Eskom	Procedure	Nuclear Engineering

Title: **Equipment Qualification Programme Process and Responsibilities**

Document Identifier: **331-187**

Alternative Reference Number: **KAA-834**

Area of Applicability: **Nuclear Engineering**

Functional Area: **Programmes Engineering**

Revision: **4**

Total Pages: **30**

Next Review Date: **November 2024**

Disclosure Classification: **Controlled Disclosure**

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Date: 2021-11-17	Date: 2021-11-17	Date: 2021-11-18

Nuclear Additional Classification Information

Business Level:	**3**
Working Document:	**3**
Importance Classification:	**NSA**
NNR Approval:	**No**
Safety Committee Approval:	**No**
ALARA Review:	**No**
Functional Control Area:	**Programmes Engineering**

Content

1. Introduction

This procedure is based on the requirements set out in RG-0027, “Ageing Management and Long Term Operations of Nuclear Power Plants” and the EQ standard 331-186, “Equipment Qualification Programme Requirements” and covers the requirements to develop, implement and maintain an equipment qualification programme for electrical and instrumentation & control (I&C) equipment important to safety at Koeberg Nuclear Power Station (KNPS).

An equipment qualification (EQ) programme is established to demonstrate with reasonable assurance that equipment important to safety can perform its safety function(s) before, during and after a design basis event (DBE), such as a loss of coolant accident (LOCA), high energy line break (HELB), main steam line break (MSLB), design extension conditions (DEC) as appropriate, seismic events and/or other environments as defined in accordance with the Interim Regulatory Guide RG-0027 for equipment qualification. The effects of significant ageing mechanisms are addressed as part of the equipment qualification programme.

The EQ Programme activities include processes that are needed to establish design requirements and to procure, install and maintain components that are within the scope of the equipment qualification programme. In addition, EQ activities include monitoring of installed components and service conditions to ensure they retain sufficient margin to support functional requirements throughout the component qualified life.

2. Supporting Clauses

2.1 Scope

The scope of this document covers the equipment qualification process and responsibilities to maintain the qualification status of qualified equipment.

2.1.1 Purpose

To describe the process and responsibilities required to develop, implement and maintain qualification of qualified equipment at Koeberg Nuclear Power Station (KNPS).

2.1.2 Applicability

This document shall apply to all departments, groups and sections, who conduct, support or verify equipment qualification related activities at KNPS.

2.1.3 Effective date

The document is effective from the authorisation date.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems

[2] 331-86: Design Changes to Plant, Plants Structures or Operating Parameters

[3] 331-94: Guide for classification of plant components, structures and parts

[4] 331-143: The Equivalency Process to Change Plant 331-144: Standard for the preparation of an Equivalency Study

[5] 331-186: Equipment Qualification Programme Requirements.

[6] 331-219: Equipment qualification Maintenance Manual for Equipment Located in Harsh Environments

[7] 331- 496: Equipment Qualification Template

[8] 240-155832775: Equipment Qualification Master List (EQML

[9] 240-130611911: Ageing Management and Qualification Requirements for Equipment Located in Mild Environments.

[10] KBA 12 22 E02 038: General specification for qualification to DBA conditions

[11] Koeberg SAR II-1.11: Environmental Qualification of electrical equipment for accident conditions

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

[13] 240-139089079: Programme Oversight Committee

[14] 240-149867926: Nuclear Steam Supply System Design Transient Monitoring Programme

2.2.2 Informative

[15] 240-98789629: Cable Ageing Management Manual for I&C Cables and Cable Systems

[16] 240-89294359: Nuclear Safety, Seismic, Environmental, Quality and Importance Classification

[17] 331-88: Temporary Alterations to Plant, Plant Structures or Operating Parameters that Affect the Design Base

[18] 331-127: Cable Ageing Management Programme at Koeberg Operating Unit

[19] 331-148: Programme Engineers' Guide

[20] ASME NQA1 (1994): Quality Assurance Program for Nuclear Facilities

[21] IAEA Safety Report Series No 3: Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and reviewing

[22] IAEA AMP 221: Equipment qualification (EQ) of Electric and Instrumentation & Control Components

[23] IAEA Safety Report Series No 3: Equipment Qualification in Operational Nuclear Power Plants: Upgrading, Preserving and reviewing

[24] IEC/IEEE 60780-323: Nuclear facilities – Electrical equipment important to safety – Qualification

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

[26] IEC 60980: Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations

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

[28] ISO 9001: 2008 Quality Management Systems - Requirements

[29] KAA-690: Operability Determinations

[30] KAA-840: Non-Conformance Report (NCR) Process

[31] KAD-025: Processing of Operating Experience

[32] KGA-035: Processing of Experience Feedback Received through the EDF Co-operation Agreement

[33] KGU-002: Guide for System Engineers

[34] KGA-124: Guide for Troubleshooting

[35] KGU-029: Monitoring and Trending in Plant Engineering

[36] KGU-031: System Health Reporting Guide

[37] KSA-011: The Requirements for Controlled Documents

[38] KSA-038: Requirements for Quality Records

[39] KSA-089: Procurement Quality Engineering Requirements

2.3 Definitions

2.3.1 Abnormal Operating Conditions: Any deviation from normal conditions anticipated to occur often enough that the design should include a capability to withstand the conditions without operational impairment.

2.3.2 Accident Conditions: A single event not reasonably expected during the course of plant operation that has been hypothesized for analysis purposes or postulated from unlikely but possible situations or that has the potential to cause a release of radioactive material.

2.3.3 Class 1E: Safety classification of the electrical equipment and systems that are essential to emergency reactor shutdown, containment isolation, reactor core cooling, and containment and reactor heat removal, or are otherwise essential in preventing significant release of radioactive material to the environment.

