| Eskom | PROCEDURE | NUCLEAR ENGINEERING |
|---|---|---|

Title: **Modifications to Simulator**

Document Identifier: **240-85520008**

Alternative Reference Number: **KAA-503**

Area of Applicability: **Eskom Holdings SOC Ltd**

Functional Area: **Design Engineering**

Revision: **3**

Total Pages: **15**

Next Review Date: **December 2025**

Disclosure Classification: **Controlled Disclosure**

| Compiled by | Functional Responsibility | Authorized by |
|---|---|---|
| **M. Scholtz** | **N. Mtoko** | **R. Goldstein** |
| **Engineer** | **Nuclear Technical Plan Manager** | **System Design Engineering Manager** |
| Date: 2022-12-07 | Date: 2022-12-12 | Date: 2022-12-13 |

## Nuclear Additional Classification Information

| | |
|---|---|
| Business Level: | **4** |
| Working Document: | **3** |
| Importance Classification: | **NSA** |
| NNR Approval: | **No** |
| Safety Committee Approval: | **No** |
| ALARA Review: | **No** |
| Functional Control Area: | **Nuclear Engineering** |

## Content

Page

# 1. Introduction

This document describes the process of implementing software model changes and control room hardware updates on the Licensed Operator Training Simulators at Koeberg Operating Unit.

# 2. Supporting Clauses

## 2.1 Scope

a) Applicable to:

- Licensed operator training simulators at Koeberg Operating Unit.
- Simulation software models.
- Software tools for the execution, control, creation or modification of simulation software models.
- Simulator control room instrumentation and the associated Panel I/O System hardware.

b) Not Applicable to:

- Modifications that affect the design basis of the simulator, or where the cost or complexity of the modification warrants the use of KAA-501.
- Operating system patches and updates where the nature of the testing applied shall be determined by the Simulator Engineer.
- Software modifications to the Simulator KIT system which is covered by procedure 331-84 "Modifications to Software on the KIT System".

### 2.1.1 Purpose

- To ensure that proposed plant modifications are screened for impact on the functional and physical fidelity of the licensed operator training simulators.
- To ensure that all proposed modifications to simulator software models and simulator control room panels and associated hardware are carried out in a controlled manner.
- To define simulator modification activities during the maintenance phase of the software lifecycle as defined in 331-174.
- To ensure full traceability of all applicable modification activities on the simulator.
- To ensure that modification activities take place within the time limits laid down in the applicable standards.

### 2.1.2 Applicability

This document shall apply to the Koeberg Operating Unit.

### 2.1.3 Effective date

The effective date means that from this date all training, artefacts and supporting systems required for compliance to the document requirements shall have been established and implemented. The effective date is the same as 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] 331-2 Quality Management Manual for Nuclear Engineering.

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

[4] 331-85 Design Basis Documentation Change Process

[5] KAA-501 Modifications to Plant, Plant Structures or Operating Parameters that Affect the Design Base

[6] 240-143604773 [KAA-709] Process for Performing Safety Evaluations, Screenings and Safety Justification

[7] KAA-848 Management of Software At KOU

[8] KAA-857 Management and Oversight of The Fullscope Operator Training Simulators At Koeberg Nuclear Power Station

[9] KGT-025 Simulator Maintenance, Access / Operation and Initial Conditions and the Training and Authorisation of Simulator Operators

[10] KWB-OP-PDB-001 Physics Data Book – Unit 1

[11] KWU-PC-SIM-001 Implementation of Simulator Software Modifications

[12] KSA-146 Simulator Testing Requirements

### 2.2.2 Informative

[13] ANS/ANSI 3.5 / 1998 Nuclear Power Plant Simulators for Use in Operator Training and Examination

[14] KAA-500 The Process for Controlled Procedures

[15] KSA-011 The Requirements for Controlled Documents

[16] 331-174 [KSA-020] Software Quality Assurance

[17] LD 1093 Requirements for the Full Scope Operator Training Simulator at Koeberg Nuclear Power Station

## 2.3 Definitions

**2.3.1 Category 1 Modification – A modification is classified as such if any of the following conditions are met:**

- Software models are modified in a way that has potential to negatively affect simulator fidelity relative to the reference unit.
- The changes proposed have the potential to negatively affect simulator capabilities.
- The changes proposed have the potential to negatively affect simulator performance with respect to repeatability of simulation model response during transients.

**2.3.2 Category 2 Modification – A simulator change that does not have the potential to negatively affect simulator fidelity, capabilities or repeatability, but involves:**

- Significant additions to code, logic, control and hydraulic schematics.
- Addition or removal of simulator functionality.
- New control room I/O devices.
- Any change that affects simulator memory mapping.

