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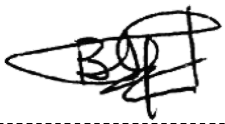		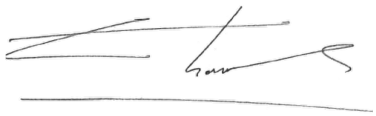
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Content

1. Introduction

This guide implements the processes of how to compile an Equivalency Study using the following EPRI guidance.

- A technical evaluation process for assuring that replacement items procured for nuclear power plants are equivalent to the original items
- A method for determining the design functions, functional safety classifications, and functional modes of replacement items
- Methods for determining the critical characteristics for design of replacement items that mitigate failures and contribute to proper functional performance
- Methods for specifying adequate technical and quality requirements in procurement documents to assure that proper replacement items are obtained

This guide also serves as evidence that the requirements stated in Nuclear Engineering Management Manual 331-2 are met.

2. Supporting Clauses

2.1 Scope

This guide is applicable to the preparation of all plant equipment equivalencies.

2.1.1 Purpose

To provide guidelines on the content and writing of equivalency studies at Koeberg Operating Unit, ensuring a structured and consistent equivalency study.

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

[6] 331-144 Standard for Performing an Equivalency Study

[7] 331-135 Process for Performing Safety Evaluations, Screenings, and Safety Justifications

2.2.2 Informative

[8] 240-149139512 Ageing Management Standard
[9] Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants (NCIG-11)
[10] Plant Support Engineering: Guidelines for the Technical Evaluation of Replacement Items in Nuclear Power Plants - Revision 1, EPRI, Palo Alto, CA: 2006. 1008256.
[11] MIL-STD-973 Military Standard Configuration Management
[12] GGG-1299 Guide for Technical Writing
[13] Boric Acid Corrosion Guidebook, Revision 1: Managing Boric Acid Corrosion Issues at PWR Power Stations, EPRI, Palo Alto, CA: 2001. 1000975.

2.3 Definitions

2.3.1 Alternate item: A replacement item not physically identical to the original, but totally interchangeable with minor changes required to the plant or documentation. These replacement items require an equivalency evaluation to ensure that the design base and function will be maintained.

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

2.3.3 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.

2.3.4 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.

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

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

2.3.7 Compiler: An authorised person who is competent and takes responsibility for compiling documents, and is authorised in writing.

2.3.8 Critical Characteristics for Design: Those properties or attributes that is 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.

2.3.9 Equipment: Any plant component or part.

2.3.10 Equivalency Study: The study comparing the original equipment and the proposed equivalent item.

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

2.3.12 Failure Mode and Effects Analysis (FMEA): An evaluation of an item's credible failure mechanism and their effect on system or component function.

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

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

2.3.15 Function: The action or actions which an item is designed to perform.

2.3.16 Item: Any piece of plant equipment.

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

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

2.3.19 Original Item: The item installed during construction, or as a result of a design change.

2.3.20 Page Change: A page change is when only a page needs to be updated due to an editorial correction.

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

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

2.4 Abbreviations

Abbreviation	Explanation
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	“CAP 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)
ISI	In-Service Inspection
IST	In-Service Testing
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
NE EPG	Nuclear Engineering Programmes Group
OE	Operating Experience
OEM	Original Equipment Manufacturer
OES	Original Equipment Supplier
PCR	Procedure Change Request
PEG	Procurement Engineering Group
RE	Reliability Engineering
SAP	System Application Products
S-BOM	Super Bill of Materials
SME	Subject Matter Expert
SPE	Specification and Procurement Engineering Group
TCR	Training Change Request
TMG	Training Material Group
TTG	Technical Training Group

2.5 Roles and Responsibilities

The SPE Manager is responsible for making sure that this guide is followed, and that the process is correctly implemented and maintained.

2.6 Process for Monitoring

The Specification & Procurement Engineering (SPE) Manager is responsible for ensuring that the guidance provided in this procedure is correctly implemented and maintained.