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

2.3.5 Design Extension Conditions: Accident conditions that are not considered for design basis events, but that are considered in the design process of the facility in accordance with best estimate methodology, and for which releases of radioactive material are kept within acceptable limits. Design extension conditions include severe accident conditions.

2.3.6 Environmental Qualification: A process for ensuring that equipment will be capable of withstanding the ambient conditions that could exist when the specific function to be performed by the equipment is actually called upon to be performed under accident conditions. For environmental qualification, the central concern involves the threat to non-metallic components of electrical and I&C components due to stresses from severe environmental service conditions resulting from a LOCA or HELB (including SLB).

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

Equipment Qualification = Environmental Qualification + Seismic Qualification

2.3.8 Harsh Environment: Harsh environments are the result of a LOCA or HELB (including SLB) inside containment and post-LOCA or HELB outside containment.

2.3.9 Mild Environment: An environment that would at no time be significantly more severe than the environment that would occur during normal plant operation, including anticipated operational occurrences.

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

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

2.3.12 Service Conditions: Actual physical states or influences during the service life of equipment, including normal operating conditions, abnormal operating conditions, design basis event conditions and conditions following a design basis event and design extension conditions.

2.4 Abbreviations

Abbreviation	Explanation
AMM	Ageing Management Matrix
AMP	Ageing Management Programme
AMR	Ageing Management Review
CSR	Critical Safety Related
DBA	Design Basis Accident
CGIs	Commercial Grade Items
DBE	Design Basis Event
EQ	Equipment Qualification
DEC	Design Extension Conditions
EQ PRM	Equipment Qualification Programme
EQMM	Equipment Qualification Maintenance Manual
EQML	Equipment Qualification Master List
HELB	High Energy Line Break
I&C	Instrumentation and Control
IAEA	International Atomic Energy Agency
IGALL	International Generic Ageing Lessons Learned
LOCA	Loss of Coolant Accident
LTO	Long Term Operation
MSLB	Main Steam Line Break
NRC	Nuclear Regulatory Commission, USA
OE	Operating Experience
QL	Qualified Life
SALTO	Safe Aspects of Long Term Operation
SR	Safety Related
SSC	System, Structure and Component
SLB	Steam Line Break
TLAA	Time Limited Ageing Analyses
WANO	World Association of Nuclear Operators

2.5 Roles and Responsibilities

Effectively preserving equipment qualification involves many entities internal and external to the plant organisation. Although the responsibility for the EQ Programme resides with the Materials Reliability Group (MRG), several plant organisations will participate in the development and preservation of equipment qualification.

Appendix A of this procedure provides a flow matrix which provides roles and responsibilities of relevant departments or groups that interface with the EQ programme.

2.5.1 Programmes Engineering Manager

The responsibilities of the Programmes Engineering Manager include the following:

- Ensure EQ Programme is implemented in accordance within appropriate regulatory and procedural requirements.
- Ensure programme oversight is effectively implemented.
- Support the programme owner participation in technical training and other relevant industry working groups.
- Provide required resources to support programme implementation.
- Monitor the effectiveness of the EQ Programme.

2.5.2 Materials Reliability Group (MRG) Manager

The responsibilities of the MRG Manager include the following:

- Responsible for ensuring that the process described in this procedure is correctly implemented and maintained.
- Ensure the EQ programme is implemented effectively to meet design and regulatory requirements including periodic reviews in accordance with the EQ standard 331-186, “Equipment Qualification Programme”.
- Provides resources to the programme engineer to resolve programme issues and ensure compliance with regulatory requirements.

2.5.3 EQ Programme Engineer

In addition to the roles and responsibilities of a programme engineer listed in 331-148, the EQ Programme Engineer performs the following functions:

- Establish and maintain EQ Programme requirements, and Equipment Qualification Master List (EQML) in accordance with RG-0027 and EQ standard 331-186.
- Ensure EQ programme documents and related programmes procedures are kept up to date and are consistent with other plant-controlled documents.
- Provide a list of EQ special maintenance, parts replacement, and repair requirements along with associated special requirements for equipment located in harsh and mild environments”.
- Perform ageing reviews as required to support long term operation (LTO).
- Evaluate industry operating experience- and research feedback for potential impact on the EQ Programme.
- Assist in performing EQ evaluations and operability assessments in accordance with KAA-840, “Non-Conformance Report” (NCR) Process.
- Provide training to those involved in the EQ process.
- Review and publish the programme health report on a frequency prescribed in accordance with 331-148, *“*Programme Engineers’ Guide*”.*
- Participate in industry EQ activities, EPRI and IAEA IGALL Working Group.

- Identify programme deficiencies and needed improvements and oversee programme corrective actions.
- Oversee the activities of all interfacing departments/groups that are required to support effective implementation of the EQ programme in accordance with 331-148.
- Review and initiate appropriate corrective actions in accordance with KAA-688 when degraded or non-conforming conditions are identified or when plant configurations occur that could affect EQ equipment.
- Initiate modifications to the plant that are consistent with EQ programme requirements, in accordance with 331-86, “Design Changes to Plant, Plants Structures or Operating Parameters”.
- Review the changes to the maintenance basis and the development of the preventive maintenance programmes for systems and components.
- Evaluate internal and external industry operational experience at Koeberg Nuclear Power Station in accordance with applicable procedures (i.e. KAA-688, KGA-035, “Processing of Experience Feedback Received through the EDF Co-Operation Agreement” and 331-23, “Processing of Industry Operating Experience in Nuclear Engineering”.

