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SENIOR TECHNOLOGIST	MANAGER RELIABILITY ENGINEERING	POWER STATION GENERAL MANAGER
DATE 2020-10-16	**DATE** 2020-10-19	**DATE** 2020-10-22

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PAGE STATUS INDEX

	REVISION							
Page	1							
1	x							
2	x							
3	x							
4	x							
5	x							
6	x							
7	x							
8	x							
9	x							
10	x							
11	x							
12	x							
13	x							
14	x							
15	x							
16	x							
17	x							
18	x							
19	x							
20	x							
21	x							
22	x							
23	x							
24	x							
END								

	REVISION							
Page								

CONTENTS **PAGE**

1.0 PURPOSE

1.1 To establish the approach to equipment reliability and to define the requirements for the development, implementation and control of the Integrated Equipment Reliability Process for the Nuclear Operating Unit, in order to maintain high levels of safe and reliable plant operation, in an efficient manner.

2.0 SCOPE

2.1 Applicable to the reliability management of all plant equipment except for structures, piping and certain components or specific degradation mechanisms where materials reliability is adequately managed by other programmes. These items are excluded from the equipment reliability process at a high level, but may share common process elements e.g. work control and life of plant planning. Non-plant equipment is also excluded.

2.2 The equipment reliability process represents the integration and co-ordination of a broad range of equipment reliability elements into one process.

2.3 This integration enables plant personnel to identify and evaluate important plant equipment, develop and implement long-term equipment health plans, monitor equipment performance and condition, and develop and make continuing adjustments to the preventive maintenance programme requirements (tasks and periodicities) based on equipment performance and operating experience.

2.4 Equipment reliability incorporates and links activities associated with plant elements such as preventive maintenance, surveillance and testing, inspection, life cycle management, equipment performance and condition monitoring.

3.0 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

3.1.1 **Acceptance Criteria** – Specified limit of a functional or condition indicator used to assess the ability of equipment to perform its design function.

3.1.2 **Activity** – Any work performed in the maintenance, inspection or testing of equipment.

3.1.3 **Bridging Strategy** – A plan developed to mitigate the risk to the safe and reliable operation of the station, while an equipment issue is being resolved. Identified risk mitigation actions will be in place until the permanent resolution is implemented.

3.1.4 **Component** – Any item of equipment whose position on the plant is uniquely identified by a trigramme (unit identifier, system-trigramme, numerical identifier and bigramme).

3.1.5 **Condition Monitoring Activity** – An activity aimed at detecting the onset of a failure or failure symptom.

3.1.6 **Controlled Document** – A document that is prepared, reviewed and authorised as defined by regulatory requirements, codes and standards and that is uniquely identified and maintained accurate and current by means of a change control process.

3.1.7 **Corrective Maintenance** – Actions that restore by repair, overhaul, or renewal, the capability of a failed component to function within acceptance criteria.

3.1.8 **Critical (ER Classification Category)** – Critical components are those that can affect nuclear safety, plant reliability or power generation and therefore every effort must be made to maximise the reliability of these components. These components will have the most aggressive PM Strategies.

3.1.9 **Deferred PM Task** – A preventive maintenance task that will exceed its original planned date (last date of grace) with an approved engineering evaluation that determines the acceptability for extension to a new due date before original late date (last date of grace) is exceeded.

3.1.10 **Delinquent PM Task** (**PM Non-Compliance)** – A preventive maintenance task that exceeds late date (last date of grace) without a sufficient technical basis.

3.1.11 **Duty Cycle** – The intensity at which the equipment is operated (operating mode, operating hours per time interval, starts/actuations/cycles per time interval).

3.1.12 **Economic (ER Classification Category)** – Economic components are those that will be considered for cost effective preventive maintenance, in order to preserve their integrity and extend their useful life. A cost effective effort should be made to maximise the reliability of these components.

3.1.13 **ER Classification** – Component ER Classification is a structured approach to evaluate the functional importance of each component within a system and forms part of the Integrated Equipment Reliability Process.

3.1.14 **Failure** – Inability or interruption of the ability of a System or Component to function within acceptance criteria.

3.1.15 **Failure Evaluation** – Systematic process of determining and documenting the mode, mechanism, causes, and apparent cause of failure of equipment.

3.1.16 **Failure Finding Activity** – An activity aimed at discovering a hidden failure before an operational demand.

