Eskom	Standard	Nuclear Engineering

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Content

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1. Introduction

This standard is to ensure that a uniform approach is used when compiling an equivalency study, that all the requirements are satisfied, and that the layout is uniform and standard.

2. Supporting Clauses

2.1 Scope

This document is applicable to all plant-related items that require replacement with equivalent or alternate items.

2.1.1 Purpose

To establish the requirements for the technical evaluation of replacement items at the Koeberg Operating Unit.

2.1.2 Applicability

This document shall apply throughout Nuclear Engineering.

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] 331-2 Nuclear Engineering Management Manual

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

[4] 331-143 The Equivalency Process to Change Plant

[5] 331-155 Guide for the preparation of an Equivalency Study

[6] 331-408 Equivalency Study Template

[7] 331-412 Equivalency Check Sheet Form

[8] 331-275 Process for the Development and Control of Ageing Management at Koeberg Operating Unit

[9] 240-149139512 Ageing Management Standard

[10] 240-101650256: Ageing Management Matrix

2.2.2 Informative

[11] Plant Support Engineering: Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants - Revision 1. EPRI, Palo Alto, CA: 2006. 1008256

[12] MIL-STD-973: Military Standard Configuration Management

[13] GGG-1299: Guide for Technical Writing

[14] 331-93 Guide for Classification of Plant Components, Structures and Parts

[15] 331-135 Process for Performing Safety Evaluations, Screenings, and Safety Justifications

[16] RD-0034 Quality and Safety Management Requirements for Nuclear Installations

[17] 331-219 Equipment Qualification Maintenance Manual

[18] RG-0027 Ageing Management and Long Term Operations of Nuclear Power Plants (Interim Regulatory Guide)

2.3 Definitions

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

2.3.2 Alternate item: A replacement item not physically identical to the original. These replacement items require an equivalency evaluation to ensure that the design function will be maintained.

2.3.3 Alternate Item Procurement: The replacement of an item with an item not physically identical to the original.

2.3.4 Bounding Conditions: Parameters that envelop the normal, abnormal and accident conditions an item is expected to meet during its lifetime in the plant (e.g. temperature, pressure, humidity and seismic response spectra).

2.3.5 Certificate of Conformance (C.O.C): A document certified by a competent authority that the supplied goods or service meets the required specifications. It is also called a certificate of compliance, or a certificate of conformity.

2.3.6 Certificate of Interchangeability (C.O.I): A certificate supplied by the OEM and signed by the OEM QA manager, stating that the proposed item is equivalent to the obsolete item. If a C.O.I. is supplied by the OES, a documented technical evaluation proving that the proposed item is equivalent to the obsolete item is required.

2.3.7 Common Cause Failure: When a single fault results in the corresponding failure of multiple components.

2.3.8 Common-Mode Failure: Multiple failures attributed to a common cause.

2.3.9 Compiler: An authorised person who is competent and takes responsibility for compiling documents.

2.3.10 Controlled Disclosure: Controlled disclosure to external parties (either enforced by law, or discretionary)

2.3.11 Critical Characteristics for Design: Those properties or attributes that are essential for the item's form, fit and functional performance. Critical characteristics for design are the identifiable and/or measurable attributes of a replacement that provide assurance that the replacement item will perform its design function.

2.3.12 Design Bases: The fundamental requirements for a system or structure that define the bounding parameters that ensure that the licensing basis requirements are met.

2.3.13 Design Function: The operation that an item is required to perform to meet the component or system design basis.

2.3.14 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 loss of coolant accident (LOCA) or high line break (HELB) (including steam line break (SLB)).

2.3.15 Equipment Qualification: 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

2.3.16 Equipment: Any plant component or part.

2.3.17 Equivalency Evaluation: A technical evaluation performed to confirm that an equivalent item or an alternate replacement item (not identical to the original) would satisfactorily perform its design function.

2.3.18 Failure Mode: The effects or conditions that result from an item's credible failure mechanism.

2.3.19 Equivalent Change: A change that does not result in an adverse change to those bounded technical requirements that (1) ensure performance of design basis functions or (2) ensure compliance with the plant licensing bases of either the item(s) or applicable interfaces.

2.3.20 Equivalent Item: A replacement item whose introduction to the facility does not alter the design functions of the SSCs.

2.3.21 Failure Mode: The effects or conditions that result from an item's credible failure mechanism.

2.3.22 Failure Mode and Effects Analysis (FMEA): An evaluation of an item's credible failure mechanisms and their effects on system or component functions.