2.5.4 Cable Ageing Management Programme (CAMP) Engineer

The CAMP Engineer performs the following functions:

- Establish and maintain the cable ageing management for all EQ cables in accordance with CAMP standard 331-127, “Cable Ageing Management Programme at Koeberg Operating Unit”.
- Provide a list of maintenance, and inspection and test requirements for cables.
- Evaluate plant and industry operating experience for potential impact on cables in accordance with KAA-688.

2.5.5 Obsolescence Management Programme (OMP) Engineer

The OMP Programme Engineer performs the following functions:

- Ensure that the OMP is effectively developed, implemented, monitored, and maintained in line with procedure 331-146, “Obsolescence Management Programme (OMP)”.
- Performs typical management oversight functions, including governance of the programme, and coordinates activities among different plant organisations.

2.5.6 Design Engineering

- Prepares technical specifications for the manufacturing, purchasing and quality requirements of plant equipment.
- Perform the systems and components classification of all plant equipment.
- Perform EQ related modification and equivalency studies in accordance with 331-86 and 331-143, “The Equivalency Process to Change Plant”.

- Ensure that temporary alterations to plant, plant structures or operating parameters that could affect the design and safe operation are assessed, approved, safely implemented, and withdrawn in a systematic and controlled manner as described 331-88, “Temporary Alterations to Plant, Plant Structures or Operating Parameters that Affect the Design Base”.
- Ensure the completion of the EQ File Template 331-496 in the absence of equipment qualification documentation.

2.5.7 Systems Engineering

- Continuously monitor parameters and perform plant walkdown to identify to identify degrading conditions before they affect plant performance and reliability in accordance with KGU-002, “Guide for System Engineers” and raise necessary corrective actions to resolve the issues.
- Monitor and trend system performance and analyse deviations from expected performance as per KGU-031, “System Health Reporting Guide” and KGU-029, “Monitoring and Trending in Plant Engineering”.
- Initiate appropriate corrective actions when degraded, component failures or non-conforming conditions are identified during system walk-downs or when plant configurations occur that could affect EQ equipment in accordance with KAA-688.

2.5.8 Programmes Engineering (Reliability Engineering Group)

- Implement relevant changes to the maintenance basis and the development of the preventive maintenance strategies for systems and components.
- Resolve any issues relating to component maintenance regimes as well as to assess the impact of modifications on the maintenance basis.

2.5.9 Maintenance Execution

- Implement the EQ maintenance requirements in accordance with the EQ maintenance manual, 331-219 to maintain qualification.
- Implement the EQ maintenance requirements in accordance with the EQ maintenance manual, 240-130611911, Ageing Management and Qualification Requirements for Equipment Located in Mild Environments.
- Prepare and maintain procedures for the repair and maintenance of in-scope equipment that incorporate configuration and maintenance requirements.
- Initiate appropriate corrective actions when degraded or non-conforming conditions or Component Failures are identified or when plant configurations occur that could affect qualified equipment.
- Ensure that the installed equipment remains in its qualified condition (e.g. mounting bolts are torqued to the proper values and parts with limited life expectancy are replaced as required).
- Ensure that the installation and configuration requirements are maintained during and after any maintenance that could affect the EQ equipment.

- Execute the preventative activities required in order to maintain equipment qualification as scheduled on SAP.

2.6 Process for Monitoring

A Programme Health Report in accordance with 331-148 is issued periodically on the status of the programme.

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)

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.

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 and any significant technical matters.

2.7 Related/Supporting Documents

Not applicable

3. Qualification Process

The requirements set out in this document apply to electrical and I&C equipment as defined in EQ standard 331-186.

The EQ Programme consists of a set of requirements to assure that activities such as design, procurement, corrective action, training, and maintenance are conducted in a manner which maintains the qualification of EQ equipment. Qualification methodology includes establishing traceability of the installed equipment, with reference to the normal service conditions, anticipated operational occurrences (abnormal conditions) and design basis event conditions.

The EQ Programme is a process that begins with the design of the plant and continues throughout its operating life including a period of long term operation (LTO).

3.1 Specifying Equipment to be Qualified

The EQ standard 331-186 requires that structures, systems and components (SSCs) important to safety at Koeberg remain functional under normal operation, abnormal conditions and postulated accident conditions.

A full list of components subject to equipment qualification requirements are given in the document 240-155832775, “Equipment Qualification Master List” (EQML).

The scope and the requirements to maintain qualification of certain electrical and I&C equipment located in mild plant environments are documented in 240-130611911, “Ageing Management and Qualification Requirements for Equipment Located in Mild Environments”.

3.2 Establishment of equipment qualification

The establishing qualification phase involves those activities where qualification data and results are compiled, developed, evaluated, accepted and documented in an auditable form that demonstrates the qualifications of specific equipment. Qualification is established by using type test, analysis, operating experience, or a combination of these methods.

Establishing qualification also includes defining EQ critical installation, operation and maintenance activities to maintain qualification. During this phase, equipment manufacturers or suppliers generate the qualification plan and test procedures, execute the tests, perform the required analysis and generate qualification test reports.

3.2.1 Qualification Conditions

Qualified equipment and components are designed to meet their functional requirements under the conditions produced by:

- Long-term exposure to normal environmental conditions during the service life of the unit.
- Subsequent exposure to post-accident conditions resulting from.
    - Loss of Coolant Accident (LOCA), Main Steam Line Break (SLB).
    - Design Extension Conditions (DEC)

The conditions used for equipment qualification for Koeberg are provided in the SAR II-1.11, Table T-II-1.11-1 and KBA 122 E02 038, “General Specification for Qualification to DBA Conditions”.

3.2.2 Qualification Methods

The basic requirements for qualifying Class 1E equipment and interfaces that are to be used in nuclear power generating stations are described in IEEE 323-1974 and the latest standard IEC/IEEE 60780-323. The qualification requirements in this standard, when met, demonstrate and document the ability of equipment to perform safety function(s) under applicable service conditions including design basis events, reducing the risk of common-cause equipment failure.