2.7 Related/Supporting Documents

- 331-408 Equivalency Study Template
- 331-412 Equivalency Check Sheet Mechanical, Electrical or C&I Form
- 331-216 Manufactures / Suppliers Catalogue Form

3. Document Content

3.1 General

The registered equivalency study template 331-408, as referenced in section 2.7, is to be used to compile an equivalency study.

3.2 Control and Administration

Equivalencies are numbered P xxx/yyE, where prefix P is one of E (electrical), I (Instrumentation) or M (Mechanical), xxx being the next sequential number, yy being a two-digit year representing the year of initiation of the equivalency study, and suffix E for equivalency being common, e.g. E005/01E, M013/99E, I102/02E. The numbers are allocated by SPE and are recorded on the Design Information System (DIS) database.

If an equivalency has to be revised, it keeps the same equivalency study number, but the revision number changes.

A full change requires revision of the whole document. A page change requires revision of the affected pages, together with the title and revision information page.

Revision numbering shall follow the principles laid out in 331-3, i.e. a full revision gets a number, and a page change gets a number plus a letter.

3.3 Records

Equivalency Studies shall be stored in scanned image format as lifetime records.

All important documents, or similar, that are deemed important to keep for future reference, can be filed separately with the SPE copy of the equivalency. Remember that storage space is at a premium.

3.4 Content of an Equivalency

The following are guidelines of what should be included in an equivalency study. Topics that are not applicable for a particular situation shall be addressed as “None” or “N/A” (Not Applicable) to demonstrate that the issue has been considered.

3.5 Introduction

Briefly explain why the equivalency study is required. The introduction should not contain requirements.

3.6 Scope

Briefly describe the original installed equipment, the previous replacement, if relevant, and the new proposed replacement equipment, stating the full model or type numbers if known.

3.7 Equipment functional location

State the functional location of the equipment to which the equivalency is applicable. If a generic equivalency is being compiled, various functional locations can be inserted. Take care not to include other functional locations that appear to have the same equipment installed without thorough investigation.

3.8 Function of the Equipment

Provide a brief description of the function of the equipment and/or the system of which it forms part.

3.9 Reason for Change

State the reason why the equivalency has been raised, e.g. obsolescence, redundancy, part number change, reverse engineering project, problematic equipment, cost benefit, spares rationalisation, etc.

3.10 Classification

State the highest classification of the equipment under consideration. More than a single classification can be stated, assuming that more than one equipment functional location is applicable. The following is an example of a classification:

Classification No.	**:**	**0201/87C**
Safety	**:**	**NSF**
Seismic	**:**	**NC**
Quality	**:**	**Q4**
Environmental	**:**	**0**
Importance	**:**	**AR (331-94) from Z:\NalApp / Classification database**

For electrical and I&C items, verify if they are included in the EQ program scope as per 331-219 or 240-155832775 (Equipment Qualification Master List (EQML) on NAL). If they are, review the environmental qualification and seismic qualification to ascertain whether the equivalent item meets EQ requirements and complete the EQ Specification Template 331-496.

3.11 References (Normative and Informative)

State all reference documents used in compiling the equivalency, i.e. MM, DSE, catalogues, communication documents, etc. Make full reference so that other persons can at a later stage readily locate these should it be necessary to obtain a better understanding. It is important to verify and confirm the correctness of any information found in the reference documents. This can be done by contacting the System Engineer, Maintenance Department, performing a plant walk down, cross-referencing, etc.

3.12 Equipment Requirements

3.13 Service Conditions

Provide full references for service conditions (i.e. normal and process environmental service conditions) to ensure that the information can be readily located and verified. It should also be clearly stated when assumptions are made about the service conditions.

3.14 Normal Environment

Refer to the relevant DSE for the design base normal environmental conditions. If this information is not available in the DSE, state the conditions in accordance with the normal everyday values using seasonal averages for minimum and maximum values. Our own weather station can be helpful, but make allowances for being indoors, running conditions, etc. SI units of measurement shall be used, unless imperial units are still in general daily use. In such a case, both the metric and imperial measurements should be stated. The compiler should add any additional environmental conditions not listed in the template, or delete those not applicable.