3.1.17 **First Performance Date** – The date of first execution of a new PM Task (First-Time Task) or the date of first execution following the revision of a pre-existing PM Task (start date).

3.1.18 **Grace Period PM Task –** Any preventive maintenance task that is to be performed beyond its original due date (planned date) but before late date (last date of grace) of that activity. Normally, this period (due date to late date) is an additional 25 percent of the original schedule interval for the PM task. No engineering evaluation is required. This grace period is provided as a reasonable flexibility to allow for alignment with surveillance activities and functional equipment grouping and to better manage station resources use. Preventive maintenance tasks are expected to be scheduled based on their due dates (planned dates).

3.1.19 **Life Cycle Management (LCM)** – The integration of ageing management and economic planning to optimise the operation, maintenance, and service life of equipment; maintain an acceptable level of performance and safety; and maximise return on investment over the service life of the plant.

3.1.20 **Maintenance** – Aggregate of direct and supporting actions that detect, preclude, or mitigate degradation of a functioning System or Component, or restore to an acceptable level the design functions of a failed System or Component.

3.1.21 **PM Basis** – The technical basis for the preventive maintenance regime applied to a specific plant system or component. The association of the component ER Classification with the relevant PM Template, influenced by the component specific OE, results in the PM Strategy, and collectively forms the PM Basis.

3.1.22 **PM Deferral** – A formal application, supported by an engineering justification and authorised by station management, to postpone a Preventive Maintenance Programme activity.

3.1.23 **PM Grace Period** – The allowable activity float expressed as a percentage of the task interval, which if exceeded constitutes a PM Non-compliance.

3.1.24 **PM Strategy** – The PM Strategy identifies and justifies the PM Programme on a component level. It includes the required PM Tasks and details, their respective task intervals, implementation recommendations, a justification for PM Template deviations and selected tasks, and PM Basis supporting information. The association of the component ER Classification with the relevant PM Template, influenced by the component specific OE, results in the PM Strategy.

3.1.25 **PM Task** – A distinct maintenance activity that may require participation by one or more disciplines or groups, performed on one or more components at pre-determined intervals.

3.1.26 **PM Template** – A PM Template is a pre-defined maintenance approach for a particular component type (or family of components) that lists significant failure modes, failure causes and recommended PM tasks and task intervals. PM Templates provide the foundation of the preventive maintenance programme by supporting the PM Strategy.

3.1.27 **Post-Maintenance Testing** – Testing after maintenance to verify that maintenance was performed correctly and that the equipment can function within acceptance criteria.

3.1.28 **Preventive Maintenance** – Actions that either detect, preclude or mitigate degradation of a functional system or component, to sustain or extend its useful life by controlling degradation and failures to an acceptable level.

3.1.29 **Reliability Centred Maintenance (RCM)** – A process used to determine the maintenance requirements of any physical asset, in its operating context.

3.1.30 **Root Cause** – Fundamental reason(s) for an observed condition of an item of equipment that, if corrected, prevents recurrence of the condition.

3.1.31 **Run-to-Maintenance (ER Classification Category)** – RTM components are those where the risks and consequences of failure are acceptable without any preventive maintenance being performed. There is also no simple cost effective method to extend the useful life of the component. These components are run until corrective maintenance is required.

3.1.32 **Service Conditions** – All actual physical states or influences (environmental, functional and operating conditions) that affect an item during its service life.

3.1.33 **Significant (ER Classification Category)** – Significant components are those that can affect personnel, industrial, environmental or radiological safety, plant reliability, power generation or may lead to regulatory or insurance consequences. Substantial effort must be made to maximise the reliability of these components.

3.1.34 **Single Point Vulnerability** – A single component whose failure will result in an immediate automatic reactor trip, or an immediate production loss of greater than 20% power (components with an ER Classification of ‘Critical’, where the C1 or C2 criteria are met).

3.1.35 **System** – A collection of components identified by the same three-letter code (system-trigramme) performing a function or part thereof.

3.1.36 **Time Directed Activity** – An activity aimed directly at failure prevention or retardation.