**2.3.3 Category 3 Modification – A minor simulator change involving:**

- Setpoint changes.
- Minor changes to existing code, logics, control and hydraulic schematics.
- Graphical changes to active schematics and panel graphics.

**2.3.4 Panel I/O:** the electronics sub-system involved with the transformation of computed information into analog and digital signals to drive control room instrumentation.

**2.3.5 Simulator Management Committee:** As defined in KGT-025.

**2.3.6 Specialist Reviewer:** A reviewer who is familiar with the Koeberg simulator software architecture or subject matter expert for a particular plant system.

## 2.4 Abbreviations

| Abbreviation | Explanation |
|---|---|
| **BLX** | Beginning of reactor core Life with equilibrium Xenon |
| **DR** | Defect Report |
| **EOL** | End Of reactor core Life |
| **I/O** | Input / Output |
| **MOL** | Middle Of reactor core Life |
| **NNR** | National Nuclear Regulator |
| **PMIR** | Plant Modification Impact Report |
| **SCR** | Software Change Request |
| **SMC** | Simulator Management Committee |
| **TD&RM** | Technical Documentation & Records Management |

## 2.5 Roles and Responsibilities

### 2.5.1 System Design Engineering Manager

- Responsible to ensure that the process described in this procedure is implemented and maintained.

### 2.5.2 Simulator Engineer

- Assesses impact of plant modifications on simulator.
- Designs and implements software modifications to simulator.
- Reviews simulator designs.
- Controls implementation of hardware modifications to simulator.
- Ensures configuration control of simulator and associated documentation.

### 2.5.3 Operating Training Group

- Identifies the training requirements.
- Performs verification and validation testing of simulator modifications.

### 2.5.4 TD & RM

- Archiving of records.

### 2.6 Process for Monitoring

The process is detailed in the Work Flow Responsibility Matrix (Appendix A), and consists of:

[A] Investigation and evaluation

[B] Design

[C] Design Review

[D] Implementation

[E] Core Model Update

### 2.7 Related/Supporting Documents

Appendix A – Workflow and Responsibility Matrix

Appendix B – Simulator Requirements Specification

## 3. Modifications to Simulator

Refer to Appendix A.

## 4. Acceptance

This document has been seen and accepted by:

| Name | Designation |
|---|---|
| J.D. Phillips | ESE |
| A. Van Der Heyden | Manager: OTG |
| S. du Toit | OTG Simulator Section Head |
| I. Greeff | RFE |
| M. Fahrenfort | Senior Technician |
| M. Scholtz | Document custodian |

## 5. Revisions

| Date | Rev. | Compiler | Remarks |
|---|---|---|---|
| December 2022 | 3 | M. Scholtz<br>(P. Harrisankar:-Co-compiler) | Full review.<br>Updated KSA-020 to 331-174.<br>Added references [7] and [8].<br>Removed names from section 4.<br>Added numbering to section 2.3 |
| February 2019 | 2 | D. M. G. Browne | Full review.<br>• Updated simulator defect to simulator issue as per KGT-025 update in Work Flow Matrix [A] 1.3 and 2.1. |
| October 2014 | 1 | J. R. Lagerwall | Original issue in new format, including a full review of KAA-503, which is superseded by 240-85520008<br>• Reference to KSA-101 removed from Work Flow Matrix [A] 3.2 due to irrelevance to the maintenance phase of a software lifecycle as per KSA-020<br>• Appendix B added |

## 6. Development Team

The following people were involved in the development of this document:

N/A

## 7. Acknowledgements

None

# Appendix A – Workflow and Responsibility Matrix

| WORK FLOW RESPONSIBILITY MATRIX | APPENDIX A |
|---|---|

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

| ACTIVITIES | 1 OPERATING TRAINING | 2 SIMULATOR ENGINEER | 3 PROJECT ENGINEERING | 4 SIMULATOR MANAGEMENT COMMITTEE | 5 PEER REVIEWER | 6 SPECIALIST REVIEWER | 7 TD & RM | 8 TMG | 9 SAFETY EVALUATOR | 10 REACTOR FUEL ENGINEERING | 11 | 12 | NOTES & REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **[A] INVESTIGATION & EVALUATION** | | | | | | | | | | | | | |
| **1. Initiation** | | | | | | | | | | | | | |
| 1.1 Modification to plant. Inform Simulator Engineer. | | [I] | [R] | | | | | | | | | | **KAA-501:** Modifications to Plant, Plant Structures or Operating Parameters that Affect the Design Base. |
| 1.2 Record plant modification on simulator database. | | [R] | | | | | | | | | | | Submit a Plant Modification Impact Report (PMIR) on simulator on-line database. |
| 1.3 Simulator Non-conformance – generate a Simulator Issue. | [R] | | | | | | | | | | | | Raise Simulator Issue on simulator on-line database. |
| **2. Modification Review** | | | | | | | | | | | | | |
| 2.1 Perform screening to ensure that the identified issue is valid and whether it impacts training. | [R] | | | | | | | | | | | | **KGT-025:** Simulator Maintenance, Access / Operation and Initial Conditions and the Training and Authorization of Simulator Operators. |
| 2.2 Assess if a plant modification impacts the simulator. | [C] | [R] | | | | | | | | | | | Update PMIR form on simulator on-line database. |
| 2.3 Does the modification have an impact on the simulator? | | Y/N | | | | | | | | | | [•] | Exit this process. |
| 2.4 Will the modification be implemented on the simulator? | | | | Y/N | | | | | | | | | SMC consulted in the event that budget constraints or technical complications prevent implementation. |

