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Content

Page

1. Introduction

This guide gives direction and assistance regarding Design Engineering (DE) processes and design related work applicable to the Koeberg Operating Unit (KOU).

2. Supporting Clauses

2.1 Scope

This guide is applicable to design staff in DE as well as to any person performing design and design related work, the main functions of design engineers and all designs for modifications to the KOU.

2.1.1 Purpose

2.1.1.1 To provide designers with information which can assist them in complying with applicable standards and procedures, in particular the modification process KAA-501 and the design process 331-86 (KAA-815).

2.1.1.2 **T**o assist designers in delivering high quality outputs.

2.1.1.3 To provide key information which can be used as induction material for new DE employees.

2.1.2 Applicability

This document shall apply throughout Nuclear Engineering and to any individual undertaking any design related work for KOU.

2.1.3 Effective date

This document shall be effective from 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] 238-6: Nuclear Document and Records Management Requirement Standard

[2] 238-86: Nuclear Design Standard

[3] 331-2: Nuclear Engineering Management Manual

[4] 331-3: Nuclear Engineering Documentation and Records Management Work

[5] 331-86 (KAA-815): Design Changes to Plant, Plant Structures or Operating

Parameters Procedure

[6] 331-90 (KAA-558): Modifications to Offsite Plant and Structures that Affect the Safety and Operation of Koeberg Nuclear Power Station Procedure

[7] 240-89294359 (KSA-010): Nuclear Safety, Seismic, Environmental, Quality, Importance and Management System Level Classification Standard

[8] ISO 9001: Quality Management Systems – Requirements

[9] KAA-501: Project Management Process for Koeberg Nuclear Power Station Modifications

[10] KAA-502: Project Management Process for New Building and Civil Projects and Changes to Existing Building and Civil Projects at Koeberg Nuclear Power Station

[11] KSU-008: Nuclear Design Standard for Koeberg Nuclear Power Station

[12] KSA-066: Standard for Nuclear Design and Licensing Basis Evaluations

[13] LD-1012: Requirements in Respect of Proposed Modifications to the Koeberg Nuclear Power Station

[14] RG-0027: Interim Regulatory Guide Ageing Management And Long Term Operations Of Nuclear Power Plants

2.2.2 Informative

[15] 10 CFR 50: Code of Federal Regulations

Appendix A: General Design Criteria for Nuclear Power Plants

Appendix B: Quality Assurance Criteria for Nuclear Power Plants and Fuel Reprocessing Plants

[16] 238-54 (GGS 1330): Radiation Protection Licensing Requirements for Koeberg Nuclear Power Station Standard

[17] 240-82737649 (GGM 0588): Generation Project Life Cycle Model Subset (Gx PLCM Subset) Manual

[18] 240-85520008 (KAA-503): Modifications to Simulator Procedure

[19] 240-119523820 (KFU-027): Project Team Review Report Form

[20] 240-119528368 (KFU-028): ALARA Screening Form for Design Changes

[21] 240-119530923 (KFU-018): Impact on the South African Grid Code (SAGC) Form

[22] 240-119531688 (KFU-019): Microprocessor and Automation Engineering and Design Form

[23] 240-119532043 (KFU-020): Software Engineering and Design Form

[24] 240-127002040 (KSA-089): Guide to Determine Quality Programme Monitoring and Verification Requirements

[25] 331-83 (KSA-113): Requirements for Plant Changes Affecting the Design of Koeberg Nuclear Power Station Procedure

[26] 331-84 (KAA-505): Modifications to Software on the KIT System

[27] 331-85 (KAA-560): Design Documentation Change Process Instruction

[28] 331-88 (KAA-506): Temporary Alterations to Plant, Plant Structures or Operating Parameters that Affect the Design Base Procedure

[29] 331-91 (KAA-562): Control of Equipment and Software Classifications Procedure

[30] 331-93 (KGA-003): Guide for Classification of Plant Components, Structures and Parts

[31] 331-94 (KLA-001): Importance Category Classification Listing

[32] 331-165 (KSA-016): Nuclear Specification Standard

[33] 331-187 (KAA-834): Environmental Qualification Programme Process and Responsibilities Procedure

[34] 331-216: Manufacturers/Suppliers Catalogue Form

[35] 331-298: Procurement Specification Template

[36] 331-308 (KSA-016): Preparation of Technical Requirement Specifications Standard

[37] 331-313 (KFA-007): Design Field Change Form

[38] 331-433 (KFU-026): Detailed Design Review Report Template

[39] ANSI/ANS N18.2: Nuclear Safety Criteria for the Design of Stationary PWR Plants

[40] ASME NQA-1: Quality Assurance Requirements for Nuclear Facility Applications

[41] DSG-318-087: Quality Requirements for the Procurement of Assets, Goods and Services

[42] IEC 60812: Analysis Techniques for System Reliability – Procedure for Failure Mode and Effects Analysis (FMEA)

[43] IEC 60880: Nuclear Power Plants – Instrumentation and Control Systems Important to Safety – Software Aspects for Computer-based Systems Performing Category A Functions

[44] IEEE 308: IEEE Standard Criteria for Class 1E Power Systems for Nuclear Power Generating Stations

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

[46] IEEE 380: IEEE Definitions and Terms Used in IEEE Standards on Nuclear Power Generating Stations

[47] IEEE 1012: IEEE Standard for System, Software, and Hardware Verification and Validation