Type testing of actual equipment using simulated service conditions is the preferred method of qualification and has been used for most electrical equipment for Koeberg.

The tests use conservative normal and accident environmental conditions to ensure that equipment will perform its safety function. Qualification documentation must be provided for qualified equipment in line with 331-186.

3.3 Preservation of the status of qualified equipment

The EQ Maintenance Manual 331-219, “Equipment Qualification Maintenance Manual for Equipment Located in Harsh Environments” describes the maintenance requirements for equipment included in the Equipment Qualification Programme.

The EQMM specifies component replacement or refurbishment activities until the end of its qualified life, unless re-qualification demonstrates additional life for the component. This manual serves as a record of the list of equipment and all the components thereof that must be maintained to preserve qualification.

Components in the EQ Programme have a qualified life (QL), and the components are replaced or refurbished at the end of that qualified life as stipulated in this document unless additional life is established through reanalysis or operating experience.

The requirements to maintain qualification of electrical and I&C equipment located in mild plant environments are documented in 240-130611911, “Ageing Management and Qualification Requirements for Equipment Located in Mild Environments”.

The Preserving EQ phase involves the following activities:

3.3.1 Preventive Actions to Minimize and Control Ageing Degradations

After EQ is established, mandatory EQ maintenance and monitoring activities are implemented and controlled so that throughout the lifetime each installed item reflects the requirements and limitations identified when EQ was established.

EQ equipment and components are qualified for specific applications in specific configurations. Once EQ has been established, it is important to preserve the qualified status of the installed equipment.

The maintenance actions that could be viewed as preventive actions include:

- Establishing the equipment service condition tolerance and ageing limits (for example, qualified life or qualification condition limit); and
- Where applicable, specific installation, inspection, monitoring, or periodic maintenance actions to maintain component ageing effects within the bounds of the qualification basis and the assumed qualified life.

The maintenance actions that could be viewed as preventive actions are covered in the EQMM 331-219 for equipment located in harsh environment.

The requirements to manage electrical and I&C equipment located in mild plant environments are documented in the document 240-130611911.

The Equipment History Records must be used to capture the inspection and maintenance results of qualified equipment.

3.3.2 Detection of Ageing Effects

The maintenance actions to detect ageing effects include the following:

- Inspecting and/or testing EQ equipment periodically with particular emphasis on the identification of adverse localized environments that may impact a component’s qualification; and

- Monitoring or inspection of certain environmental conditions or component parameters to ensure that the component is within the bounds of its qualification basis, or as a means to modify the qualified life.

The actions are covered in the EQMM 331-219, Cable Ageing Management Manuals and the PM Programme database.

For mild environment equipment, the requirements to manage electrical and I&C equipment located in mild plant environments are documented in 240-130611911.

3.3.3 Monitoring and Trending of Ageing Effects

Monitoring and trending of equipment condition or performance parameters are not required to manage the effects of ageing but may be applicable to ongoing qualification including condition based qualification methodologies.

EQ programme actions that could be viewed as monitoring and trending include the verification of how long qualified equipment have been installed with respect to its qualified life to ensure that qualified life is not expired or qualified condition is not exceeded.

A monitoring or trending programme may be used to ensure that the qualified equipment is within the bounds of its qualification basis, or as a means to modify qualified life (e.g., programs for monitoring and trending of environmental conditions (such as temperature, radiation levels), may be implemented for EQ components).

The monitoring and trending frequency may be adjusted based on component inspection and test results. A modification to qualified life either by reanalysis or ongoing qualification demonstrates that adequate conservatism is maintained, consistent with the original analysis, accounting for uncertainties established in the EQ ageing evaluation for the equipment.

Monitoring and trending of the system performance are performed in accordance with the System Health reporting guide, KGU-031. This is to identify problems and age-related concerns before they adversely affect the functionality of the component.

Necessary corrective actions are raised in accordance with KAA-688 to correct any anomaly.

EQ programme actions that could be viewed as monitoring and trending are covered in the EQMM 331-219 and 240-130611911.

For mild environment equipment, the requirements to manage electrical and I&C equipment located in mild plant environments are documented in the document 240-130611911.

3.3.4 Mitigating Ageing Effects

There are no specific operations, maintenance, repair or replacement mitigation aspects provided in this document.

3.3.5 Acceptance Criteria

The acceptance criteria are that the in-service EQ equipment is maintained within the bounds of its qualification basis, including:

- The established qualified life.

- Continued qualification for the projected accident conditions. The EQ programme requires refurbishment, replacement, or requalification prior to exceeding the qualified life of each installed equipment.
- When monitoring and trending is used to modify the equipment qualified life or qualified conditions, plant-specific acceptance criteria are established based on applicable qualification methods in accordance the national regulatory requirements.
- Recommendations from the manufacturers.

An installed EQ component is maintained within the bounds of its qualification basis in accordance with the requirements set out in the EQMM 331-219 and 240-130611911.

Compliance with EQ requirements provides reasonable assurance that the component can perform its intended functions during accident conditions after experiencing the effects of in-service ageing.

If an EQ component is found to be outside the bounds of its qualification basis and the acceptance criteria, the following corrective actions are implemented in accordance with the plant corrective action programme, KAA-688:

- When unexpected adverse conditions are identified during operational or maintenance activities that affect the environment of qualified equipment, the affected EQ equipment is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions.
- When an emerging industry ageing issue is identified that affects the qualification of the EQ equipment, the affected equipment is evaluated and appropriate corrective actions are taken, which may include changes to the qualification bases and conclusions.