2.3.23 Fit: The ability of an item to physically interface or interconnect with or become an integral part of an item.

2.3.24 Form: The shape, size, dimensions, mass, weight, and other visual parameters, which uniquely characterise an item. For software, form denotes the language and media.

2.3.25 Function: The action or actions that an item is designed to perform.

2.3.26 Identical item: An item that exhibits the same technical and physical characteristics (physically identical fit, form and function).

2.3.27 Item: Any level of unit assembly, including structures, systems, subsystems, subassembly, component, part, or material.

2.3.28 Like-for-like Procurement: The replacement of an item with an identical item.

2.3.29 Obsolete Item: Items in plant service that are no longer manufactured, or are otherwise difficult to procure and qualify.

2.3.30 Original Item: The item installed during construction, or because of a design change.

2.3.31 Page Change: A page change is when only a page(s) need to be updated due to an editorial correction or minor changes.

2.3.32 Replacement item: An item that replaces an original or installed item that can be either identical to the original or an alternate item.

2.3.33 Reviewer: An authorised person from Specification Engineering who is technically competent and takes responsibility for reviewing the technical content of documents.

2.3.34 Subject Matter Expert: An expert in a particular area or on a specific subject.

2.4 Abbreviations

AMM	Ageing Management Matrix
CCF	Common Cause Failure
CE	Component Engineering
CMF	Common Mode Failure
C.O.C	Certificate of Conformance
C.O.I	Certificate of Interchangeability
DCC	Document Control Centre
DDR	Document and Drawing Revision
DEVONWAY	Corrective Action and Observation Programmes
DSE	System Description Manual
E-BOM	Engineering Bill of Materials
EPRI	Electrical Power Research Institute
EQ	Equipment Qualification
FMEA	Failure Modes and Effects Analysis
GA	General Action (Devonway)
HELB	High Energy Line Break
KOU	Koeberg Operating Unit
LOCA	Loss of Coolant Accident
M-BOM	Maintenance Bill of Materials
MM	Maintenance Manual
MRG	Materials Reliability Group
NE-CMG	Nuclear Engineering Configuration Management Group
OE	Operating Experience
OEM	Original Equipment Manufacturer
OES	Original Equipment Supplier
PCR	Procedure Change Request
PEG	Procurement Engineering Group
RE	Reliability Engineering
SAP	Systems, Applications and Products
S-BOM	Super Bill of Materials
SEG	Specification Engineering Group
SLB	Steam Line Break
SME	Subject Matter Expert
SSC	Structures, Systems and Components
TCR	Training Change Request
TMG	Training Material Group
TTG	Technical Training Group

2.5 Requirements

The Specification Engineering Group (SEG) manager is responsible for the development and maintenance of requirements associated with the equivalency process.

2.5.1 Compiler:

- The authorised compiler shall ensure the completeness and technical accuracy of the equivalency study and that all feasible options have been considered. The compiler shall acquire input from other disciplines, if necessary. The study shall be compiled in accordance with GGG-1299 Guide for Technical Writing.
- The compiler shall as a minimum specify:

a) Design functional requirements, operating modes, equipment classifications and training requirements of the replacement items;

b) Critical characteristics for design (properties or attributes that are essential for the system, structure and component's (SSC's) form, fit and functional performance) of replacement items that mitigate failures and contribute to proper functional performance;

c) Adequate technical and quality assurance requirements in commercial/procurement documents to assure that proper replacement items are obtained. An equivalency check sheet shall be completed and will form part of the equivalency.

d) Ensure the completeness and technical accuracy of the equivalency study and that all feasible options have been considered. The compiler shall acquire input from other disciplines, if necessary. The study shall be compiled in accordance with GGG-1299 Guide for Technical Writing.

2.5.2 Reviewer

a) The independent authorised reviewer shall verify the completeness and technical accuracy of the equivalency study and that all the relevant standards (local and international) have been considered.

b) When additional specialist review is required, use will be made of subject matter experts (SME) from within the Chemistry Department, Maintenance Department, Systems Engineering, and/or Nuclear Engineering.

c) When the interpretation of standards relating to the nuclear industry is involved, an independent review is required. The independent reviewer shall ensure that all the requirements are covered and that the conclusions drawn are correct.

d) The reviewer shall as a minimum review effectiveness and compliance with reference to commercial, technical, process flow, and product quality aspects.

2.5.3 Authoriser

The authoriser shall ensure that:

a) The compiler and reviewer are suitably trained and authorised to perform their respective tasks.

b) The equivalency process has been correctly followed and that all options have been considered as detailed in The Equivalency Process to Change Plant Procedure 331-143 and the
Guide for the preparation of an Equivalency Study 331-155

c) An independent review has been performed in accordance with § 3.1.3.

