ensuring the long term operation and integrity of the plant; and ensuring monitoring of the Programme Health and Key Performance Indicators (KPIs)) of the existing engineering programmes (including future and under-development) programmes.

The POC manages oversight and:

- Ensure that the necessary priority is placed on all aspects of the existing programmes to ensure plant integrity, availability and reliability and drive programme performance processes.
- Support the effective implementation of engineering/maintenance programmes, which requires an integrated and co-ordinated approach from a cross-functional NOU team.
- Monitor the progress of the implementation of new and revised programmes, and address any delays or constraints.
- Direct the establishment of integrated cross-functional teams to address programmatic issues and ensure communication between cross-functional NOU organisations, in support of plant integrity and reliability.
- Monitor programme progress as reported by the Materials Reliability Group Manager and Reliability Engineering Group (RE) Manager to generate an understanding of the overall

programme health and to pro-actively identify gaps in performance and prioritise actions for resolution.

- Ensure that the activities and management of engineering/maintenance programmes are carried out in compliance with established regulations, rules and policies, and that allocated resources are managed economically, effectively, and efficiently through the provision of an independent, objective and professional appraisal.
- Provide periodic feedback to the NOU senior management and the Plant Health Committee (PHC) and assurances on the timely, efficient and effective achievement of results through objective and independent programme evaluations, programme implementation monitoring and performance assessment.

2.6.2 Engineering Programmes Technical Review Meeting

The Engineering Programmes Technical Review Meeting (TRM) provides direction, support and continuous technical management oversight pertaining to engineering programmes, programme health reports and significant technical matters the Programmes Engineering (PE) Department is tasked with.

The decision whether a new programme is required or the need for new programmes will be presented by a Programme Engineer for endorsement to TRM with clear description of the new programme basis, regulatory/licensing requirements, programme driver(s), objectives, scope, level, safety, reliability impact and value, and external requirements.

TRM endorses the action plans and timeliness for programme development and implementation and also actions stipulated in the Nuclear Engineering Position Papers (NEPPs).

3. Engineering Programmes

Engineering Programmes (*also referred to as Ageing Management Programmes (AMPs) or Plant Programmes*) at nuclear power facilities are established to implement regulatory requirements or were based on industry operating experience, where similar equipment issues were identified that affected or could affect plant safety or operation.

Programmes specific to ageing effects and degradation mechanisms associated with structure, system or component (SSCs) should be developed. Appropriate acceptance criteria for the inspection and monitoring of ageing effects should be established for ageing management programmes and should be based on the design basis or on the technical requirements for the SSCs,, and the relevant regulatory requirements, codes and standards, so that a corrective action can be implemented sufficiently before loss of the intended function(s) of the SSC. The need for sufficient margins should be taken into account in these acceptance criteria [4].

Particular attention should be paid when developing programmes to ensure that the programme has in place provisions to prevent, detect, evaluate and mitigate the ageing effects of anticipated degradation mechanisms, based on the findings from the ageing management review. This includes timely replacement of a component that cannot be maintained but needs to be replaced.

Programmes should be implemented in a timely manner to ensure that the intended functions of SSCs continue to be performed.

Effective engineering programmes should not only comply with the nine attributes as defined in Appendix A) but also take into consideration to the following:

- Compliance with regulatory requirements and plant specific requirement;
- Collect and recorded appropriate data;
- Maintain the prescribed programme documentation;
- Health Reporting;
- Timelines for the development and implementation of programmes;
- Review and improvement of existing programmes;
- Evaluation of relevant operating experience;
- Links to the Ageing Management Matrix;
- Technical Conscience.

These requirements are discussed below.

3.1 Attributes of an effective programme

In accordance with the RG-0027, each programme should be consistent with the generic attributes of an effective ageing management programme, as listed in Appendix A of the document.

In accordance with RG-0027, existing plant programmes should be consistent with the nine attributes (Appendix A) to determine whether they are effective in detecting, monitoring and preventing or mitigating ageing effects and degradation mechanisms in the structures or components for which the programme is credited. If a programme is of such a nature that it does not meet all nine attributes, its use should be properly justified and documented.