3.2 Abbreviations

3.2.1 **AR** – Availability Related

3.2.2 **BDBA** – Beyond-Design-Base Accident

3.2.3 **CR** – Condition Report

3.2.4 **CSR** – Critical Safety Related

3.2.5 **EDF** – Electricité de France

3.2.6 **EPRI** – Electric Power Research Institute

3.2.7 **ER** – Equipment Reliability

3.2.8 **FMEA** – Failure Mode and Effects Analysis

3.2.9 **INPO** – Institute of Nuclear Power Operations

3.2.10 **LCM** – Life Cycle Management

3.2.11 **LOPP** – Life of Plant Plan

3.2.12 **NNR** – National Nuclear Regulator

3.2.13 **NOU** – Nuclear Operating Unit

3.2.14 **OE** – Operating Experience

3.2.15 **OEM** – Original Equipment Manufacturer

3.2.16 **OTS** – Operating Technical Specifications

3.2.17 **PHC** – Plant Health Committee

3.2.18 **PM** – Preventive Maintenance

3.2.19 **PSA** – Probabilistic Safety Assessment

3.2.20 **RCM** – Reliability Centred Maintenance

3.2.21 **RTM** – Run-to-Maintenance

3.2.22 **SAR** – Safety Analysis Report

3.2.23 **SPV** – Single Point Vulnerability

3.2.24 **SR** – Safety Related

3.2.25 **TD & RM** – Technical Documentation and Records Management

3.2.26 **WANO** – World Association of Nuclear Operators

4.0 REFERENCES

4.1 Referenced Documents

4.1.1 335-2, Rev 5: Koeberg Nuclear Power Station Management Manual

4.1.2 36-197, Rev 2: Koeberg Licencing Basis Manual

4.1.3 AP-913, Rev 6: INPO Equipment Reliability Process Description

4.1.4 AP-928, Rev 5: INPO Online Work Management Process Description

4.1.5 KAA-500, Rev 13: The Process for Controlled Documents

4.1.6 KAA-913, Rev 1: Integrated Equipment Reliability Process

4.1.7 KSA-011, Rev 14: The Requirements for Controlled Documents

4.1.8 KSM-LIC-001, Rev 2: Requirements for the Control of Maintenance

4.1.9 LD-1023, Rev 4: Quality Management Requirements for Koeberg Power Station

4.1.10 LD-1091, Rev 3: Requirements for Licences of Nuclear Installations regarding Risk Assessment and Compliance with the Safety Criteria of the NNR

4.1.11 NS-G-2.6: IAEA Safety Standards Series - Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants

4.1.12 RD-0034, Rev 0: Quality and Safety Management Requirements for Nuclear Installations

4.1.13 Reliability-centred Maintenance, Anthony M. Smith, McGraw-Hill Inc., 1993

4.1.14 Reliability-centred Maintenance, John Moubray, Butterworth Heineman, 1997

4.1.15 RG-0027, Rev 0: Interim Regulatory Guide – Ageing Management and Long Term Operations of Nuclear Power Plants

4.1.16 SAR, Rev 4: Koeberg Safety Analysis Report

4.1.17 SSG-48: IAEA Safety Standards Series - Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants

4.1.18 TR-100844: EPRI Nuclear Power Plant Common Ageing Terminology

4.1.19 WANO 2019-1: WANO Performance Objectives and Criteria (PO&C)

4.2 Applicable Documents

4.2.1 331-94: Importance Category Classification Listing (previously KLA-001)

5.0 REQUIREMENTS

5.1 General

5.1.1 The performance objectives of the Integrated Equipment Reliability Process shall be as follows:

- Equipment performs reliably throughout the operating cycle.
- Stand-by safety equipment and plant related BDBA equipment operates properly on demand.
- Equipment is capable of satisfactory performance under all design conditions.
- In-service failures of critical equipment are minimal between scheduled maintenance interventions.
- Potential failures and failure causes of concern are identified for critical equipment and measures are established to prevent such failures.
- Equipment unavailability associated with preventive maintenance activities is balanced against the resulting improvement in equipment reliability and availability from prevented failures.
- Documented technical bases exist for preventive maintenance activities and ageing management programmes.
- Predictive maintenance technologies are implemented to detect equipment degradation well in advance of any potential failure condition and to optimise equipment performance.
- Equipment is classified according to its impact to plant safety and reliability.
- Using a graded approach, equipment and system performance criteria are established and monitored. Trends are identified, and actions are implemented and verified as necessary.
- The need for in-depth analysis of equipment failure is commensurate with the equipment’s importance to plant safety and reliability and the likelihood of failure recurrence.
- Equipment ageing is managed using PM techniques and LCM, including mitigation of environmental stressors (such as temperature, radiation and moisture) and operating stressors (such as duty cycles and vibration).
- Equipment performance data and associated trend information are uniformly collected and are readily accessible to support the prompt identification of problems and root causes.