[48] KAA-647: Control of Non-routine Testing and Infrequently Performed Activities

[49] 240-149081050 (KAA-689): Control of the Operating Technical Specifications

[50] KAA-690: Operability Determinations

[51] 240-119744497 (KAA-697): Control of the Safety Analysis Report

[52] 240-143604773 (KAA-709): Process for Performing Safety Screenings, Safety Evaluations, Safety Justifications and Safety Cases

[53] KFA-002: Project Engineering Work Plan

[54] KFA-006: Testing Procedure for Plant Modifications

[55] 240-142639998 (KGA-025): Screening and Safety Evaluation Guide

[56] KSA-020: Software Quality Assurance

[57] 240-146088803 (KTA-005): Training and Qualification Requirements for Safety Screenings and Evaluations

[58] OTS: Operating Technical Specification

[59] SANS 10400: The Application of the National Building Regulations

[60] SAR: Safety Analysis Report

[61] 240-143890978: Detailed Design Template

[62] 240-132364298: Initial List of Time Limited Ageing Analyses for Koeberg Nuclear Power Station

2.3 Definitions

2.3.1 Concurrence Review Process: A technical review of the design package by each project team member to assess impact on functional area.

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

2.3.3 Design Bases: Information that identifies the specific function to be performed by a structure, system, or component of a facility, and the specific values, or ranges of values, chosen for controlling parameters and reference bounds for design.

2.3.4 Design Document: The document, format in accordance with the detailed design template, which is kept in the following folder: G:\Forms\Design Engineering.

2.3.5 Design Field Change (DFC): A change to an approved design that does not affect the intent or design base of the design.

2.3.6 Design Input: Design objectives, all data, loadings, parameters, calculation models, calculation algorithms, assumptions or other information that could affect the design.

2.3.7 Design Lead: The Eskom designer appointed to the project team.

2.3.8 Design Output: The design document, calculations, drawings, computer printouts, parameters or other documentary information produced.

2.3.9 Detailed Design Package: The design package that documents the proposed plant modification

2.3.10 Hazardous Location: Any three dimensional area or space where an explosive atmosphere or flammable dust layer can occur, in quantities such as to require special precautions for the construction, installation and use of equipment, and divided into hazardous zones.

2.3.11 KIT System: Computer and Data Processing System.

2.3.12 Modification: Any change, deletion or addition to structures systems or components or changes to operating parameters that affect the design base.

2.3.13 Plant: Structures, systems and components that are used for the purposes of power generation

2.3.14 Project Team: A group of individuals nominated to contribute to the design and implementation of a particular modification. The Project Team members represent their Groups/Departments for the purposes of the modification.

2.4 Abbreviations

Abbreviation	Explanation
ALARA	As Low As Reasonably Achievable (Radiation Protection)
ANSI/ANS	American National Standards Institute/American Nuclear Society
AR	Availability Related
ASME	American Society of Mechanical Engineers
BOM	Bill Of Materials
CD-ROM	Compact Disc-Read Only Memory
CRACK	Chemical Restrictions and Control at Koeberg
CSR	Critically Safety Related
DCIF	Document Change Identification Form
DDR	Document and Drawing Request
DDT	Document and Drawing Tracking
DE	Design Engineering
DFC	Design Field Change
DRA	Definition Release Approval
DSE	Dossier de Système Élémentaire (System Description Manual)
EOP	Emergency Operating Procedure
ERA	Execution Release Approval
ESE	Electrical System Engineering
FAT	Factory Acceptance Test
FMEA	Failure Modes and Effects Analysis
FRM	Fire Risk Management
FRP	Functional Restoration Procedure
HFE	Human Factors Engineering
HSI	Human System Interface
ICD	Instrumentation Maintenance Services Digital
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IPDK	Integrated Plant Design Koeberg
ISO	International Standards Organisation
KIT	Koeberg Integrated Team
KOU	Koeberg Operating Unit
LAN	Local Area Network
LCO	Limited Conditions of Operation
LTO	Long Term Operation
MRB	Management Review Board
MSDS	Material Safety Data Sheets
NAL	Network Application Launcher
NCR	Non-conformance Report
NNR	National Nuclear Regulator

Abbreviation	Explanation
NPM	Nuclear Project Management
NSA	Not Safety or Availability Related
OEM	Original Equipment Manufacturer
OPG	Operating Procedures Group
OTS	Operating Technical Specifications
PCR	Procedure Change Request
PEWA	Project Engineering Works Authority
QADP	Quality Assurance Data Package
QC	Quality Control
QCP	Quality Control Plan
RFO	Request For Offer
RP	Radiation Protection
RPC	Radiation Protection Certificate
SANS	South African National Standards
SAR	Safety Analysis Report
SR	Safety Related
SRSM	Safety Related Surveillance Manual
SWA	Site Work Authorisation
SWP	Site Work Package
TAF	Temporary Alteration Form
TCR	Training Change Request
TD&RM	Technical Documentation And Records Management
TLAA	Time Limited Ageing Analyses
TRS	Technical Requirement Specification
URS	User Requirement Specification

2.5 Roles and Responsibilities

2.5.1 General

Prior to DE involvement, the system engineer assesses a plant problem and decides that a modification is necessary to correct the problem.