**WORK FLOW RESPONSIBILITY MATRIX** — **APPENDIX A**

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Flow Path: Main Flow ⟷ Secondary Flow

| ACTIVITIES | 1 OPERATING TRAINING | 2 SIMULATOR ENGINEER | 3 PROJECT ENGINEERING | 4 SIMULATOR MANAGEMENT COMMITTEE | 5 PEER REVIEWER | 6 SPECIALIST REVIEWER | 7 TD & RM | 8 TMG | 9 SAFETY EVALUATOR | 10 REACTOR FUEL ENGINEERING | 11 | 12 | NOTES & REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | Otherwise, impacting plant modifications will automatically proceed for implementation. |
| 2.5 Perform safety evaluation. | | | | | | | | | [R] | | | | **KAA-709:** Process for Performing Safety Evaluations, Screenings and Safety Justification. If implementation is deemed mandatory, proceed to 2.6. |
| 2.6 Does the modification affect the simulator design basis or does the cost or complexity warrant the use of the plant modification process? | | N/Y | | [C] | | | | | | | | [•] | **Obtain SMC concurrence** **KAA-501:** Modifications to Plant, Plant Structures or Operating Parameters that Affect the Design Base. Exit this process. |
| 2.7 Perform training needs analysis for simulator impacting plant modifications. | [R] | | | | | | | [S] | | | | | Establish relative importance with respect to training. Is simulator implementation required prior to plant implementation? |
| 2.8 Prioritise the modification on a scale of 1 to 3. | [C] | [R] | | | | | | | | | | | Enter priority when SCR form is raised in step 2.11. |
| 2.9 Establish the category of modification. | | [R] | | | | | | | | | | | |
| 2.10 Is it a Category 3 modification? | | N/Y | | | | | | | | | | | |
| 2.11 Raise a Software Change Request. | | [R] | | | | | | | | | | | Raise SCR on simulator on-line database. |
| **3. Requirements Specification** | | | | | | | | | | | | | |
| 3.1 Produce a User Requirements Specification, if applicable. | (R) | (S) | | | | | | | | | | | **KGA-060:** Guide to User Requirement Specifications for Software. |
| 3.2 Produce a Simulator | | [R] | | | | | | | | | | | **Appendix B:** Simulator |

**WORK FLOW RESPONSIBILITY MATRIX** — **APPENDIX A**

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Flow Path:
Main Flow — Secondary Flow

| ACTIVITIES | 1 OPERATING TRAINING | 2 SIMULATOR ENGINEER | 3 PROJECT ENGINEERING | 4 SIMULATOR MANAGEMENT COMMITTEE | 5 PEER REVIEWER | 6 SPECIALIST REVIEWER | 7 TD & RM | 8 TMG | 9 SAFETY EVALUATOR | 10 REACTOR FUEL ENGINEERING | 11 | 12 | NOTES & REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Requirements Specification. | | | | | | | | | | | | | Requirements Specifications |
| **4. Concurrence** | | | | | | | | | | | | | |
| 4.1 Establish contract with customer. | [C] | [R] | | | | | | | | | | | Schedule modification according to priority |
| **5. Functional Review** | | | | | | | | | | | | | |
| 5.1 Review the Requirement Specification. | [R] | | | | | | | | | | | | Approval by OTG Manager |
| 5.2 Approval given? | Y/N | | | | | | | | | | | | Go to activity [A]3.1 |
| **[B] DESIGN** | | | | | | | | | | | | | |
| **1. Design and Specification** | | | | | | | | | | | | | |
| 1.1 Produce a software design to accepted standards to satisfy the requirements specification. | | [R] | | | | | | | | | | | User manuals for simulator development environment. |
| 1.2 Produce hardware design if applicable. | | [R] | | | | | | | | | | | Simulator hardware database |
| 1.3 Analyse the problem and define the required changes. | | [R] | | | | | | | | | | | Update DR on simulator on-line database. |
| **2. Testing and Requalification Requirements** | | | | | | | | | | | | | |
| 2.1 Produce a test procedure specifying testing and requalification requirements. | [R] | [R] | | | | | | | | | | | For Category 3, test is documented on DR on simulator on-line database. |
| **3. Documentation Requirements** | | | | | | | | | | | | | |
| 3.1 Make changes to documentation using | | [R] | | | | | | | | | | | **KAA-560:** Procedure for the Control of Documents as a Result of a Design Change or |