Temperature	:	State min/max in °C
Pressure	:	Use the word “Atmospheric” or state absolute or min/max pressure as applicable.
Relative Humidity	:	State min/max in % (Normally 40% to 80%).
Radiation	:	State expected values or use the word “Background”

3.15 Process Environment

The environment referred to with regard to electrical equipment is the outside environment, whereas with regard to mechanical equipment, it is usually the inside environment that is of importance, i.e. the fluid properties inside pipes, valves, tanks, etc.

Temperature (max)	:	State in °C.
Pressure (max)	:	State max system pressure.
Relative Humidity	:	State min/max in % (Normally 40% to 80%).
Radiation	:	State expected values or use the word “Background”

Medium : State what the medium within is.
(Note: if boric acid, use EPRI guide 1000975: Boric Acid Corrosion Guidebook page 9-6)

The environment referred to with regard to electrical equipment is the outside environment, whereas with regard to mechanical equipment, it is usually the inside environment that is of importance, i.e. the fluid properties inside pipes, valves, tanks, etc.

3.16 Accident Conditions

State the known unusual or extreme conditions in which the equipment is expected to operate. The headings above and/or more may be applicable. Consider any special considerations that would apply, e.g. earthquake (seismic), flooding, LOCA, etc. This information can be found in the relevant DSE. Should the equipment not be required to operate under accident conditions, a statement to this effect should be added.

3.17 Functional Requirements

State in full what the functional or service requirements of the system in which the equipment is being used are and not the parameters of the existing equipment. This information should be available in the DSEs and Maintenance Manuals. The specification of the original equipment should only be used as functional requirements, if there is no system data available in the DSE or Maintenance Manuals. These functional requirements should reflect those unique parameters that are vital to making the decision as to the suitability of the proposed items. Each functional requirement is to be inserted in its own row in the Technical Evaluations table (Make use of the Equivalency Check Sheet. The Equivalency Check Sheet shall be saved in the equivalency file and attached as part of the equivalency.

The Equivalency Check Sheet template, reference 331-412, can be found on **Hyperwave.** If an Equivalency Check Sheet has not been compiled for the item being evaluated, the compiler of the equivalency study is responsible for the compilation of the check sheet.

Function: the replacement item shall perform its design and safety functions in an equivalent manner and within the same acceptance criteria and parameters as the existing item to be considered equivalent in function.

Form: the replacement item shall have the changes in geometry, size and shape from the existing item evaluated to be acceptable to be considered equivalent in form. For software, form donates the language and media.

Fit: the physical dimensions of the replacement item, as well as connections to existing plant equipment, shall be verified to be acceptable, to be considered equivalent in fit.

Material: the replacement item shall be made of equal or better material of construction (medium) for the existing item to be considered equivalent in material.

3.18 Physical Requirements

State in full what the physical requirements are of the equipment being used that will impact on the assembly or mounting of the proposed new equipment. These requirements should reflect those unique parameters that are vital in deciding whether or not the proposed new equipment will physically fit into place. Evaluate each physical requirement by placing it in a separate row in the Technical Evaluations table. State a reason for those inputs that are “Not Applicable”. (Make use of the Equivalency Check Sheet. The Equivalency Check Sheet shall be saved in the equivalency file and attached as part of the equivalency.)

3.19 Verification and Test

State any method that is to be adopted to verify and/or test the equipment. The tests stated should be those of KOU, or a third party on KOU’s behalf, is expected to witness and/or conduct. Be specific, especially naming the applicable procedures and/or standards and the parties involved at KOU and the acceptance criteria.

3.20 Quality Assurance

Elaborate on the quality assurance that is required following from the classification in section 2.5 of the equivalency. State what is required, e.g. should testing of the equipment itself be required. The tests that are expected should be stated. These are the tests and certificates that we expect the supplier (OEM or distributor) of the equipment to provide. State the details of any specifications that may exist for the procurement of the equipment. This is obviously more important for Q1 to Q3 qualified equipment.

3.21 Availability

State the supplier (if sole agent), agent or distributor name, if known, and any other relevant details such as lead times, minimum order quantities, etc., that may aid the users of the equivalency.