3.3.5.1 Equipment Failures

Component failures or defects should be raised and addressed in accordance with KAA-688. Maintenance defects are raised for any defect evaluation by Engineering.

EQ component failure evaluations will be performed according to KGU-033, “Failure Investigation of Plant Equipment and Evaluation of Experience”.

The EQ Engineer must be informed of component failures, defects raised on EQ equipment.

3.3.5.2 Non-Conforming (NC) Conditions

Non-compliance (NC) with EQ requirements places the equipment out of the qualification boundaries and could lead to inability of equipment to fulfil its safety functions.

Appropriate corrective actions should be initiated when degraded or non-conforming (NCR) conditions are identified on EQ equipment or when plant configurations occur that could affect EQ equipment. Procedures KAA-840, “Non-conformance Process” and procedure KAA-690, “Operability Determination” are to be used to assess non-conforming conditions.

This is to ensure that EQ equipment remains within the bounds of their qualification and to provide safety justification for any deviations.

3.3.5.3 Assessing ageing effects

Significant ageing mechanisms will vary according to device design and normal service conditions. The following service conditions are related to potentially significant ageing mechanisms:

- Temperature (external and internal)
- Thermal cycling
- Radiation
- Humidity
- Over- or under- voltage
- Partial discharge phenomenon
- Electrical transients
- Overloading
- Vibration
- Corrosion
- Erosion
- Operation (cyclical or continuous).
- Submergence

EQ requires ageing to be specifically considered when qualification is established for electrical and I & C equipment located in harsh environments. Experience and research have demonstrated that several significant ageing mechanisms can contribute to failures when electrical equipment containing electronics and non-metallic materials is subsequently exposed to harsh environmental conditions, particularly steam and radiation. Similar ageing mechanisms can exist for the non-metallic parts of mechanical equipment.

3.3.5.4 Periodic tests, Calibrations and Validations

Instrument calibrations and validations are carried out periodically to check and maintain instrument accuracy and drift. For Koeberg, periodic tests, surveillance, calibrations and validations are document in the Safety Related Surveillance Manual (SRSM), IQ Review (INPO AP-913), Maintenance Basis and maintenance listing KLM-005.

3.3.5.5 Replacement Parts / Equipment

When a part is replaced in a qualified equipment item, it is necessary to ensure that the original conclusions regarding qualification of this item remain valid. Originally purchased equipment contains parts that were selected, inspected or, in some cases, manufactured to an approved QA programme. This was most likely true even if the manufacturer of the equipment purchased the parts as commercial grade items (CGIs).

However, when replacements are purchased later, changes may have been made to their design, materials of construction or manufacturing process.

Obsolescence may dictate substitution of the original part with an equivalent or a specially fabricated part. Therefore, substitute parts have to be identified and critical characteristics evaluated to ensure that they will perform adequately to preserve qualification.

Engineering evaluation (Equivalency Study) of replacement equipment/parts in accordance with 331-144, “Equivalency Study Process” should include the following considerations:

- What is the safety class of the item and its basis?
- What QA requirements are to be applied to the supplier?
- What documentation is required to demonstrate continued qualification of the parent equipment?
- How is shelf-life assigned and controlled?
- What critical characteristics (i.e. form, fit, function and materials of construction) of the part(s) are important to preserve the capability of the equipment item in which the part is installed to perform its specified safety functions in harsh environments?
- Have there been any changes in the design, material and manufacturing process and, if so, how will these changes affect the critical characteristics and parent equipment qualification?
- How can the critical characteristics be replaced?
- Where, when and by whom will the critical characteristics be verified?

Note: If the original equipment qualification reports cannot be obtained from original equipment manufacturer (OEM) due to proprietary rights for review, the EQ specifications 331-496, “Equipment Qualification Assessment Template” should be completed as part of the Equivalency Study.

3.3.5.6 Plant Modifications

Modifications can involve changes either to the plant configuration, the design basis or both. Design basis modifications can involve changes to licensing commitments, normal and/or Postulated Initiating Event (PIE) service conditions, accident analysis assumptions, system and component operating parameters, system operating configurations and emergency operating procedures.

Modifications to the plant configuration can involve relocation, change, addition or deletion of systems, structure or components (e.g. revised electrical circuit configuration, addition of new instrument channels), and equipment performance requirements (e.g. valve opening time, maximum flow output).

Plant modifications of EQ components are performed in accordance with 331-86.

Before being implemented, all modifications should be evaluated for their EQ impact.

Changes can be temporary or permanent. Temporary changes can also have an impact on EQ. Temporary alterations (TAF) to plant, plant structures or operating parameters that could affect the design and safe operation should be assessed, approved, safely implemented, and withdrawn in a systematic and controlled manner as described in 331-88.

Modifications that involve only non-safety systems or equipment can also affect EQ. To ensure EQ preservation, these changes should be evaluated for possible impact on the original qualification of affected qualified equipment.

Procedure 331-86 require the evaluation of changes to assess their impact on EQ. Considerations in such evaluations include the following:

- Does the proposed change affect the scope or location of equipment required to mitigate the consequences of LOCA or pipe break events?
- Does the proposed change affect the required performance levels or duration of operability for the qualified equipment?
- Does the proposed change affect accident (LOCA and other pipe break) mass and energy releases and their spatial distribution within plant areas (e.g. barrier or piping changes, etc.); or the resulting temperature, pressure, steam or flooding conditions experienced by the equipment?
- Does the proposed change affect the radiation source term releases, their distribution within plant areas or systems, or doses experienced by equipment?
- Does the proposed change affect other PIE environmental conditions (spray composition, submergence) or their distribution within plant areas?
- Does the proposed change affect the normal environments (in particular, changes in temperature or radiation levels) of equipment in the scope of the EQ programme?
- Does the proposed change affect the operating conditions or limits for electrical or mechanical systems containing or supporting operation of qualified equipment?