The system engineer will prepare the Management Review Board (MRB) presentation and present the proposal to the MRB. If the MRB approves the proposal, the new modification is allocated a number and added to Project Track. The overall modification process is specified in KAA-501. The system engineer raises a modification by following the applicable procedure and will compile a user requirement specification where all the requirements will be listed.

The plant may only be modified if the proposed modification is described and documented in a design change package which is subject to review and approval by DE. This design change package is commonly referred to as a detailed design. The process and responsibilities that govern design changes to plant, plant structures or operating parameters are specified in 331-86 (KAA-815**).**

2.5.2 The Design Package Compiler

2.5.2.1 The design package compiler is a person who is competent and takes responsibility for compiling the design package and who is authorized in writing by the DE manager. The compiler also has the responsibility of reviewing documentation compiled by the assigned design package co-compiler. Although the design review is one of the most crucial stages of the design process, the design compiler is ultimately responsible for the design package. It is strongly recommended that the compiler does a review of his/her own work before passing it on to the reviewer. Once the compiler has compiled the package, he/she should sign the document before passing it to the reviewer. This indicates to the reviewer that the compiler considers the document to be 100% correct, i.e. the compiler is of the opinion that the document could be approved in its current state.

2.5.2.2 It is strongly recommended that the compiler seek advice or a partial specialist review from applicable system specialists within DE or the rest of KOU, especially for Critically Safety Related (CSR) and Safety Related (SR) systems requiring a unique knowledge base such as the Reactor Protection System (RPR), Full Length Rod Control System (RGL), Plant Radiation Monitoring System (KRT), Alarm Processing System (KSA), Fuel Handling and Storage System (PMC), etc.

2.5.3 The Design Package Co-compiler

2.5.3.1 The design package co-compiler is a person who is competent and takes responsibility for compiling documents but who is not yet authorized in writing by the DE manager. The design co-compiler together with the authorized design package compiler is ultimately responsible for the design package. It is strongly recommended that the co-compiler does a review of his/her own work before passing it on to the design package compiler. Once the co-compiler has compiled the package, he/she should sign the document before passing it to the authorized design package compiler. This indicates to the compiler that the co-compiler considers the document to be 100% correct, i.e. the co-compiler is of the opinion that the document could be approved in its current state**.**

2.5.3.2 It is strongly recommended that the co-compiler seek advice or a partial specialist review from applicable system specialists within DE or the rest of KOU, especially for CSR and SR systems or systems requiring a unique knowledge base such as the Reactor Protection System (RPR), Full Length Rod Control System (RGL), Plant Radiation Monitoring System (KRT), Alarm Processing System (KSA), Fuel Handling and Storage System (PMC), etc.

2.5.4 The Design Package Reviewer

2.5.4.1 Refer to Appendix A for guidance on performing independent design reviews.

2.5.4.2 The design review is one of the most crucial parts of the design process. The

importance of being independent cannot be overemphasised. Independence is mainly related to remaining uninvolved in the design process. A design document can be considered to be reviewed when the reviewer:

- is in agreement with the technical content of the design;
- is sure that no detail has been omitted;
- is satisfied that the document is unambiguous and;
- is satisfied that the document is a professional report that he/she is proud to sign.

2.5.4.3 The reviewer must refrain from becoming a "co-designer", i.e. of being dissatisfied with the proposed solution and then asserting another solution and then reviewing his/her own solution. At this point the reviewer loses independence.

2.5.4.4 The reviewer must check the assumptions that the originator has used, and not to take it for granted that these are correct. In addition, the interfaces to existing plant must be checked for conformance to generally accepted design conventions whenever the design assumes that such rules have been adhered to. This is particularly relevant to wiring, relaying, power supply and programming conventions.

2.5.4.5 The reviewer must verify that the latest design template was used.

2.5.4.6 The reviewer must check beyond the contents of the design document, for information or details that might have been omitted. Omissions could result in design field changes (DFCs) and will at least result in misunderstandings on the part of the readers.

2.5.4.7 When designs are not performed by staff within DE, there will always be a DE review, even if this review is contracted out to an authorized specialist.

2.5.4.8 The reviewer must review (and sign on Document and Drawing Tracking system (DDT)) the Document and Drawing Requests (DDRs) as part of the review process. Special attention should be given to how “common” documents are updated for installation on one unit at a time.

2.5.5 Concurrence Review Process

2.5.5.1 A concurrence signature meeting should be scheduled but signatures can be obtained separately from each individual**. NOTE:** the detailed design package will not be authorized until all the concurrence signatures have been received.

2.5.5.2 The design change package that is split into different disciplines shall be seen by all disciplines of engineering within DE for concurrence.

2.5.5.3 Fire Risk Management (FRM) concurrence shall be required on any building renovations in terms of Annex A of SANS 10400 Regulation T1 (1) (a) to (e) as well as Paragraph (2).

2.5.5.4 Each member of the project team shall complete and sign the Project Team Review Report Form – 240-119523820 (KFU-027) as identified in 331-86 (KAA-815).

2.5.5.5 The project team members shall be involved in the project and be consulted throughout the design process. The concurrence signature meeting is merely a formal acceptance and final review of material that they are already familiar with.

2.5.5.6 Anomalies noted during the concurrence signature meeting shall be minuted during the meeting and the design package compiler shall be responsible to incorporate these changes into the package.

2.5.5.7 The design change package shall be authorized once all the team members, independent reviewers and compilers sign off the concurrence.