3.2 Ageing Management Requirements at Koeberg

The ageing management (AM) standard, 240-14913951, has been developed to provide overall requirements for the ageing management of safety related equipment. The standard provides the requirements and the framework for physical ageing management processes at Koeberg Nuclear Power Station for the life of the plant, including LTO. It covers all stages of equipment life of the plant i.e. design, construction, manufacturing, commissioning, operating, LTO, suspended operation and decommissioning.

The document 331-275, “Process for the development and control of ageing management at Koeberg Operating Unit”, describes the process used to develop, control, and update the Koeberg Ageing Management Matrix (AMM), including the roles and responsibilities for updating of the information contained therein. The document further describes AMM oversight roles and how to correct ageing aspects that requires improved management. 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 Long Term Operation (LTO).

The existing programmes (including plant processes) that are essential to ageing management and evaluations for long term operation are listed in document 240-150384693, “Ageing Management Programmes List”.

3.3 Appropriate data to be collected and recorded

As part of the implementation of the programmes, appropriate data should be collected and recorded to provide a basis for decisions on the type and timing of ageing management actions [8].

This includes but is not limited to:

- Identification of fabrication, 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 the service lives of SSCs;
- Records of configuration and modification management;
- Maintenance, surveillance and in-service inspection results;
- Chemistry control records.

3.4 Programme Documentation

Engineering programmes would typically have the following controlling documentation as described either by the licensing basis, the regulatory authority, regulations or station processes:

- Standard - prescribing the requirements for the Programme, including reporting.
- Administrative Procedure - describing the process and responsibilities for the Programme.
- Programme Manual - providing the technical basis and specific requirements for the programme, including acceptance criteria.
- Working level implementation documents.

Note: Not all programmes will have the entire suite of controlling documents as given above.

Some programmes consist of the Programme Manual, which should then include the applicable attributes, objectives, scope and main requirements, technical basis, acceptance criteria, references, responsibilities, process descriptions, and requirements. These programmes should reference the AM standard as the higher tier document.

In the case of the obsolescence management, the process document 331-146, “Obsolescence Management Programme’ is used as the controlling document. According to RG-0027, the technological obsolescence programme should be consistent with the nine attributes.

Detailed implementation procedures that describe preventive and mitigating actions, monitoring or inspection and assessment actions, acceptance criteria, and corrective actions should be established and shared among the different units of the nuclear power plant (e.g. operations, maintenance and engineering units) that are responsible for implementing ageing management programmes[8].

3.5 Programme Health Reporting

Programme Health Reports (PHRs) are an efficient means to convey the overall condition of a programme to all levels of management. The reports convey immediate and long-term issues that could impact programme health, emerging industry and regulatory issues, equipment trends and personnel issues.

PHRs can be used as a measurement of the general effectiveness of site programmes and processes to maintain and improve plant safety, integrity, material condition and equipment reliability.

3.5.1 Reporting Frequency

The PHRs are compiled by the programme engineers and evaluated against the nine attributes. The PHRs are typically updated on a frequency that is reflective of programme health performance. The frequency of reporting is as follows:

- On a six monthly or one yearly basis for all programmes.
- At intervals determined by the Materials Reliability Manager and oversight bodies for specific programmes based on the health colour and those requiring additional attention, urgent action and management focus, i.e. Red and yellow rated programmes.

3.5.2 Compilation of the PHRs

The milestones and timeframes for the compilation of the PHR are as follows:

- Compilation: Compiled by the Programme Engineer covering the programme health assessment for the previous 6 months or 12 months.
- Review: PHR is internally reviewed by other Programmes Engineers with sufficient knowledge of the specific programme.
- Management Oversight: Programmes to be presented within one (1) month after the compilation of the report to TRM.
- Finalisation: The MRG manager finalises and issues the PHR taking into account comments from the TRM.
- Within one (1) month after the PHR is authorised, any significant issues, such as drivers for Red and Yellow programmes, are presented to the POC to ensure that they are receiving the appropriate level of management review.

3.5.3 Programme Health Report Structure

In the PHR, Programme Engineers evaluate the status of a programme against the nine attributes of an effective AMP as provided in Appendix A and relevant health indicators as detailed in Appendix C.