Note: For plant modification, if the original equipment qualification reports cannot be obtained from original equipment manufacturer (OEM) due to proprietary rights for review, the EQ specifications 331-496 should be completed.

3.3.5.7 Condition monitoring

Condition monitoring refers to activities performed to assess the functional capability/operational readiness of the equipment. It can be a valuable adjunct to EQ because it can support:

- Assessment of in-service ageing effects and remaining equipment capability;
- Validation and possible revision of the qualified life, if applicable;
- Identification of ageing mechanisms that may not have been adequately addressed during original qualification;
- Identification of incipient failures.

Condition monitoring may be implemented wherever additional information on in-service degradation is needed to preserve qualification and when a practical monitoring technology is available. Condition monitoring should be considered when:

- Service conditions are suspected to be more severe than previously assumed;
- Ageing evaluations contain significant assumptions or uncertainties; or
- Known ageing mechanisms cannot be fully evaluated or simulated when
- Qualification is established.

3.3.5.8 Environmental monitoring

The qualification process typically utilizes conservative design estimates for normal service conditions such as temperature, radiation and operational cycling based on the original plant design calculation estimates. Hence, the qualified life and parts replacement intervals established, if applicable, may also be very restrictive.

Monitoring of the actual plant conditions under various operating modes and shutdown, taking into consideration seasonal climatic changes, may provide a basis for re-evaluating and extending the qualified life.

Additional temperature and radiation monitoring instrumentation will be installed, as required, in the containment and in some critical outside-containment areas. The data collected from these instruments have been used to refine the qualified life estimates and maintenance and parts replacement intervals.

3.3.5.9 Failure trending and analysis

Monitoring equipment operating and failure history can assist in identifying in-service degradation trends to prevent failure. Performing a failure analysis can assist in identifying potential failure mechanisms and prevent future equipment malfunctions. These conditions can be evaluated to determine whether previous qualification conclusions or installation, maintenance or replacement requirements should be revised.

Additional maintenance, more frequent equipment replacement or refurbishment, and equipment and plant modifications are some of the types of corrective action that may be implemented on the basis of this analysis.

3.3.6 Use of Operating Experience (OE)

Relevant plant specific operating experience is considered in the development of the EQ Programme.

In accordance with the KAA-688, KAD-025, 331-23 and KGA-035, plant implements a feedback process to periodically evaluate plant and industry-wide operating experience and research and development (R&D) results, and, as necessary, either modifies the programme to ensure the continued effectiveness of the ageing management.

The EQ programme includes consideration of operating experience to modify qualification bases and conclusions, including qualified life.

Sources of external operating experience include but not limited to EPRI, INPO, IAEA IGALL, NRC information notices and generic communications.

3.3.7 Quality Assurance (QA)

The role of the QA function within the organization is to ensure that the work is being performed and documented consistently by using proper procedures and to identify potential trouble spots and programmatic weaknesses. This is achieved by a system of independent reviews, audits, inspections and evaluations of activities that affect work quality.

QA personnel should perform periodic audits (as a minimum, once in two years) and inspections and surveillance of the EQ programme activities. Such audits and inspections focus on the programmatic and technical aspects of EQ.

3.4 Documentation and Records

In accordance with EQ standard 331-186, records of the qualification must be maintained in an auditable form for the entire period of operation during which the covered item is installed in the nuclear power plant or is stored for future use. This permits verification that each EQ item is qualified for its application and meets its specified performance requirements when it is subjected to the conditions predicted to be present when it must perform a safety function up to the end of qualified life.

Documented evidence of qualification needs to be available in an auditable form for the life of the plant and component including period of extended operation. Records demonstrating that EQ has been established contain information on the specific equipment items being qualified, the safety functions, applicable service conditions, qualification methods, results, limitations, justifications and relevant supporting technical data.

The EQ standard requires that an EQ file, containing or referencing information relevant to establishing qualification, be maintained by the plant of the manufacturer. EQ files are typically organised by equipment type and manufacturer.

Qualification records and documentation include but are not limited to the following:

- EQ Master lists
- Environmental and Seismic Qualification Test Reports
- PIE and normal operation performance requirements
- List of limited life items and replacement intervals
- Maintenance requirements and intervals
- Initial event and normal operation service conditions
- Calculations and analyses (seismic stress evaluation, qualified life, etc.)
- Walk-down verification checklists, if any
- Maintenance and Equipment History Records
- Maintenance procedures
- Failure trending and analysis procedures
- Equipment and parts procurement procedures

Note: Records are not necessarily archived in the same package but accessible through the plant depository or at the OEM depository.

For Koeberg, some of the original qualification reports or summary of qualification are listed in KBA 12 22 E02 034, “Seismic and DBA qualification - Summary document”.

3.5 Ageing Management Review

In accordance 240-149139512, “Ageing Management Requirements for Koeberg Nuclear Power Station” and 331-275, “Process for the Development and Control of Ageing Management at Koeberg Operating Unit’, equipment and components within the scope of the EQ Programme and their associated ageing degradations are listed in the Ageing Management database.

3.6 Re-assessment of initial qualification

As required, EQ equipment not qualified for the current operating term is refurbished, replaced, or have their qualification extended prior to reaching the ageing limits (qualified life or qualified condition) established in the evaluation. Ageing evaluations for EQ equipment that are qualified for at least the current operating term are considered time-limited ageing analyses (TLAAs) for the intended operating period.