NOTE: *The concurrence reviewers must sign off that they are satisfied that the designer has identified all relevant procedures affected by the modification. The concurrence reviewer should be aware that each group should assess the need for additional reviews by specialists within the concurrence reviewers group. The designer must ensure that the reviewers are aware of this.*

2.5.6 Post Implementation Design Review Meeting

2.5.6.1 A post implementation design review meeting should be held in order to identify errors in designs, especially in vendor-produced products, which would otherwise not be identified and corrected.

2.5.6.2 The meeting is especially important when designs are produced by vendors.

2.5.6.3 This meeting must as a minimum include the Eskom lead engineer, the implementation engineer and the vendor design engineer. The meeting should preferably also include the project leader, as well as management representatives from both Eskom and the vendor.

2.5.6.4 The primary focus of the meeting should be to review lessons learned while performing and installing the design.

2.6 Process for Monitoring

Not applicable.

2.7 Related/Supporting Documents

Not applicable.

3. The Design Process

3.1 Description

The overall process for preparation of detailed design packages is illustrated in Table 1. *Note that the entire modification process from initiation to final handover is governed by KAA-501.* The detailed design package preparation process begins with the “Kick-off Meeting” and concludes with the design approval. 331-86 (KAA-815) covers the preparation of the detailed design package.

Table 1: Design Package Preparation Process

Kick-off Meeting	Subsection 3.1.1
Contracting for the Work Scope	Subsection 3.1.2

The Feasibility Study (Definition Phase)	
The Detailed Design (Execution Phase)	Subsection 3.1.3
Design Package Approval	Subsection 3.1.4

3.1.1 The Kick-off Meeting

3.1.1.1 Soon after the modification has been approved by the MRB, a “kick-off” meeting is the next step. This meeting is chaired by a project manager. A design engineer will attend this meeting.

3.1.1.2 DE will determine if the feasibility study or design package is to be prepared by Eskom or a contracted consultant. This decision is based primarily on the resources available to meet the due dates and the design complexity. An internal designer, the design lead, is nominated when the design is contracted out. DE will prepare a Technical Requirement Specification (TRS), which describes the engineering work that is to be performed by an outside contractor.

3.1.1.3 A rough cost estimate is made and Nuclear Project Management (NPM) will raise the Definition Release Approval (DRA) or Execution Release Approval (ERA), as appropriate

3.1.1.4 The project manager and design engineer are responsible for determining which groups need to be represented in the project team and request that the members are assigned.

3.1.1.5 Project team members are considered, based on the need for interfaces such as Operating Shift, Operating Procedures, Training, Maintenance, FRM, Environmental, Radiation Protection, Chemistry and Plant Engineering.

3.1.1.6 The project manager shall set up a meeting to ensure that the team is established, and is aware of the project scope and major milestones.

3.1.1.7 If the design is contracted out to a locally based design contractor, then the external designer and the design lead should attend the meeting. The designer should prepare himself for the meeting to be able to make full use of the project team assembled.

3.1.2 Contracting for Work Scope

3.1.2.1 The designer is required to establish the amount of design work necessary to complete the design. This is based on the scope of the plant change as defined in the User Requirement Specification (URS) prepared by the system engineer. In most cases only a feasibility study will be required at this stage. In the case of an internal design, the designer will raise a Project Engineering Works Authority (PEWA) to cover his design work as well as the review. The spreadsheet attached as Appendix B can be used to assist in estimating time. Note that a PEWA must also be raised for the review of external designs.

3.1.2.2 The PEWA forms a contract between the designer and the project manager. Should the time estimate, work scope, or the completion date change, a new PEWA must be negotiated with the project manager in good time.

3.1.3 The Detailed Design (Execution Phase)

3.1.3.1 The compilation of a detailed design package according to 331-86 (KAA-815) is the first part of the execution phase of the project. The entire modification must undergo a risk assessment to be performed by the project team or by individuals chosen by the project manager and designer. The aim of the risk assessment is to identify potential risks to the successful implementation of the design and to identify suitable measures in mitigation. These may include increased inspection during fabrication or installation, more stringent Factory Acceptance Test (FAT) procedures or specialist assistance during installation.

3.1.3.2 The final detailed design is constrained by the option selected in Part A or the Scheme Design and by the costs approved. If it is discovered that the proposed solution is no longer suitable, or is more expensive than the estimate, then the project manager shall be notified and work on the design shall be halted pending input or go ahead from the project manager. Therefore, it is recommended that externally prepared scheme designs are presented for a concurrence review prior to compilation of the implementation specification and other documents associated with a detailed design package.

3.1.3.3 During this phase, it is crucial that the physical design layout such as routing for piping or cables, cable routes, drawings and plant documentation are verified on the plant (if accessible) to ensure that the as-built status is accurately known. Invert levels and dimensions of all physical obstructions should be known to ensure that these are taken into consideration in the design. If this is not done DFCs are likely to result.