5.1.2 The Integrated Equipment Reliability Process shall comprise of 6 main elements:

- Scoping and Classification of Components
- Continuing Equipment Reliability Improvement
- PM Implementation
- Long-Term Planning and Life-Cycle Management
- Corrective Action
- Performance Monitoring

5.1.3 Responsibilities for the development, implementation, execution and control of equipment reliability activities shall be assigned and controlled.

5.1.4 The processes, responsibilities and methodologies that comprise the Integrated Equipment Reliability Process shall be described in controlled documents.

5.1.5 Where a software database is used to manage the Equipment Reliability data, controls shall be established and documented in order to ensure the accuracy and security of the data. User access to the database shall be controlled in accordance with an authorised process.

5.1.6 The adherence to these requirements shall be periodically audited in accordance with NOUs Quality Assurance Programme and any adverse findings shall be reported and corrected.

5.2 Scoping and Classification of Components

5.2.1 A systematic and structured approach shall be established, documented and used for the scoping and classification of plant components, in terms of their functional importance, that is according to its impact to plant safety and reliability.

5.2.2 As a minimum, all equipment with an importance category classification of CSR, SR or AR in ‘Importance Category Classification Listing’, 331-94 and plant related BDBA mitigation equipment shall be included within the scope of the ER process and shall be classified.

5.2.3 Specific components or component types may be excluded from the ER process scope, where such components are adequately addressed by other programmes. Excluded component groups / types shall be identified in a controlled document and authorised by management.

5.2.4 A four tiered approach shall be adopted for the classification of equipment and specific classification criteria shall be developed and documented.

5.2.5 Component ER Classification shall comprise the following four functional importance categories:

- Critical
- Significant
- Economic
- Run-to-Maintenance

5.2.6 Critical equipment shall be identified based on importance to safety function, safe shutdown capability and power generation capability. Insight from PSA shall be considered in this determination.

5.2.7 Single Point Vulnerabilities (SPVs), a subset of Critical components shall be identified and the component SPV status shall be available for reference by plant personnel.

5.2.8 In-scope components with any ER Classification other than Run-to-Maintenance shall also be categorised in terms of their duty cycle and service conditions.

5.2.9 Components evaluated as having potential hidden failures shall be identified.

5.2.10 A technical basis for the component ER Classification shall be recorded.

5.2.11 Component ER Classification shall provide a common input to both Performance Monitoring and Continuing Equipment Reliability Improvement.

5.2.12 Component ER Classifications shall be readily accessible via SAP and shall be printed on the maintenance work orders.

5.2.13 Compilers of ER Classifications shall be suitably trained and experienced and shall be authorised in writing.

5.2.14 ER Classifications shall be reviewed by persons with the appropriate level of training and experience and shall be identified based on the scope.

5.2.15 The approval of ER Classifications shall be delegated to suitably trained and experienced persons appointed in writing by the Programmes Engineering Manager. The approver shall ensure that the appropriate reviews have been performed.

5.3 Continuing Equipment Reliability Improvement

5.3.1 A preventive maintenance programme shall be established and implemented, in order to prevent or minimise the probability of system or component functional failure, where the consequences of such failure would be unacceptable in terms of:

- Nuclear Safety Impact;
- Personnel Safety Impact;
- Breach of Environmental Standards;
- Production or Operational Impact;
- Economic Impact.

5.3.2 Preventive maintenance shall be focused on maintaining the functional capabilities of plant systems and components.

5.3.3 Maintenance is divided into two broad categories:

- Preventive Maintenance;
- Corrective Maintenance.

5.3.4 The objectives of preventive maintenance tasks are to:

- Prevent failure;
- Detect the onset of failure;
- Discover hidden failures.

5.3.5 Preventive maintenance activities fall into three broad task categories:

- Time Directed;
- Condition Monitoring (also referred to as predictive maintenance);
- Failure Finding.

NOTE: *"Run-to-Maintenance" (Corrective maintenance only) is a conscious decision not to perform any preventive maintenance on specific equipment, where the risks and consequences of failure are acceptable without any preventive maintenance being performed. There is also no simple cost effective method to extend the useful life of the component. These components are run until corrective maintenance is required.*

5.3.6 The objective of a corrective maintenance task is to restore failed or degraded equipment to an acceptable condition, in order to meet the required performance standard.