Re-analysis of an ageing evaluation to extend the qualification of components for intended operating period is performed on a routine basis as part of an EQ programme. Important attributes for the reanalysis of an ageing evaluation include analytical methods, data collection and reduction methods, underlying assumptions, acceptance criteria, and corrective actions (if acceptance criteria are not met).

The plant shall either replace qualified equipment at the end of the qualified life or extend the qualification using the methods that are described in procedure 331-186.

3.6.1 Review of operational and design transients

Plant operational and design transients are managed in accordance with the Design Transient Monitoring Programme in accordance with document 240-149867926, “Nuclear Steam Supply System Design Transient Monitoring Programme” implemented at Koeberg Nuclear Power Station (KNPS).

Materials Reliability Group (MRG) performs a yearly review of the NSSS Design Transient Monitoring Programme results. The effects of these transients on qualified equipment will then evaluated and appropriate corrective action taken.

3.7 Training

To ensure that EQ related tasks are performed in a consistent, technically acceptable manner, the personnel involved need to possess adequate skills and knowledge.

Adequate EQ related knowledge and skills are achieved through an appropriate mix of EQ training, on the job experience/training and technical education.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
A Kamroodien	Middle Manager - Programmes Engineering
R Cassim	Manager – Materials Engineering Group
Z Isaacs	Manager- Electrical Systems Engineering
C Samuels	Manager – Electrical Maintenance Manager
D Smith	Manager – Instrumentation Maintenance Manager
R Maapola	Engineer - Design Engineering
A Jakoet	Senior Engineer - Materials Engineering Group

5. Revisions

Date	Rev.	Compiler	Remarks
November 2021	4	K Moroka	Document reviewed to address the PSR General Conditions CR 123106 & CR 123276. Change classification of document from SR to NSA as the document only provides roles and responsibilities relating to EQ not for the SSCs.
November 2020	3	K Moroka	Document reviewed to align with the requirements of RG-0027
January 2019	2	K Moroka	Full Review
January 2016	1	K Moroka	Document updated in line with the IAEA guidelines and to clarify the roles and responsibilities.
March 2014	0	K Moroka	Updated to align with the new Nuclear Engineering organisation document structure. Reliability Engineering added to the process matrix. EQ background information (Appendix C) added to the document.
April 2010	0	L Nieuwoudt	New process written to facilitate the creation of the EQ programme

6. Development Team

Not applicable.

7. Acknowledgements

Not applicable.

Appendix A: Flow Matrix

WORK FLOW RESPONSIBILITY MATRIX

R – Responsible
A – Approve
F – File
• – Outside Matrix Scope
Y/N or N/Y – Decision
C – Concur
I – Informed
S – Service
[ ] – Mandatory Requirement
( ) – As Appropriate/Required
Flow Path:
Main Flow Secondary Flow

ORGANISATION / FUNCTION

ACTIVITIES	1 ORIGINATOR	2 MATERIALS RELIABILITY GROUP	3 DESIGN ENGINEERING	4 MAINTENANCE EXECUTION	5 MATERIALS RELIABILITY GROUP MANAGER	6 SYSTEMS ENGINEERING	7	8	9	10	11	12	**Notes & References**
A. QUALIFICATION EVALUATION FOR NEW EQUIPMENT													
1. Identify the new equipment to be installed		[S]	[R]			[S]							Equivalency Process, 331-143, or Plant Modification, 331-86.
2. Obtain and review associated proof of qualification.		[S]	[R]										Use EQ Template 331-496 in Appendix C Checklist
3. Assesses the Equipment Qualifcation (Environmental and Seismic qualification) of the new equipment for use at Koeberg.		(S)	[R]			(S)							Refer to EQ Template 331-496 and other applicable design requirements.
4. Complete EQ specification, EQ requirements and installation requirements.		[C]	[R]										Refer to EQ Template 331-496
5. Verify if the selected equipment meet the plant EQ and plant requirements.			[R]										Refer to EQ Template 331-496
6. Justify any difference between the expected requirement and actual test			[R]										Update the EQ requirements, if required.

B. EXISTING EQUIPMENT: REVISION/ COMPILATION OF EQ FILE													
1. Identify the need to revise an existing EQ file or to compile new EQ requirements for existing equipment	[R]												
2. Source and review associated proof of qualification in accordance with the EQ specification		[R]	[S]										
3. Obtain Word version of current revision or a new reference number from document controller		[R]											
4. Revise or compile EQ specification/requirements.		[R]											
5. Verify if the installed or modified equipment meet the EQ requirements?		[R]											
6. Justify any difference between the requirement and actual test performed.		[R]	[S]										
7. Go to C: Review/Update the EQ Maintenance Requirements Manual (EQMM).													331-219
C. REVIEW/UPDATE THE EQMM													
1. New EQ preservation maintenance and installation and surveillance requirements, lessons learned from Industry/Operating Experience, Research & Development findings, have been defined.		[R]		[S]		[S]							Documented in approved EQ file/ EQ Specification Template 331-496 or EQ Test Reports.
2. Obtain Word version of current revision of EQMM from NE DRM		[R											331-219
3. Update the EQMM 331-219 with the relevant information.		[R]											As per 331-3
4. Go to D: REVIEW AND AUTHORISATION													

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Flow Path:
Main Flow Secondary Flow