Due consideration should be taken for cabling and cable tray installations during modification implementation since inaccessible or obstructed equipment may adversely affect maintenance interventions (repairs and replacement). Equipment that is inaccessible due to obstructions caused by cables or cable trays may affect Operating Technical Specifications (OTS) related systems and can result in non-compliance to OTS specified repair periods. Ensure that, as far as possible, the placement of dampers and cable trays have the best possible access by Maintenance and Operating personnel**.**

3.1.3.4 It is important to verify and understand the full design requirements prior to equipment selection. If, for example, the requirements of an isolation valve to meet American Society of Mechanical Engineers (ASME) III Subsection NC (for Safety Class 2 components) requirements are not identified early enough during the design compilation, the selected supplier may not be able to meet ASME III NC requirements because it was not initially taken into consideration. New equipment or a new supplier will need to be sourced. This leads to delays.

It is important that the designer ensures that all materials specified, for applicable systems only, are Chemical Restrictions and Control at Koeberg (CRACK) approved or can be CRACK approved. All the relevant information must be provided with the design in order to process materials for CRACK approvals such as Material Safety Data Sheets (MSDSs).

3.1.3.5 During this stage, the Human Factors Engineering (HFE) programme should identify the required HFE activities based on the extent and level of importance of the change. Refer to HFE guides in G:\Nuclear Engineering\Design Eng\Design_Eng\SDE Plant Support\HFE Guides.

3.1.3.6 Ageing management should be considered in the design changes, repairs or replacement to facilitate effective ageing management for Long Term Operation (LTO) of the plant. Appropriate measures and design features should be introduced in the design stage to facilitate effective aging management. E.g. measures to facilitate ageing management activities such as monitoring, inspections…etc.

3.1.3.7 The designer is usually required to compile a TRS that describes any equipment or work required as a result of the modification. This will be used in the procurement process as the technical document that describes the requirements. The TRS is also subject to review and approval. The TRS can be compiled once the technical requirements are known, not necessarily only after the detailed design has been authorized. This approach is typically used for long lead items that must be ordered before the design package has been approved

3.1.4 Design Package Approval

Once all the reviewer's comments have been resolved, the final design is ready for approval. The design engineer should ensure that the final design contains all the required attachments and is properly assembled before submitting it to the DE manager for approval.

3.2 The Design Document

3.2.1 Refer to hyperwave (https://hyperwave.eskom.co.za) for the latest version of the detailed design document template (240-143890978). This document is in the standard DE format and guide material on a paragraph-by-paragraph basis is provided in the template and all items listed on the design input consideration checklist shall be considered. This guide material must be removed and replaced by the recommended information concerning the design change. **It is essential that designers use the master template on Hyperwave for each new design because the template is updated regularly with new checklists, guide material, new paragraphs, etc.**

3.2.2 The designer should be aware that only one of the two accepted design formats (standard format or the complicated design format as described below) may be used. The design format chosen will depend on the complexity of the design and this will typically be discussed with and agreed to by the designer and project manager.

3.2.3 Simpler, less complicated designs would be compiled as a single design document made up of Part A, B, C and D, which is the standard DE design format.

3.2.4 Complicated designs are typically compiled in stages and are therefore made up of several packages, i.e. first a Scheme Design (which must be equivalent in content to Part A), followed by an Installation Specification. A Separate Commissioning Requirements Report and Configuration Management File may also be produced but they can also be included in the Installation Specification. Complicated designs must be composed of, at a minimum, a Scheme Design, followed by an Installation Specification. The following table provides a comparison of the two possible design package formats.

Table 2: Comparison of Design Package Formats

Part A	Or Scheme Design
Part B	Or an Installation Specification that covers the installation as well as the commissioning and testing or an Installation Specification which only discusses the installation with a separate Commissioning Requirements Report that discusses the testing and commissioning requirements.
Part C	Installation Specification or an Installation Specification which only discusses the installation with a separate Bill of Materials (BOM).
Part D	Installation Specification or, an Installation Specification which only discusses the installation, with a separate Configuration Management File that lists all the documents that will be revised due to the modification.

NOTE: *The format of the detailed design document, located in G:\Forms\Design Engineering, shall be followed regardless of whether the design is compiled as*

a standard or complicated package. Section headings shall remain unchanged and the designer shall provide the necessary information under each section heading. All designs shall be equivalent to and contain all the elements of a Part A, B, C, D design format as described in Table 2.

3.2.5 Below are the tests that can be used to determine the placement of information in the various parts:

- If you are trying to understand why the modification is being done, how it works and what impact it has on the plant, then you should not have to look outside of Part A or the Scheme Design.
- If you want to know how to install, test and commission the modification, then you should not have to look beyond Part B or the Installation Specification with a Commissioning Requirements Report, if the Commissioning Requirements Report is provided separately. **NOTE**: The testing and commissioning requirements provided in the design will be used to complete KFA-006; therefore the testing and commissioning requirements provided in the detailed design must be comprehensive.
- If you are required to procure the equipment and materials for the modification, then you should not need more than Part C, which contains the BOM, the cost estimate and equipment specifications or the Installation Specification. **NOTE**: The cost estimate is not mandatory and the designer should consider whether to show prices if the design package will be used for tendering purposes.
- Part D contains the administration associated with the package as a whole, rather than with a particular part, such as the concurrence list and configuration control (the Document Change Identification Form (DCIF)).

- The review reports are separate documents and are not part of the design document, but accompany the detailed design package, becoming part of the project manager's project file. An additional HFE review report shall be included in the detailed design package for any design change resulting in the modification of the control room. The detailed design package and the review report are presented to the DE manager for approval at the same time and the detailed design package is only considered authorized if both have been approved by the DE Manager.
- In a complicated design, the configuration management file is used to keep a record of all the documents related to the design. This can be a stand-alone document or form part of the Installation Specification. **NOTE**: Regardless of the format, both form part of a detailed design package and are approved as part of the design.