3. Document Content

3.1 General

Critical design characteristics essential for evaluating the SSC's form, fit and functional performance shall be established up front.

Equivalent items shall be evaluated for functionality, form and fit as defined in §3.1.4

Functional requirements shall include operation in normal, transient, and accident conditions.

Requirements for fit shall address all applicable plant interfaces including civil, electrical, environmental, chemical, software, SSC, process interfaces, material compatibility, and applicable engineering codes and standards.

Requirements for form shall include dimensional, mass, spatial requirements, and operator human-machine interfaces.

Equivalency Check Sheet 331-412 listing critical parameters for comparison (evaluation) shall be used to ensure a consistent approach to equivalencies.

The completed Equivalency Check Sheet shall form part of the equivalency study.

A graded approach shall be followed with three possible evaluation process routes:

a. **Like for Like**: This process shall be used to determine the degree of engineering evaluation necessary to specify the item correctly. If the design of the item has not changed, the technical and quality requirements can be specified using the current data sheet. A simple short form engineering evaluation is required.

b. **COI with limited technical evaluation data**: This shall include an evaluation of the variances. Note should be taken that material changes and manufacturing methodology changes are considered variances and should be evaluated for impact and introduction of new failure modes. This is only valid for original engineering manufacturers (OEMs).

c. **Alternate items**: This process requires the full technical evaluation process.

A safety screening shall be compiled for the equivalency study in accordance with the Process for Performing Safety Evaluations, Screenings, and Safety Justifications 331-135. If a safety evaluation is required, the minor modification or modification process is to be followed.

Impact on the safety analysis report (SAR), including editorial changes, shall be assessed. If any changes (other than editorial changes) are required to the SAR, then a design change process shall be followed.

An average target duration of 3 months shall be acceptable for the completion of an equivalency study since registration of the engineering work request.

3.2 Criteria for Acceptability

- Equivalent changes shall maintain the intended design and licensing bases but are allowed to result in a different configuration than the current or original installation. Hence, an equivalent change could result in either a like-for-like item or an alternate item.
- Equivalent changes might result in both hardware changes and document-only changes that do not affect the bounded technical requirements in existing plant documents.

i. Like-For-Like Procurement Criteria

1. Like-for-like procurement shall meet the following criteria:

a) The fit, form and function of the replacement items shall be the same as that of the original item, without any exceptions.

b) The replacement item must be fully interchangeable with the original item.

ii. Alternate Item Procurement Criteria

1. While the design function of the original item may never be altered, the form and fit of the replacement item may be compromised, provided that the following conditions are met:

a) The change does not adversely impact the design function or the method of performing the design function.

b) The change does not introduce additional unintended functions.

c) The replacement item does not require an introduction of additional system changes in order to enable it to perform its design function.

d) The change can be performed within the constraints of the design bases or the bounding conditions.

e) No changes are required to the system, interfacing systems, supporting structures or adjoining system elements.

f) The safety screening shall not lead to a safety evaluation or a SAR change that affects the design or licensing bases.

g) A full technical engineering evaluation shall be performed in order to ensure that the design bases are not adversely impacted.

3.3 FORMAT AND CONTENT

3.3.1 Equivalency Numbering

The standard format of the equivalency number should read as follows:

Format: M, I or Exxx/yyE

M : Mechanical
I : Instrumentation
E : Electrical
xxx : Sequential number
yy : year

3.3.2 Content of the Equivalency Study (Equivalency Template 331-408)

The output of an equivalency study shall be a document containing the following mandatory headings:

3.3.2.1 Scope

The scope shall briefly describe the trigramme (functional location), the original equipment and the proposed replacement, the function of the equipment in detail, the reason for the equivalency and the classification of the equipment.

3.3.2.2 References

All reference material used in compiling the equivalency study shall be listed.

3.3.2.3 Equipment Requirements

The following are the minimum requirements:

a) Conditions in which the equipment is expected to operate, including transient and accident conditions if applicable.

b) The functional and process requirements of the system in which the equipment is being used.

c) The fit and physical requirements of the equipment and the impact on the assembly of the proposed equipment.

d) The verification and / or validation to be carried out and the quality assurance required. The verification and validation requirements must be commensurate with the classification of the item.

e) The commercial availability of the proposed equipment.

3.3.2.4 Technical Evaluation

The classification and specifications of the proposed equipment shall be evaluated against the form, fit, and functional requirements of the system in which the equipment will be used.