As part of the report, Programme Engineers:

- Report on any changes to the programme requirements
- Investigate abnormal operating conditions thoroughly and evaluate potential impact both individually and in the aggregate.
- Analyse deviations, including equipment availability and reliability impacts.
- Examine physical conditions or use the results of testing to validate evaluation inputs and assumptions for design changes, plant conditions and equipment performance where possible.
- Engage plant and maintenance personnel to fully understand equipment condition and performance issues, the operational impact of those issues, and programme effectiveness.
- Proactively identify, evaluate and address design vulnerabilities through modifications, maintenance, or other compensating measures to restore or improve design and operating margins.
- Communicate plant design requirements and bases, including design and operating margins, design codes, models and safety analyses, emerging technical issues, related potential risks as well as respective limitations, to management.
- Maintain technical programmes with current industry best practices and OE.
- Perform thorough, critical reviews of work performed by external organisations to verify that all requirements are met, risks are identified, and necessary compensatory or contingency actions are implemented.

3.5.4 Performance Indicators

Performance indicators are parameters used to monitor the performance and gain insight into the effectiveness of a programme. Performance indicators focus both on process implementation performance and equipment performance. The indicators should be considered when compile a programme health report and when assessment the effectiveness of the programme.

Existing programmes are evaluated for continued consistency with the nine attributes to determine if they are effective in detecting, monitoring and preventing or mitigating ageing effects and degradation mechanisms in the structures or components for which the programme is credited.

If an existing ageing management programme or another plant programme is not sufficiently effective, then the existing programme is improved or modified or a new programme is developed, consistent with the nine attributes.

Appendix C provides a list of typical programme health or performance indicators based on the guidance from Nuclear Energy Institute (NEI) document NEI-14-12, “Ageing Management Programme Effectiveness”. The list is not exhaustive and individual programmes may have different indicators depending on the nature of the programme and its basis.

3.5.5 Programme Health Colours

The assessed colour is an indication of the status of the programme attribute or specific key indicators.

In accordance with Appendix B of this document, each attribute or indicator is colour rated as *Green, White, Yellow, or Red* and contributes to the overall programme health report colour rating.

Programme engineer should use the most appropriate method to obtain insight into the status of the various programme elements. The assessed colour is an indication of the status of the programme element.

3.5.6 Action plans

Action plans are developed for White, Yellow and Red rated programmes in order to improve the overall programme health, and managed by the assigned Programme Engineer.

3.6 Timelines for the development and implementation of programmes

3.6.1 Development of new programmes

The guidelines for the development of programme requirements are provided below:

- The timelines for the development of a new programme is twelve (12) months or as determined by TRM. This does not include implementation of the programme requirements.
- The action plan to track the development of a new programme should be developed and presented to TRM for endorsement and tracking.
- The Programme Engineer will provide the progress and status of the programme every six months or as required by the MRG manager or to the relevant oversight committee.
- Programme under development will not be reported in the PHR.

3.6.2 Implementation of new programmes

The guidelines for the implementation of new programme are provided below:

- Programme should be presented to POC to facilitate implementation.
- A roll-out plan will then be developed by the implementation department/groups/section within six (6) months after the programme requirements have been issued.
- Overall progress of new programmes will be reported and tracked by the POC.
- A line implementation counterpart or I&T implementation engineers allocated to facilitate implementation.

Note: There may be programmes that follow a defined timeline in accordance with the regulatory requirements.

3.7 Review and improvement of existing programmes

The effectiveness of existing programmes should be periodically evaluated in the light of current knowledge and feedback from the programme and the performance indicators and should be updated and adjusted as appropriate. Relevant knowledge includes information on the operation of the structure or component, surveillance and maintenance histories, information from the results of research and development, and operating experience from other nuclear facilities.

In accordance with SSG-48, to evaluate the effectiveness of the programmes, performance indicators should be developed and used by the operating organization. Examples of such performance indicators are:

- Material condition with respect to acceptance criteria;
- Trends of data relating to failure and degradation;
- Percentage of recurrent ageing driven failures and instances of degradation;
- Status of compliance with inspection programmes;
- Newly discovered ageing effects and degradation mechanisms;
- Newly developed ageing management programmes.

Appendix C of this document provides additional examples of performance indicators based on NEI 14-12, “Ageing Management Programme Effectiveness”.

Periodic assessments, such as programme health reports and focused self-assessments, can contribute to a basis for determining when programme may need adjustment.

The PHR is used as a tool not only to assess the health of the programme, but also to evaluate the effectiveness of the programme requirements.