3.2.6 The Installation Specification contained in Part B of the detailed design must include site-level detailed installation instruction that will allow an independent reader to understand how installation will be performed. High level installation instructions with deferment of site-level details to SWPs are not allowed.

3.2.7 Installation instructions must be provided for all items to be installed in Part B of the detailed design. For example, having the following installation instruction and relying on the installers to consult appendixes (such as isometric drawings, general arrangement drawings etc.) is not acceptable: 'Install 1 DEG 007 TY in accordance with Appendix 1'.

3.2.8 The design document forms a permanent part of the design of the plant, and must therefore be written with this is mind. The designer should write the document considering that a reader is going to read the document in later years. All significant information and reasoning should be included or referenced in the document. If the designer needs to verbally explain the design to the reviewer, then the document can be considered incomplete.

Each design output must show clearly the input as well as the explicit method of achieving the output, for example, calculations to demonstrate the capability to withstand seismic and worst case operational loading. Sketches or drawings shall be used where appropriate.

The Calculations Sheet and the Isometric Sheet (both available on G:\Nuclear Engineering\Design Engineering\Masters) are used for hand calculations and sketches. These sheets are to be included in attachments to Part A of the design document, where applicable. Guidance on set point changes is given in Appendix C. The allocation of new Computer and Data Processing System (KIT system) inputs must follow the guidance of Appendix F.

Every design document shall be subject to the safety evaluation process, KAA-709 (331-135), prior to approval by the DE manager.

3.2.9 Ensure that a comprehensive audit trail to all source information is available. Use reference numbers, attach documents, supply details of decisions made, etc. If pencil is used for any part of the design, an indelible copy must be made and original signatures, if necessary, applied to the copy. Ensure that the design document is a COMPLETE record.

3.2.10 Where a design is contracted out, it is important to reach an agreement before work commences that the design will be done in accordance with the format of the detailed design template located (240-143890978). Contractors are to understand that the format that they usually use within their companies is not sufficient. Exceptions to this may occur, after discussion with the relevant lead designer, due to the contractor charging significantly extra for this. It is common for Koeberg designers to have to provide guidance to contractors in the preparation of the design document.

All designs shall be reviewed in accordance with 331-86 (KAA-815) and approved internally by the contracted company. The designer will obtain concurrence from all members of the Koeberg project team.

The design shall also undergo a review by an authorized Eskom design engineer in accordance with 331-86 (KAA-815) and the original design specification or contract. Appendix A provides additional guidance on performing reviews.

The design shall undergo an HFE review at the discretion of the reviewer and/or the design team. Appendix D provides additional guidance on performing an HFE review.

3.2.11 In all cases where a signature is required in a detailed design package, etc., the person's name is to be clearly printed alongside the signature for positive identification.

3.2.12 The content of the design document must be entered in the regular "Arial" font with a size of 12 points.

3.2.13 The "splash" on the front cover of the design can be edited by double clicking on it; the text can then be changed to reflect the appropriate importance category of the design, i.e. CSR, SR, Availability Related (AR), Not Safety or Availability Related (NSA) in accordance with 331-94 (KLA-001).

3.2.14 Where the design package is separated into different documents for different disciplines, a numbering convention as follows is suggested:

99061S: This is the system level design providing the overview. It is the material that would have been duplicated in the discipline design documents.

99061M: The mechanical design.

99061E: The electrical and instrumentation design.

99061A: The automation design, including all wiring and instrumentation specific to any PLCs or computers.

3.3 Multi-disciplinary Designs

When performing a multi-disciplinary design, the discipline with the greater input will initiate the design document. The required content is entered in the regular font. This will then be followed by the secondary discipline content, typed with a contrasting font attribute such as italic, blue or red in the same document. Each portion will be reviewed by a reviewer from the applicable discipline. The designers are to ensure that the reviewers are clear about which portions they will be reviewing, and that the entire design will be reviewed.

Once the review is complete, this contrasting font attribute can be removed before the final print. In the case of a large design that includes significant portions from several disciplines, a separate design document can be produced for each discipline. In this case, each designer must ensure that he is always using applicable and up to date inputs from the other designers. Final design output must be correlated for agreement.

3.4 Attachments

3.4.1 Only attach information that is essential for the understanding or implementation of the design, or that is clearly of interest to the reader (limit these to Parts A and D only). It is not necessary to attach to the design a marked up copy of each document/drawing listed in the DCIF. The attachments section of each part (A, B, C and D) of the design template contains guidance specific to that part.

3.4.2 Do not cross-refer to attachments in other parts of the design, for example, do not refer to attachment B9 from Part A. Either repeat the attachment for Part A or move it to Part A if it is not used for installation.

3.4.3 With the exception of "default" attachments such as the Design Input Consideration Checklist and the DCIF, do not include an attachment that is not referred to in the text. Conversely, make sure that you refer to each useful attachment.

3.4.4 The DDRs/document markups are NOT attachments to the design but are to be provided to the reviewer with the design at the review stage.