3.22 Technical Evaluations / Operating Experience

A graded approach shall be followed with three possible evaluation process routes. The compiler shall consider the workscope of the equivalency and select one of the three possible evaluation process routes:

Like for Like: This process shall be used for part number and/or manufacturer name changes only or COIs with a full technical evaluation. This is only valid for OEM and OES. This change should result in a short form equivalency study stating the proposed changes, reasons for the change, commercial updates, configuration control, full supporting technical information as an attachment along with the required data sheets updated and included in the respective DSE’s.

For this short form equivalency, sections 4.0, 5.0 and 6.0 can be omitted.

COI with limited technical evaluation data: This process could require the compilation of a component specification sheet for OEM/OES updating. 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 OEMs. For this short form equivalency, section 4.0 shall be omitted. Section 5.0 shall evaluate the variances only.

Replacement items (Alternative items): This process requires the full technical evaluation process.

Each description line in the first column should cover the functional (or service) and physical requirements in accordance with sections 4.2 and 4.3 of the equivalency, with actual numerical values in the second column. Columns 3 and 4 should contain the values being compared to the functional / physical requirements. Remember the comparison is between the proposed new parameters and the minimum / maximum functional / physical requirements of the system, i.e. columns 2 and 4, and not directly comparing columns 3 and 4. The last column allows comments of “same, acceptable, better, or see below”, which can be qualified by inserting a numbered note below the table block. Any comment of “acceptable or better” shall be justified with notes below the evaluation block. Add as many rows as necessary to ensure a complete technical evaluation.

Should the equivalent item require any optional extras, this fact should be clearly stated to ensure that the item is procured with such extras. The SAP purchase order text is usually taken from sections 4.2, 4.3 and 5.0. The fact that certain operations are required should be highlighted in these paragraphs. If the manufacturer uses product codes to specify the various options or combinations, these should be clearly provided.

3.23 Operating Experience

Make use of the OE to ensure that no problems are been encountered with the original installed equipment, and/or the proposed equivalent item at other nuclear installations worldwide.

3.24 Failure modes and effects analysis (FMEA) – where applicable.

FMEA is a methodology used for analysing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues. It is generally applicable to but not limited to complex electronic items e.g. instrumentation with different embedded software, motor soft starters etc.

FMEA is used to identify potential failure modes, determine their effect on the operation of the item, and identify actions to mitigate the failures.

A crucial step is anticipating what might go wrong with the product. While anticipating every failure mode is not possible, formulate as extensive a list of credible failure modes as possible.

State the item’s potential failure modes in this section and the actions identified to mitigate this failure mode.

3.25 Ageing Management Programmes

Use the classification database (ageing management), 240-119362012 (ISI) and 240-97087308 (IST) to verify whether the item covered by the equivalency study is included in either the ageing management, ISI or IST programme scope. If included in any one of these programmes, send the equivalency study to MRG for review and raise a GA for MRG to review the equivalency study for impact on ageing management and Ageing Management programmes.

3.26 Conclusions

At this stage the item under consideration is deemed equivalent. This fact needs to be clearly stated using a combination of words like "…due to fit, form and function of the proposed equipment…" and "…no changes to the design base of the Plant…" and "…is considered by SPE as a suitable replacement for the…". Where a COI from the original manufacturer has been obtained, the conclusion can merely reference this fact.

The findings or results of the safety screening shall be stated here. The wording used would be similar to "The outcome of the safety screening S ……, is that neither a Safety Evaluation nor NNR approval is required".

A statement shall be added as a recommendation to the relevant maintenance group to consider using different teams for each installation. This is to reduce the probability of Common Cause Failure.

3.27 Installation

All differences affecting the installation of the equivalent item must be documented in this section. Due to the fact that the equivalency is not a design package, all relevant information on the installation needs to be stated. Do not neglect the mounting requirements of the equipment. Should the equipment require special brackets, attachments, etc. this fact should be clearly stated with as much detail as possible.

Due to operating experience feedback, consideration of common mode effects is highly desirable. The common mode effects referred to include the failure of equipment installed in various places by the same team or person. Include in the equivalency, a paragraph that advises the users of the equivalency to consider means of minimising common mode effects when installing items in the plant. For example, a statement similar to the following should be included in the equivalency: "To minimise or eliminate the possibility of common mode effects when the item is to be installed in various places, it is advisable to have different teams or persons perform each of the installations".