Self-assessments should be performed in accordance with KGA-053, “Self-Assessment at Koeberg Nuclear Power Station”, at a frequency not exceeding 5 years. Self–assessment frequencies would be adjusted depending on the programme health colour or as required by TRM. Programme strengths and weaknesses are documented in accordance with existing procedures. Deficiencies that may be indicative of ineffectiveness associated with an AMP element are addressed using the corrective action programme.

Existing programmes should be continuously reviewed and the following improvements perform as required:

- Modification of frequencies for maintenance and inspection programmes;
- Introduction of better environment and material control;
- Setting up new research and development programmes;
- Implementation of enhanced inspection or monitoring techniques.

3.8 Evaluation of relevant operating experience

Evaluation of relevant operating experience (OE) and research and development programmes should be continuously performed to support better understanding of degradation mechanisms and their ageing effects. Relevant plant and industry OE should be continuously collected and evaluated and should be used for improving the plant programmes and the inspection requirements [12][20][22].

If a new ageing effect or degradation mechanism is discovered (e.g. through feedback of operating experience or research and development), ageing management review should be performed and additional ageing management should be implemented as necessary [24].

Relevant OE includes information on the operation of the SSCs, surveillance and maintenance histories, information from the results of research and development, and OE from other nuclear facilities.

Inputs and OE for periodic review and continuous improvement of programmes include:

- IAEA IGALL information updates;
- EDF OE;
- Relevant plant specific and industry operating experience;
- Structure or component level, system level and plant level performance indicators;
- Relevant results from research and development;
- Periodic review of the effectiveness of programmes;
- Structure or component failure rate;
- Number of non-conformities of structures or components;
- Structure or component level, system level and plant level performance indicators;
- Benchmarking with practices and performance of other similar plants.

3.9 Ageing Management Matrix

The Koeberg Ageing Management Matrix' (AMM), 240-101650256, is used to identify the ageing mechanisms and the SSCs that are affected by ageing mechanisms or degradations that can impact equipment life or capability. The AMM is based on the Électricité de France (EDF) Ageing Matrix. The underlying assumption for the initial version of the AMM was that the ageing concerns of EDF and Koeberg are similar enough to adopt the EDF ageing matrix for Koeberg.

The AMM links the plant programmes and other plant processes, which are already in place and active, to address the identified ageing mechanisms. The AMM intends to ensure that all engineering or plant programmes are comprehensive and address all known.

3.10 Technical Conscience

In accordance with INPO-15-003, when programme reviews identify conditions or concerns that potentially reduce operating, design or safety margins, organizations with an effective technical conscience take action to thoroughly identify the cause, evaluate issue significance, correct the condition and restore margins commensurate with its safety significance. Many important industry events were caused, in part, by insufficient technical reviews of plant conditions, technically incorrect plant design changes, or improper justification and acceptance of degraded or questionable conditions. Also contributing to events has been weak regard for technical considerations by individuals or organisations at large when making operational, maintenance and technical decisions.

In April 2014, INPO issued report L1-14-20, "Integrated Risk – Healthy Technical Conscience". All managers and programme engineers should be familiar with this IER and how their programmes

can impact plant safety an operational risk. Enterprise risk is best defined as high consequence, low probability, station operational and project risks that could affect the viability of the unit.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
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R Cassim	Manager - Materials Reliability Group
C Stolle	Chief Technologist – Programmes Engineering
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5. Revisions

Date	Rev.	Compiler	Remarks
February 2021	3	K Moroka	Document updated to address GA 39998 and to make reference to the POC TOR 204-139089079 as an oversight committee. (All references to PHC-S must be revised). Requirements of RG-0027 and the Ageing Management Standard were taken into consideration during the review of this document.
November 2018	2	K Moroka	Document updated to align the Programme health colours with the INPO colours used for System health Report at Koeberg. To address CR 99057-002 CA and CR 99057-002 CA.

Date	Rev.	Compiler	Remarks
January 2017	1	K Moroka A Jakoet	Complete review to align with the nine attributes of an effective Ageing Management Programme in line with the IAEA Safety Reports Series No. 82. To include some aspects of engineering programmes in accordance with INPO-15-003.
April 2013	0	A Kotze	Complete update to adapt the programme process to align with new Nuclear Engineering responsibilities.
	0	A Kotze	New guide developed to provide guidance to Programme Owners.