Each change made to an operating/maintenance procedure, training material (operating or other), maintenance manual, Safety Analysis Report (SAR), OTS, Dossier de Système Élémentaire (DSE or System Description Manual) or drawing must be linked to a specific DDR by obtaining a reference number on the DDT system (available on the Network Application Launcher (NAL)), or by raising a notification on Devonway (for Procedure Change Requests (PCRs), Training Change Requests (TCRs)), or in the case of a SAR change, obtaining a reference number from the SAR group within Integrated Plant Design Koeberg (IPDK).

The Manufacturers/Suppliers Catalogue form (331-216) should be used for any updates related to maintenance manuals. DE is responsible for providing the information for 331-216 and the form must be completed when new documents are to be added to the maintenance manuals.

NOTE: *The DDRs are delivered to the Configuration Control section of Technical Documentation and Records Management (TD&RM). Each DDR shall be identified on the DCIF and be identified with a reference number for tracking purposes. The project manager will request updates to the documents in accordance with KAA-501. PCRs and TCRs are not processed by the designer, but by the relevant operating, training or maintenance group who need to be notified of the requirement for changes to their procedures by raising a notification on Devonway as described above. The designer is expected to discuss possible changes to any procedures with the affected groups and to provide the relevant information that will enable them to revise the affected procedures accurately.*

3.5 Electronic Storage of Design Files

The completed design document should be saved in the appropriate place within the DE data area on the LAN. In cases where a large amount of information associated with the design is computer- based, it is recommended that all these files be written to a Compact Disc-Read Only Memory (CD-ROM).

3.6 Controlled Copies

The original approved detailed design package is stored at TD&RM. DE and NPM is supplied with controlled copies.

3.7 Safety Evaluations

A minimum of a safety screening is required for each design. A design requires a draft safety evaluation. **NOTE**: the draft safety evaluation shall consider installation activities. A safety evaluation may be completed and authorized at the Scheme Design stage. The evaluation must be checked once the Installation Specification is complete to ensure it is still valid, otherwise it should be revised. Refer to KAA-709 and KGA-025 for information on safety evaluations. **It is essential that installation activities are considered in the initial design safety evaluation draft and not deferred to a safety evaluation for the safety case, to avoid potential delays at the later stages of the design.**

3.8 Temporary Alteration Forms (TAFs)

3.8.1 DE is responsible for providing a design service as required for TAFs and is responsible for reviewing them.

3.8.2 If DE is required to do design work for a TAF then an additional designer is required for the review.

3.8.3 Special attention shall be given to the description and completeness of the TAF. Do not allow space on the form to be a constraining factor as any supporting information can be attached. Any change to a rating, set point or any sizing or capacity of temporary equipment must have supporting calculations. Ensure that the TAF is numbered and is accompanied by a valid safety evaluation before signing as reviewer.

3.8.4 The TAF design can be in the detailed design format for more significant temporary alterations.

3.9 Specifications

Designers could be required to compile technical specifications as part of the design process. There are typically two types of specifications, a procurement specification and a TRS.

The procurement specification is usually for the design, manufacture and supply of components or equipment, and would normally be attached to Part C or the Installation Specification, depending on the selected design format. **NOTE**: The procurement specification is to be compiled using template 331-298. The TRS typically describes a system and can also be used to describe a service (typically used for designs to be performed by outside companies) and should be included in Part A. The TRS is to be compiled in accordance with 331-308. Classification of components, structures, parts or services are to be compiled in accordance with the 331-93.

When compiling any specification, the designer should ensure that operating conditions such as hazardous locations, ambient temperature, wind speed, humidity, dust and noise levels, nuclear and electromagnetic radiation, flow, fluid types, etc., are considered.

3.10 Factory Acceptance Tests (FATs)

It is a requirement that in addition to the relevant system engineer, a designer should also attend the FAT associated with their modification. FATs are done to ensure that the manufactured equipment meets the acceptance criteria that were agreed to by both Eskom and the Original Equipment Manufacturer (OEM) at the tender phase of the procurement process. Should a FAT be required, the designer is encouraged to make use of the FAT guidelines outlined in Appendix E.

3.11 Time Limited Ageing Analysis or Engineering Analysis

Time Limited Ageing Analysis (TLAA) could form part of a major design or be a standalone engineering analysis. TLAAs are plant specific safety analyses that consider time and ageing, and involve SSCs within the scope of ageing management.

Criteria for identifying TLAAs is documented in 240-132364298. Following identification of TLAA, for SSCs in-scope of ageing management, demonstration that the analyses will remain valid for the planned period of long term operation should be performed as required by RG-0027.

The process for TLAAs is as follows (if performed separate to a design for plant modification):

3.11.1 Perform analysis or re-analysis of the TLAAs to validate the analyses for the intended period of long term operation.

3.11.2 Identify the necessary configuration management using the Design Input Consideration Checklist or DCIF, and perform safety evaluation for SAR updates.

3.11.3 .Submit the SAR (other licensing basis documents) updates to the NNR, with the TLAA reports as supporting document.

3.12 Revision to Design

3.12.1 Once a design has been approved and it is subsequently established that a change to the intent or design base of the design is required, the change shall be handled as a complete revision to the design.

3.12.2 The original design package shall be issued as Revision 1 and marked as such in the revisions table in the front of the design package and in the header of each page of the design.

3.12.3 Any subsequent revisions to the design shall be made by changing the effected text in the electronic format and then a vertical line shall be placed to the left of this text.

3.12.4 The revision number and scope of the revision shall be recorded in the revisions table in the front of the design package and must be initialled by the designer, reviewer and approver.