3.28 Training

3.29 Engineering Training

Ascertain the effect of the replacement item on Engineering Training. Where Engineering training is required, raise a GA on DevonWay to the relevant Engineering Group (after the equivalency has been authorised) stating the training needs identified.

3.30 OPS / Maintenance Training

A TCR must be raised to TMG / TTG to assess the impact on OPS and Maintenance Training. State the TCR number in this section.

3.31 Documentation Updates

Detail all documents that have been identified as requiring updating as a result of the change to the item. Documents to be updated may include:

- Maintenance Manuals,
- DSE's,
- Drawings,
- Valve, / Pipe Listing,
- Installation Requirements,
- EQ Requirements,
- Maintenance Requirements,
- Procurement Requirements.

DDRs are to be raised where changes are required to be made to documentation, such as inclusion of catalogue into Maintenance Manual and component specific drawings. The Configuration Management Group can assist in raising DDRs. Documentation requiring changes should have the changes marked up in red and, together with the DDR, submitted to NE CMG. The end user of the equivalent item shall submit plant status DDRs on installing the item. (mention drawings).

Complete the EQ Specification Template 331-496 if the item under evaluation falls in the EQ scope.

A PCR is to be raised for any Operating Procedure that requires an update.

Equivalency to be logged on Devonway as type GA.

3.32 Commercial Updates

List all new SAP material numbers (allocated by Materials Planning Cataloguer) associated with the new items that will require updating or changing and any further instructions for the commercial Configuration Management / SAP groups. Be very clear and precise in the instructions since it is unlikely that the changes made will be checked.

Add all further instructions that are to be carried out to ensure complete commercial updates. A sample layout is shown below:

SAP purchase order text for material No. 0000000 must be created to reflect the following description.

MANUFACTURER : TELEMECANIQUE
SUPPLIER : All Control
EQUIPMENT TYPE : Fused Isolator
PART No. : GS1-DD3 and handle type GS1-AH103
SPECIFICATION : list here
CERTIFICATION : list here

3.33 Revision Information Page

In the block, record the changes made. The information pertaining to all revisions must remain for traceability and new information merely added as revisions are made.

3.34 Attachments

Attach data sheets of the original and equivalent items, as well as all relevant documentation. Each attachment is to have a cover page stating the number of pages, including the cover page. Clean, clear single sided copies are required due to the fact that it may be required to produce further copies from these and/or they may be scanned for electronic archiving. Facsimile paper copies shall not be used as attachments due to fading with time. Remember to number the attachments in accordance with the number assigned and keep them in numerical order. Each page must clearly reflect the equivalency number and revision.

3.35 Raising the associated actions required on Devonway

On the authorisation of the equivalency, the following is to be created in Devonway, using the parent GA number that was raised for the equivalency, by adding a new action General; Equivalences:

Raise a GA on Devonway to NE CMG to have an S-BOM created and to have the relevant DDR's processed to update Maintenance Manual, Drawings and Material Lists.

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

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

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

Raise a GA on Devonway to RELIABILITY ENGINEERING to have the maintenance basis reviewed. ***This is only required if a FMEA has been done and there are changes required.***

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Lester Thomas	Manager – SPE
Marck Fahrenfort	Senior Technician Engineering– SPE
Vivian Phalane	Senior Advisor – SPE

5. Revisions

Date	Rev.	Compiler	Remarks
July 2022	2	B Ogle	Complete revision to address the following: • The outcome of SE 38465 detailed in SE 38465-013GA and SE 38465-014GA. • The outcome of QA finding detailed in CR 127884. • To add Ageing Management and existing MRG program requirements.
May 2016	1	PN Clark	Complete revision to address the QA audit findings detailed in CR 90904 and CR 90907
October 2014	0	PN Clark	Original

6. Development Team

N/A

7. Acknowledgments

N/A

APPENDIX 1: Process

The generic process for the technical evaluation of replacement items is shown below. The user may bypass certain steps in the generic process where the required information has been developed or where the step is unnecessary.