5.3.7 Predictive maintenance technologies shall be identified and implemented to detect equipment degradation well in advance of potential failure and to optimise equipment performance.

5.3.8 Equipment unavailability associated with preventive maintenance activities shall be balanced against the resulting improvement in equipment reliability and availability from prevented failures.

5.3.9 PM Basis

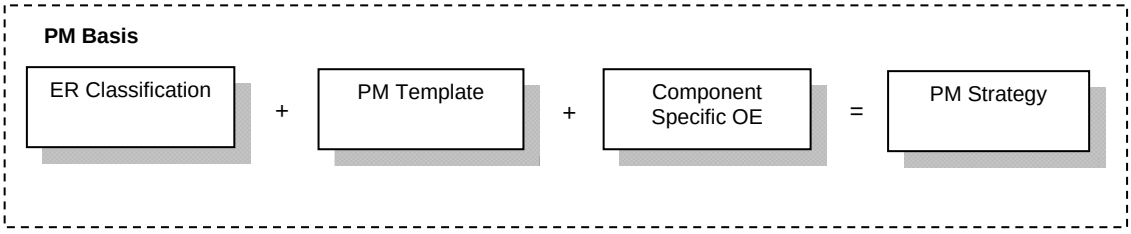
5.3.9.1 A documented technical basis shall exist for all preventive maintenance requirements on critical plant systems and components.

5.3.9.2 The PM Basis, as a minimum, shall identify the scope of applicability (Boundary), PM task requirements and applicable periodicities, as well as the rationale for each PM requirement.

5.3.9.3 The PM Basis shall comprise the following elements:

- Component ER Classification;
- PM Template;
- Component Specific OE;
- Resulting PM Strategy.

5.3.9.4 The association of a component ER Classification, the relevant PM Template and any component specific OE results in a PM Strategy and collectively forms the PM Basis.



5.3.9.5 The PM Basis shall be established using Equipment Reliability (ER) and Reliability Centred Maintenance (RCM) principles.

5.3.9.6 Determination of and changes to the PM Basis, shall be controlled in accordance with an authorised process. This process shall ensure that the changes to the basis will not give rise to an adverse impact on nuclear safety in terms of the Koeberg Safety Assessment (e.g. SAR, PSA, OTS) and in terms of meeting the Safety Criteria of the NNR.

5.3.9.7 PM Basis changes shall be clearly documented and shall be supported by an appropriate technical justification.

5.3.9.8 Where a PM regime has been previously established, but the basis is unrecorded, the validity of the regime shall be accepted and no technical basis shall be required until such time as a new PM Strategy is developed. However, should any change to the intent or periodicity of the tasks be required, a new PM Basis shall be established.

5.3.9.9 PM Templates and PM Strategies shall be developed to establish the most applicable and effective maintenance regime for plant systems and components.

5.3.10 PM Templates

5.3.10.1 A set of PM Templates shall be developed for the NOU covering all major component types prevalent on the plant.

5.3.10.2 Where only a small number of a specific component type is installed in the plant, the PM Strategy may be developed directly for each component without a PM Template.

5.3.10.3 PM Templates shall be categorised by discipline and then by sub-category of the component type/grouping.

5.3.10.4 The boundary of applicability of each PM Template shall be clearly defined.

5.3.10.5 Prescribed PM task periodicities shall take into account component duty cycle and service conditions.

5.3.10.6 For each PM task identified as a requirement in a PM Template, the following task details shall be recorded:

- Task Objective
- Task Content
- Task Interval
- Task Limitations/Conditions

5.3.10.7 PM Templates shall be reviewed and updated as required, taking into consideration any new OE (internal or external) since their previous revision.

5.3.10.8 Compilers of PM Templates shall be suitably trained and experienced and shall be authorised in writing.

5.3.11 PM Strategies

5.3.11.1 A PM Strategy shall identify and justify the preventive maintenance requirements on the component level.

5.3.11.2 Each PM Strategy shall identify the required PM tasks for a component, selected from the applicable PM Template where appropriate. Where no applicable PM Template exists for the component type, the PM tasks may be developed directly in the PM Strategy.

5.3.11.3 Component specific operating experience shall be evaluated and used to optimise the selected PM Template tasks and periodicities, for the specific component PM Strategy.