Appendix A: Generic Attributes of an Effective Ageing Management Programme (*Source: RG-0027 Annexure A*)

Attribute	Description
1. Scope of the ageing management programme based on understanding ageing	• Structures (including structural elements) and components subject to ageing management. • Understanding of ageing phenomena (significant degradation mechanisms, susceptible sites): ∗ Structure or component materials, service conditions, stressors, degradation sites, degradation mechanisms and ageing effects. ∗ Structure or component condition indicators and acceptance criteria. Quantitative or qualitative predictive models of relevant ageing phenomena.
2. Preventive actions to minimise and control ageing effects	• Specification of preventive actions. Determination of service conditions (i.e. environmental conditions and operating conditions) to be maintained and operating practices aimed at precluding potential degradation of the structure or component.
3. Detection of ageing effects	• Specification of parameters to be monitored or inspected. Effective technology (inspection, testing and monitoring methods) for detecting ageing effects before failure of the structure or component.
4. Monitoring and trending of ageing effects	• Operations, maintenance, repair and replacement actions to mitigate detected ageing effects and/or degradation of the structure or component.

Attribute	Description
5. Mitigating ageing effects	• Condition indicators and parameters monitored. • Data collected to facilitate assessment of structure or component ageing. Assessment methods (including data analysis and trending).
6. Acceptance criteria	Acceptance criteria against which the need for corrective actions is evaluated.
7. Corrective actions	Corrective actions if a structure or component fails to meet the acceptance criteria.
8. Operating experience and feedback of research and development results	Mechanism that ensures timely feedback of operating experience and research and development results (if applicable), and provides objective evidence that they are taken into account in the ageing management programme.
9. Quality management	• Administrative controls that document the implementation of the ageing management programme and actions taken. • Indicators to facilitate evaluation and improvement of the ageing management programme. • Confirmation (verification) process for ensuring that preventive actions are adequate and appropriate and that all corrective actions have been completed and are effective. Record keeping practices to be followed.

Appendix B: Programme Health Determination and Colour Definitions

Indicator Colours	Health Percentage	Status	Description of performance indicators and potential action
Green	> 90%	Acceptable	• Programme performance is meeting defined processes, with only minor improvements being pursued. AND • Key Performance Indicators identify programme as GREEN • To be reported to the TRM at the discretion of the Manager • **Note:** *Oversight may be reduced*
White	75% to 90%	Monitor / Largely Satisfied	• Programme does not fall into any of the RED or YELLOW criteria AND • Programme performance is meeting defined processes, but improvement in the process can be made in light of such factors as OE lessons learned AND • No significant programme issues for the quarter AND • No regulatory or budget risks are foreseen AND • Key Performance Indicators identify programme as White • To be reported to the TRM at the discretion of the responsible Manager • ***Note:*** *Areas for improvement to be identified*
Yellow	60% to 74%	Degraded / Partially Satisfied	• Programme performance is not meeting defined processes but causes or fixes are identified. OR • Has some unresolved self-assessment or corrective action findings that have minor potential regulatory or minor financial risk. OR • Have experienced a significant problem or a small number of programme issues (e.g., late corrective action completion) OR • Better programme implementation could have prevented significant lost generation. OR • Programme performance not meeting management expectations. OR • Key Performance Indicators identify programme as YELLOW • To be reported to the TRM on a six-monthly basis once the PHR is issued • ***Note:*** *Additional attention required*

Indicator Colours	Health Percentage	Status	Description of performance indicators and potential action
Red	< 60%	Unacceptable	• Programme performance is not meeting defined processes and causes or fixes are not identified. OR • Have numerous unresolved self-assessments or corrective action findings that have potential regulatory or substantial financial risk. OR • A recurring significant programme problem exists. OR • Contributor to maintenance goals not being met. OR • Programme performance is consistently not meeting management expectations. OR • Key Performance Indicators identify programme as RED • To be reported to the TRM on a six-monthly basis once the PHR is issued • ***Note:*** *Require significant attention, urgent action & management focus*