ACTIVITIES	ORIGINATOR	MATERIALS RELIABILITY GROUP	DESIGN ENGINEERING	MAINTENANCE EXECUTION	MATERILAS RILIABILITYMANAGER	SYSTEMS ENGINEERING							Notes & References
	1	2	3	4	5	6	7	8	9	10	11	12	
D. REVIEW & AUTHORISATION													
1. Issue the draft document or EQ Specification Template for review.		[R]	[R]	[S]		[S]							
2. Review the draft document or EQ Specification Template and return any comments to the compiler for resolution.	[S]	[R]	[S]	[S]		[S]							
3. Correlate and resolve all comments and amend the draft EQ document or EQ Specification Template as required.		[R]											
4. Sign and submit the EQ document to the reviewers for signature.	[S]	[R]	[R]	[S]		[S]							
5. Authorise the EQ document. Or EQ Specification Template		[R]			[A]								Process in accordance with 331-3
6. Submit signed hardcopy and electronic copy to NE document controller for storage, processing.		[R]											
7. Go to E: IMPLEMENTATION													

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Flow Path:
Main Flow Secondary Flow

ACTIVITIES	ORIGINATOR	MATERIALS RELIABILITY GROUP	DESIGN ENGINEERING	MAINTENANCE EXECUTION	MATERIALS RELIABILITY MANAGER	SYSTEMS ENGINEERING							Notes & References
	ORGANISATION / FUNCTION												
	1	2	3	4	5	6	7	8	9	10	11	12	
E. IMPLEMENTATION													
1. Issue the EQ requirements (including Maintenance, Surveillance, Monitoring and Inspections), for each Maintenance Execution group.		[R]		[S]		[S]							Refer to EQMM 331-219
2. Discuss a suitable completion dates with each of the Maintenance Group managers and load onto DevonWay as general actions or SAP Notifications		[R]		[S]									Refer to EQMM 331-219
3. Compile/revise service notifications as required.		[S]		[R]									Use SAP change control form
4. Compile/review working procedures as required.		[S]		[R]									
5. Review all completed service notifications and maintenance working procedures against the EQ maintenance requirements.		[R]											Refer to EQMM
6. Raise the Service notifications & maintenance working procedures.				[R]									SAP change control process
7. Follow the SAP change control process for classification, scheduling and download dates.				[R]									As per EQ 331-219 As per Work Control (SAP change control process)

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Main Flow Secondary Flow

ACTIVITIES	ORGANISATION / FUNCTION												Notes & References
	ORIGINATOR	MATERIALS RELIABILITY GROUP	DESIGN ENGINEERING	MAINTENANCE EXECUTION	MATERIALS RELIABILITY MANAGER	SYSTEMS ENGINEERING							
	1	2	3	4	5	6	7	8	9	10	11	12	
F. EVALUATING COMPONENT FAILURES / NON-CONFORMANCES													
1. Identify components failure, or equipment deficiency relating to EQ components including cable failures	[R]			[S]		[S]							CF or NC process
2. Raise a Corrective Actions	[R]					[R]							As per KAA-688
3. Perform evaluation or assessment		[S]				[R]							Follow the NCR process for Non-conformance
4. Identify corrective measures required to restore equipment to service or replace with new equipment		[S]				[R]							
5. Send evaluation or assessment report to MRG / EQ Engineering for review						[R]							
6. Issue final report and implement corrective actions						[R]							
G. REPLACEMENT OF EQ EQUIPMENT													
1. Identify EQ Equipment to be replaced based on Qualified Life, Failure, etc.		[I]		[R]		[I]							Refer to 331-219
2. Verify that the equipment is being replaced with an identical equipment or alternative but qualified equipment as per equivalency process/mod			[S]	[R]									Refer to applicable Equivalency Study or Modification

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ACTIVITIES	ORIGINATOR	MATERIALS RELIABILITY GROUP	DESIGN ENGINEERING	MAINTENANCE EXECUTION	MATERIALS RELIABILITY MANAGER	SYSTEMS ENGINEERING							Notes & References
	1	2	3	4	5	6	7	8	9	10	11	12	
3. Follow correct maintenance process and procedures for replacement				[R]									Complete the EHR
4. Raise an EWR to MRG to update the EQMM 331-219				[R]									Inform EQ Programme Owner
H. EVALUATION OF RELEVANT OPERATING EXPEREINCE													
1. Obtain and review relevant OE (internal or external)	[S]	[R]											KAA-688
2. Evaluate impact on EQ		[R]											
3. Document findings and raise appropriate actions to prevent similar occurrence		[R]											
4. Update the EQ requirements, if required.		[R]											331-219
I. RE-ASSESSMENT OF QUALIFIED LIFE													
1. Identify Existing EQ TLAAs to be re-assessment		[S]	[R]										Refer to 331-219
2. Review original Test Reports, EQ File & DSE		[S]	[R]										
3. Obtain applicable plant data, i.e temperature, radiation, transients, OE, etc		[S]	[R]										
4. Revalidate EQ TLAAs		[S]	[R]	[S]									

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ACTIVITIES	ORIGINATOR	MATERIALS RELIABILITY GROUP	DESIGN ENGINEERING	MAINTENANCE EXECUTION	MATERIALS RELIABILITY MANAGER	SYSTEMS ENGINEERING							Notes & References
	1	2	3	4	5	6	7	8	9	10	11	12	
5. Update the relevant EQ Files with new information		[S]	[R]										
6. Update EQ Requirements specified in EQMM 331-219		[R]											Refer to 331-219
7. Raise appropriate actions to update SAP with new the Qualified Life		[R]											
J. AGEING MANAGEMENT REVIEW													
1. Check if associated ageing degradations and mechanisms are identified		[R]											Refer to 331-275
2. Create links to all relevant plant programmes and processes		[R]											
3. Review IGALL Master Table or other Industry sources for new ageing effects/ageing degradations		[R]											
4. Update the Ageing Database and EQMM, if required		[R]											As per procedure 331-275
K. Programme Review													
1. Check effectiveness of the EQ Programme, via Health Report and Audits		[R]	[S]	[S]	[S]								Refer to 331-148
2. Review/update the programme requirements, as required.		[R]											