5.3.11.4 Where a PM task specified in the PM Template is not selected for a specific component, a technical justification for the deviation shall be included in the component PM Strategy.

5.3.11.5 For each PM task included into the PM Strategy, an optimised task interval shall be established based on the component specific requirements and operating experience.

5.3.11.6 Any deviation from the applicable PM Template task interval exceeding ± 25% of the interval shall be appropriately justified in the PM Strategy.

5.3.11.7 Component specific PM tasks shall be identified as appropriate, in addition to the PM tasks selected from the applicable PM Template.

5.3.11.8 PM Strategies shall be reviewed as appropriate during the life of the plant, to take into account plant modifications and operational experience.

5.3.11.9 The following shall be considered where applicable when motivating the PM Strategy requirements:

- OEM recommendations;
- Industry practice and recommendations;
- Koeberg Operating Experience;
- Maintenance history;
- Koeberg specific reliability information;
- Industry reliability information;

- EDF experience (RCM analyses, failure history, FMEAs, PM Templates, PM Strategies, etc.)
- EPRI PM Templates.

5.3.11.10 Activities resulting from an interpretation of the Nuclear Licence, Occupational Health and Safety Act, Operating Technical Specifications, and the various applicable codes and regulations, documented in the various NOU statutory and non-statutory programmes, shall be considered when establishing the Preventive Maintenance Programme.

5.3.11.11 Compilers of PM Strategies shall be suitably trained and experienced and shall be authorised in writing.

5.3.13 PM Basis Change Management

5.3.13.1 Optimisation, changes and revisions to PM Templates and PM Strategies shall be controlled and monitored using a systematic and structured approach.

5.3.13.2 The prioritisation of these changes shall be established and monitored using a graded approach.

5.4 PM Implementation

5.4.1 Mandatory Preventive Maintenance Listing

5.4.1.1 All Preventive Maintenance Programme requirements on components with an ER Classification of ‘Critical’ shall be listed in a controlled document. As a minimum, this listing shall identify the following:

- Equipment Functional Location;
- Equipment Description;
- PM Task Description;
- Task Periodicity;
- Revision number of the last change to the activity.

5.4.1.2 A summary report listing Preventive Maintenance Programme activities on critical equipment shall be submitted to the NNR on a periodic basis and within 30 days of authorisation of a new revision of the listing. The report shall identify all PM Strategy updates on critical equipment since the previous submission.

5.4.2 First Performance Dates

5.4.2.1 A risk based approach shall be adopted to prioritise and establish appropriate first performance dates for PM activities, with the overriding consideration being the reliability of the affected equipment and the need for timely preventive maintenance.

5.4.2.2 The risk based approach shall strive to balance the reliability of the affected equipment against the practical considerations of PM implementation in the Work Management Database.

5.4.2.3 The risk based approach adopted, as well as the time allowed to first performance of each activity, shall be supported by nuclear industry guidelines and practice.

5.4.3 PM Strategy Implementation

5.4.3.1 The PM Programme shall comply with the requirements of the approved PM Strategies.

5.4.3.2 An integrated cross-functional process shall exist to control and monitor the implementation of PM tasks, following the development or revision of PM Strategy requirements.

5.4.3.3 The requirements of the PM Strategies shall be entered into the Work Management Database in a controlled manner and in accordance with an authorised process.

5.4.3.4 Controls shall be established and implemented to ensure that the information contained in the Work Management Database is in compliance with the current authorised PM Strategy requirements.

5.4.3.5 All working documentation used in the execution of maintenance activities shall be produced in a standard format and shall be controlled in accordance with an authorised process.

5.4.3.6 The level of detail of working documentation shall be commensurate with the functional importance of the equipment and the complexity of the activity.

5.4.3.7 Working documentation shall include appropriate acceptance criteria in order to demonstrate that important activities have been accomplished satisfactorily.

5.4.3.8 A process shall exist to ensure that all work activities are scheduled to meet their periodicities, as defined in the PM Strategies and that they do not exceed the allowable grace period.

5.4.3.9 The allowable PM Grace period for Preventive Maintenance Programme activities, excluding First Performance Tasks, shall be 25% of the task interval.

5.4.3.10 All Preventive Maintenance Programme non-compliances shall be investigated, rectified and actions taken to prevent re-occurrence.

5.4.4 PM Execution

5.4.4.1 Processes shall exist to control the effective execution of work activities.

5.4.4.2 Maintenance activities shall be graded and the work shall be performed to a level commensurate with the effect that the activity may have on the ability of the component to perform its function.