Appendix C: Typical Key Performance Indicators (*Source: NEI 14-12)*

Attribute	Typical Performance Criteria/Indicator
1. Scope of the ageing management programme based on understanding ageing	• Scope is consistent with the regulatory requirements and applicable Codes and Standards. • In scope SSCs properly identified and documented. • Procedures and work orders contain appropriate components. • For programmes that require sample selection, the sample bases are properly justified and documented. • Implementing procedures and work orders are clearly tied to commitments. • Additions or deletions to programme scope are properly addressed.
2. Preventive actions to minimise and control ageing effects	• Identified programme enhancements are instituted in implementing procedures. • Specific commitments should be verified to be in place (and changes, if any, approved per commitment management procedures). • Implementing activities are completed as scheduled and not deferred without adequate technical justification. • Preventive measures are appropriate for the applicable degradation mechanisms. • Engineering requirements established and documented. • Maintenance interventions and programme tasks performed successfully.
3. Detection of ageing effects	• Implementing procedures identify parameters the programme monitors. • Parameters monitored should be those being controlled to achieve prevention or mitigation of ageing effects. • When evidence of an ageing effect or mechanism is observed, document the extent of the condition. • Service notifications generated for requirements. • M&TE and inspection tools available. • Working procedures developed and authorised. • Resources and skills requirements developed and

Attribute	Typical Performance Criteria/Indicator
	implemented. • Required Training for maintenance personnel/I&T completed. • Maintenance interventions and programme tasks scheduled. • Required Inspection / Testing/Monitoring performed as planned. • Outage Scope deferrals issued. • Significant findings from inspections reported and addressed.
4. Monitoring and trending of ageing effects	• Inspections and examinations are conducted at appropriate intervals. • Ageing effects are identified and actions are implemented before loss of intended function. • Samples are biased toward locations most susceptible to ageing effect of concern and sample size is expanded when degradation is detected in the initial sample. • Unexpected results are evaluated and programme adjustments are made as warranted. • Operating experience is considered in evaluating the appropriateness of technique and frequency and adoption of new (enhanced) techniques as they become available. • Trends developed and adverse trends evaluated.
5. Mitigating ageing effects	• Ageing effects are monitored and trended such that no loss of intended function occurs. • Results are used to establish a rate of degradation in order to confirm that timing of the next scheduled inspection will occur before a loss of intended function. • Inspection frequencies are adjusted when warranted. • Any medication repair and replacements performed evaluated for impact.
6. Acceptance criteria	• Defect description and criteria developed and documented. • Implementing procedures contain acceptance criteria for each parameter monitored or inspected. • Acceptance criteria should anticipate rates of change and

Attribute	Typical Performance Criteria/Indicator
	margin to loss of function. • Unexpected or new ageing mechanisms trigger actions to address extent of condition. • Waiver/exemption process initiated. • Technical deficiency raised, i.e. NCR/EWRs. • Engineering assessment/justification performed. • Appropriate corrective action identified.
7. Corrective actions	• Condition reports are generated when programme results fail to meet acceptance criteria and upon detection of unexpected significant ageing degradation. • Cause evaluations are performed per station procedures. • Appropriate extent of condition is applied. • Prediction of the extent of degradation is used to effect timely preventive actions. • Additional preventive actions, monitoring and inspections are stipulated and instituted as necessary. • Programme waiver/exemption process developed and documented. • Results and history properly recorded and available. • Results and history archived. • Results / History / Anomalies reported to Engineering.
8. Operating experience and feedback of research and development results	• Industry operating experience is evaluated and programme adjustments are made as necessary. • Plant-specific operating experience is used to adjust programme as necessary. • Reporting requirements and feedback loop specified and documented. • Review changes to legislative/regulatory/codes/standard changes. • Review Plant condition, trends and local OE feedback.
9. Quality management	• Evaluations are conducted when unexpected conditions of significant ageing effects are discovered. The evaluations should address the expected conditions, rates, future inspections, and consideration of the impact on intended

Attribute	Typical Performance Criteria/Indicator
	functions. • Self-assessments are conducted and programme improvements instituted as necessary. • Recommendations or deficiencies from external assessments should be addressed. • Recommendations or deficiencies from external assessments are being addressed. • Commitments are managed in accordance with site procedures. • Changes in commitments should be flagged and administrative controls employed. • Appropriate documentation is verified in accordance with existing procedures. • Programme documentation kept current.