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Flow Path:
Main Flow — Secondary Flow

**ORGANISATION / FUNCTION**

| | 1 OPERATING TRAINING | 2 SIMULATOR ENGINEER | 3 PROJECT ENGINEERING | 4 SIMULATOR MANAGEMENT COMMITTEE | 5 PEER REVIEWER | 6 SPECIALIST REVIEWER | 7 TD & RM | 8 TMG | 9 SAFETY EVALUATOR | 10 REACTOR FUEL ENGINEERING | 11 | 12 | NOTES & REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ACTIVITIES** | | | | | | | | | | | | | |
| approved procedures. | | | | | | | | | | | | | Plant Anomaly |
| **[C] DESIGN REVIEW** | | | | | | | | | | | | | |
| 1. Is it a Category 3 modification? | | N/Y | | | | | | | | | | | |
| 2. Is it a Category 1 modification? | | N/Y | | | | | | | | | | | |
| 3. Review the modification. | | Category 2 Modification | | | Category 1 Modification | [R] | | | | | | | |
| 4. Review to ensure the adequacy of the design. | | | | | [R] | | | | | | | | |
| **[D] IMPLEMENTATION** | | | | | | | | | | | | | |
| 1. Schedule implementation of the modification (all modification categories). | [C] | [R] | | | | | | | | | | | |
| 2. Will control room documentation affected by a plant modification be in place by the implementation date? (If applicable). | | Y/N | | | | | | | | | | | Reschedule implementation on the simulator – [D]1. |
| 3. Co-ordinate the software/hardware implementation. | | [R] | | | | | | | | | | | **KWU-PC-SIM-001:** Implementation of Simulator Software Modifications |
| 4. Carry out verification testing. | [R] | [R] | | | | | | | | | | | **KWU-PC-SIM-001:** Implementation of Simulator Software Modifications |
| 5. Carry out simulator operability testing (Category 1 mods only). | [R] | (S) | | | | | | | | | | | **KSA-146:** Simulator Testing Requirements |
| 6. Operability testing completed successfully and approved? (If | Y/N | | | | | | | | | | | | To activity [B]1.1 |

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Flow Path:
Main Flow — Secondary Flow

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| applicable). | | | | | | | | | | | | | |
| 7. Ensure that documentation package is complete. | | [R] | | | | | | | | | | | |
| 8. Submit records for archiving. | | [R] | | | | | [S] | | | | | | [TD&RM] records section |
| **[E] CORE MODEL UPDATE** | | | | | | | | | | | | | |
| 1. **New Core Load in Unit 1** Generate new simulator core model input data for BLX, MOL and EOL. | | | | | | | | | | [R] | | | Generate using neutronics code. |
| 2. Process core data to produce core performance characteristics consistent with Unit 1 Physics Data Book. | | [R] | | | | | | | | (S) | | | **KWU-PC-SIM-001:** Implementation of Simulator Software Modifications **KWB-OP-PDB-001:** Physics Data Book – Unit 1. |
| 3. Implement new core model in a test configuration and stabilise on the simulator. | | [R] | | | | | | | | | | | **KWU-PC-SIM-001:** Implementation of Simulator Software Modifications. |
| 4. Perform core physics tests to qualify the new core model on the simulator. | [R] | | | | | | | | | [S] | | | **KSA-146:** Simulator Testing Requirements. |
| 5. Have the acceptance criteria been met? | [C] | Y/N | | | | | | | | [C] | | | Return to step [E]2. |
| 6. Export the new core model to the training configuration. | | [R] | | | | | | | | | | | **KWU-PC-SIM-001:** Implementation of Simulator Software Modifications. |
| 7. Submit records for archiving. | [R] | | | | | | [S] | | | | | | |

## Appendix B- SIMULATOR REQUIREMENTS SPECIFICATION

*The simulator requirements specification is to address the proposed changes to the simulator using the following headings (where applicable):*

1. Description of the Plant Modification

2. Impact on Simulator

    - Main Control Room changes
    - Common Control Room changes
    - Software changes
    - Hardware changes
    - KIT changes
    - Instructor Station changes
    - Panel graphics; Sim diagrams; Remote functions; Malfunctions

3. Implementation