5.4.4.3 Maintenance activities shall not be used to change equipment from its original specification or to alter the design base of the plant or equipment.

5.4.4.4 A process shall exist to ensure the recording, storage and retrieval of appropriate maintenance history.

5.4.4.5 A process shall exist to ensure the control of plant asset configuration.

5.4.5 Post-Maintenance Testing

5.4.5.1 A process shall exist to verify the post-maintenance integrity of equipment.

5.4.5.2 A standard set of post-maintenance tests shall be developed, that verify the important component functions and the effectiveness of the maintenance performed.

5.4.5.3 The scope of post-maintenance testing shall be based on the extent of the preventive or corrective maintenance performed.

5.4.5.4 Predictive techniques shall be included into the post-maintenance tests, to demonstrate satisfactory performance and to establish new baseline data for performance trending.

5.4.5.5 Post-maintenance requalification testing requirements and acceptance criteria shall be determined during the work preparation phase.

5.4.6 As-Found Condition Assessment

5.4.6.1 A process shall exist to record the as-found condition of equipment during maintenance, in order that PM tasks and periodicities can be adjusted based on actual plant specific equipment operating experience.

5.4.6.2 The as-found condition assessment process shall make use of a set of as-found condition codes, to allow the maintenance technician / artisan to easily select the appropriate equipment condition from a checklist.

5.4.7 Proactive PM Review

5.4.7.1 A Proactive PM work order review process shall be established and implemented, to review and challenge work after execution of a task, in order to validate the current applicability of the PM task based on as-found condition codes and operating experience.

5.4.8 PM Deferral

5.4.8.1 Any deferral of a Preventive Maintenance Programme activity shall be strictly controlled in accordance with an authorised process, which shall assess the impact of and justify any such postponement.

5.4.8.2 PM deferrals on Mandatory PM Tasks (critical components) shall be tracked and reported to the Plant Health Committee (PHC) on a periodic basis.

5.4.8.3 The NNR shall be notified of all PM Deferrals that are in force on Mandatory PM Tasks.

5.5 Long-Term Planning and Life-Cycle Management

5.5.1 SPV Management

5.5.1.1 A process shall exist to evaluate all Single Point Vulnerabilities (SPVs) and to identify and implement appropriate elimination or mitigation actions to manage the associated risk.

5.5.1.2 SPV elimination and mitigation actions shall be tracked and controlled.

5.5.2 Life of Plant Plan Development

5.5.2.1 Long-term system strategies and strategic initiatives shall be established and documented until end of life of Koeberg, and shall input to the station planning budgeting tools and financial accounting planning process.

5.5.2.2 Long-term system strategies and strategic initiatives shall identify expected future interventions and proposed expenditure (including all major refurbishments and modifications), with a proposed lead time and justification to support the business and financial planning processes.

5.5.2.3 Long-term system strategies shall include equipment reliability analyses for long-term effects such as ageing.

5.5.2.4 Long-term planning shall include economic evaluation of alternative ageing and obsolescence management approaches and the basis for the optimum solution selected.

5.5.2.5 Risk assessments shall be performed and documented, in order to quantify any plant risk by assessing the various issues facing the system or component. New risks identified shall be highlighted to the relevant technical committee and recorded on the Integrated Risk Management Database (CURA).

5.5.2.6 The results of Life-Cycle Management analyses shall be documented in a Life of Plant Plan (LOPP).

5.5.2.7 A master list of LOPPs shall be developed and maintained current.

5.5.2.8 LOPP documents shall be periodically reviewed.

5.6 Corrective Action

5.6.1 Equipment Failure Investigation, Determine Cause and Corrective Action

5.6.1.1 A failure investigation shall be initiated following any unanticipated component failure or potential component failure that should have been prevented.

5.6.1.2 A failure that is unanticipated, preventable and meets any of the following criteria is unacceptable and should be prevented:

- creates an unintended or unexpected operational effect;
- measurably degrades the margin of safety;
- initiates a transient;
- complicates the response to a transient;
- the failed component cannot be classified as ‘Run-to-Maintenance’.

5.6.1.3 Corrective maintenance shall be performed in a timely manner, appropriate to the ER Classification of the component.

5.6.1.4 Maintenance personnel investigating plant defects and compiling maintenance work packages shall be assigned the responsibility of identifying component failures for investigation in the Corrective Action Process (CAP) software.