3.3.2.5 Operating Experience

List all OE found for the item

3.3.2.6 Failure Mode and Effects Analysis (Where applicable, for Safety Related Items)

A review shall be made to ascertain the item's credible failure mechanisms and the effects those failure mechanisms have on the system or component functions.

3.3.2.7 Ageing Management (Where applicable, for Safety Related Items)

- Identify known/potential ageing degradation/effects related to the equivalent item in accordance with the Ageing Management process 331-275 (Process for the Development and Control of Ageing Management at Koeberg Operating Unit), the Ageing Management Standard (240-149139512), to ensure that the proposed replacement item is operated and maintained within acceptable limits.
- State the identified ageing degradation and ageing effects if they are not covered in the existing Ageing Management Matrix.

3.3.2.8 Obsolescence

The dates for the planned / expected end of production and end of support for the proposed equipment shall be stated here.

3.3.2.9 Conclusions

a) Capture the conclusions resulting from the technical evaluation, taking into consideration all the issues of the study in general.

b) The findings of the safety screening shall also be included.

3.3.2.10 Installation

All differences affecting the installation of the equivalent equipment, including all relevant information, shall be comprehensively and clearly documented.

3.3.2.11 Training

A training change request (TCR) shall be raised for the Training Materials Group (TMG) / the Technical Training Group (TTG) to identify any training requirements that might be necessary as a result of the equivalent change. Documentation Updates

a) All documents that require changing and/or inclusion shall be detailed and shall include the relevant document and drawing revision (DDR) and / or procedure change request (PCR) numbers.
b) Equivalency to be logged on Devonway as type GA.

3.3.2.12 Commercial Updates

All SAP numbers associated with the original equipment that will require updating or changing and any further instructions for the commercial configuration management SAP group shall be fully documented.

3.3.2.13 Attachments

Data sheets of the original and equivalent equipment as well as all relevant documentation shall be attached to the equivalency study. No double-sided copies are permitted.

3.3.3 Raising the associated actions required on Devonway

Upon the authorisation of the equivalency, the following is to be created in Devonway, using the parent general action (GA) number that was raised for the equivalency, by adding a new action:

a) Raise a GA on Devonway to Nuclear Engineering Configuration Management Group (NE CMG) to have a supplier bill of material (S-BOM) created and to have the relevant DDR's processed to update Maintenance Manuals, Drawings and Material Lists.

b) Raise a GA on Devonway to MATERIALS to capture the Equivalency in SAP.

c) Raise a CA on Devonway to the relevant Maintenance group (EMS, IMS, MMS) and word as follows:

d) *"Assess the impact of equivalency XXX/xxE on applicable working procedures, training, M-BOM's and service notifications, and update if required".*

e) If applicable, raise a GA on Devonway to NE MRG to assess the impact on applicable plant programmes and the Ageing Management Matrix.

f) Raise a GA (Type Equipment Reliability Change Request) on Devonway to RELIABILITY ENGINEERING to have the preventive maintenance basis reviewed. ***This is only required if a failure mode and effect analysis (FMEA) has been done and there are changes required.***

g) For equivalencies that affect the EQ programme, raise a GA on Devonway to NE MRG to review the EQ programme for relevance.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
S Ebrahim	Senior Advisor - SEG
B Ogle	Senior Advisor - SEG
Bradley Paulse	Senior Advisor - Materials Management
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5. Revisions

Date	Rev.	Compiler	Remarks
November 2020	5	MV Phalane	Inclusion of section 3.3.2.7 on Ageing Management to address SE 38545-016 CA
July 2020	4	Mary-Ann Scholtz	Update section 5.4.2.14. Change GAs to CAs.
May 2016	3	PN Clark	Complete revision to address the QA audit findings detailed in CR 90904 and CR 90907
July 2015	2	PN Clark	5.4.2.10 Detail the requirement to capture the equivalency study on Devonway
November 2014	1	GP Shale	2.1 PURPOSE – Replaced “evaluating alternative equipment used” with “the technical evaluation of replacement items”. 4.1.1 Updated the definition of Alternate Item. 4.1.2 Added the definition of Alternate Item Procurement 4.1.11 Added the definition of Design Basis. 4.1.12 Added the definition of Design Functions. 4.1.14 Added the definition of Equivalent Change. Included “5.3 CRITERIA FOR ACCEPTABILITY. 4.1.17 Updated the definition of Equivalent Item. 4.1.25 Replaced the definition of “Like for like” with the definition of Like-for-like Procurement. 4.1 Included SSC. 5.4.2.9 Made the requirement to raise a TCR mandatory for all equivalency studies.

6. Development Team

N/A

7. Acknowledgements

N/A