5.6.1.5 A graded approach shall be applied to the level of investigation, the type of causal analysis and the ‘extent of condition’ development, in accordance with NOUs Corrective Action Process and considering the ER Classification of the failed component.

5.6.1.6 The depth of analysis of equipment failures shall be commensurate with the equipment’s importance to plant safety and reliability, the complexity of the equipment, the likelihood of recurrence and the impact of the actual or potential failure.

5.6.1.7 Failure investigation shall be assigned to a responsible Engineering group for investigation.

5.6.1.8 Component failure investigations shall include input from Maintenance, Operating and Engineering, as appropriate.

5.6.1.9 The significance to nuclear safety shall be determined during the failure investigation and a risk statement shall be added to the investigation.

5.6.1.10 A report shall be compiled for each failure investigation. The level of the investigation shall determine the requirements for the content, complexity and storage of the report.

5.6.1.11 All assigned corrective actions shall be tracked and controlled in accordance with an authorised process.

5.6.1.12 Periodic trend analysis shall be performed to proactively identify any adverse trends and to determine appropriate action.

5.6.2 Troubleshooting

5.6.2.1 Clear and systematic troubleshooting guidance shall be developed and authorised.

5.6.2.2 Where the resolution of a failure is unknown, troubleshooting shall be performed to understand the actual failure, so that an effective corrective action plan can be developed.

5.6.3 Equipment Problem Prioritisation

5.6.3.1 A cross-functional station process shall be established to identify and prioritise Top Equipment Reliability Issues based on plant safety, operational impact and station availability.

5.6.3.2 Resolution action plans to address Top ER Issues shall be developed and monitored.

5.7 Performance Monitoring

5.7.1 A graded approach shall be established to monitor the health of plant systems and components. The systems and components to be monitored shall be identified and controlled in accordance with an authorised process.

5.7.2 System and equipment performance criteria shall be established, performance shall be monitored, adverse trends shall be identified and corrective actions shall be implemented and verified for effectiveness.

5.7.3 Performance monitoring results shall be periodically summarised and presented to station leadership, in order to ensure that the current status of the system, component and programme health, the risk impact of any degraded health indicators and any actions required to recover, are well understood.

5.7.4 Station management oversight shall be provided on equipment reliability, plant health and performance.

5.7.5 A performance indicator shall be developed, implemented and maintained for NOU, to measure the overall status of equipment reliability.

6.0 ATTACHMENTS

Appendix 1 – Justification

APPENDIX 1

JUSTIFICATION

Revision 1

1. Full review to incorporate all the elements of the Equipment Reliability Process identified in INPO AP-913, 'Equipment Reliability Process Description'.

2. Title change to remove 'Preventive Maintenance Basis', since the standard now includes all aspects of equipment reliability as identified in INPO AP-913.

3. Incorporation of aspects of the withdrawn standard KSM-016, 'Equipment Failure Investigation and Evaluation of Experience'. See action SE 35244-048 SE: "Revise KSA-913, 'Integrated Equipment Reliability Standard' to incorporate the requirement for equipment failure investigation and supersede KSM-016."

4. Remove the pressure equipment for conventional service at NOU from the ER scope.

5. Refer to Nuclear Operating Unit (NOU) rather than Koeberg Operating Unit (KOU).

6. Clarified that the scope of BDBA equipment that is in-scope of the PM Programme is plant BDBA equipment.

7. Reference IAEA SSG-48, 'Ageing Management and Development of a Programme for Long Term Operation of Nuclear Power Plants' and RG-0027, 'Interim Regulatory Guide – Ageing Management and Long Term Operations of Nuclear Power Plants' as recommended in the IAEA SALTO (Safety Aspects of Long Term Operation) interview on 5 September 2019.

8. Reference the updated version of the WANO Performance Objectives and Criteria.

9. Partially address CR 109925-001CA: " Review the following procedures: KGU-029 - Monitoring and Trending in Plant Engineering, KGU-030 - Guidelines To Develop Position Specific Training Reference Modules For Engineering Positions, KSA-913 - Integrated Equipment Reliability Standard: Preventive Maintenance Basis, KGU-040 - Integrated ER Process: Establishing PM Task First Performance Dates, KLU-001 - Listing Of Plant Systems And Components".

10. Remove the term ERI (Equipment Reliability Index) and rather use the generic term "performance indicator".