3.12.5 The previous revision number at the top of each page of the master, in the information block shall be marked with a cross to indicate that the next revision number is applicable. In the electronic format of the design, the revision number no longer applicable will be shaded-in, in the information block in the header.

3.12.6 The cover page, the revisions table and all changed pages shall be reprinted and sent to TD&RM to update the master. Should the revision lead to changes in page numbers then the entire section shall be reprinted and sent to TD&RM.

3.12.7 Design Field Changes (DFCs)

3.12.8 If, during the implementation phase of a design, it is discovered that a change is required that does not impact on the intent or design base of the design, then this may be handled as a DFC.

3.12.9 A change that does not impact on the intent or design base of the design can be considered a change that is small in scope (both in terms of the installation and work required to update the design package). Any major changes to scope, calculations or analysis methods cannot be considered a DFC and would require a revision to the detailed design package.

3.12.10 A DFC is initiated by anybody (usually the project engineer, project leader, design engineer, etc.). The electronic format of this form, 331-313 (KFA-007), can be found on Hyperwave. The designer will process the DFC, making all required technical changes and updating all affected documentation. Where possible, DFC will be designed and reviewed by the original designer and reviewer. The project leader/supervisor shall update the existing work and test plans or compile new ones if required.

NOTE: *A safety screening is not required for a DFC, as the design envelope is not being changed. The DFC will then be approved by the DE manager.*

3.13 Completing the DFC Form 331-313 (KFA-007)

3.13.1 The originator shall describe the problem clearly and succinctly. Neat sketches and photographs are recommended in order to ensure that the problem description is clear. Any attachments must have page numbers and be referenced in this section. A DFC is raised during the installation phase and covers actual changes that need to be made on the plant (with associated changes to the design and site work packages).

3.13.2 The designer shall assess the problem and describe the proposed solution after considering all the items listed in 331-433 (KFU-026), Detailed Design Review Report. This section needs to describe the impact on other plant stakeholders for the scope of the DFC (including Koeberg Integrated Team (KIT), Simulator, Operating Procedures Group (OPG), Operating, Maintenance, etc.).

3.13.3 Under the solution justification section the designer shall justify why the solution is safe and acceptable.

3.13.4 Under the justification for using DFC section the designer shall justify use of the DFC process, i.e. why does the design itself not need revision? Under this section the designer shall confirm no impact on the original design KAA-709 process. If the original KAA-709 process is affected, a design revision is required. Editorial changes to the KAA-709 process can be managed by means of a DFC.

3.13.5 Under the test requirements section the designer shall specify the test and commissioning requirements for the DFC. This is not a detailed step by step procedure, but rather an overall outline of how the designer wants the change to be requalified.

3.13.6 Under the documentation control section the designer needs to list all the documents affected by the DFC. The following needs to be considered:

- KBA documents, DSE, Maintenance Manual DDR
- Operating Procedures PCR
- Maintenance Basis MB
- OTS CO
- Safety Related Surveillance Manual (SRSM) CS
- Training TCR

The DFC package shall include the DDRs and other mark-ups raised for the change. The design reviewer will then review both the DDRs and the DFC.

3.13.7 The DFC is compiled and reviewed by authorized designers and preferably those that compiled and reviewed the original design. The DFC is approved by the DE manager or delegate. For large projects/outages, it is recommended that the DE manager delegates this authority to a senior member/s of his staff.

3.13.8 The DFC shall be sent to the National Nuclear Regulator (NNR) once the NPM manager has approved it.

3.13.9 Modifications are generally installed on one unit at a time during that unit's outage. During installation, plant discrepancies may be identified and addressed using the DFC process. After the first unit's installation and before the next unit's installation (typically the next outage), the DFCs of the first unit installation shall be incorporated into the original design so as to have a single accurate design package for the second unit installation. In the case of units 9 or 6 the installation work is normally divided into batches and it is between batch completions that DFCs must be incorporated into the original design before installation on the next batch starts.

DFCs are therefore incorporated into the original designs primarily to aid and improve installation on the next unit or batch. Another benefit is that it provides traceability to the overall scope of the plant design changes and that it improves plant configuration control.

Once the design has been updated, the DFC shall be signed off by the design engineer. When there is a design intent change (i.e. no DFC is permitted), the design shall be revised immediately.

At the end of installation on all units or batches, the decision whether to incorporate DFCs into the original design shall reside with the DE manager, in consultation with the NPM manager and with due regards for the possible increase in time, effort and costs involved.

All DFCs shall be retained in the project file and Quality Assurance Data Package (QADP) as a record.

3.13.10 Work plan changes shall by incorporated by:

- Updating the original work plan and quality plans and attaching them to the DFC (these updates are to be reviewed by the design engineer).

OR

- A new instruction shall be written in the DFC form.

3.13.11 The revised or new work instructions shall contain all pertinent information for performing the work including but not limited to:

- Step by step instructions.
- Isolation plan (to be discussed with Operating Support).
- As Low As Reasonable Achievable (ALARA) and Radiation Protection Certificate (RPC) requirements (to be discussed with Radiation Protection (RP)).
- Quality Control (QC) requirements (to be discussed with QC).
- Tools.
- Risks.
- Precautions.

3.13.12 The format for the work plan in 331-313 (KFA-007) is a guide. It should follow the same structure as the original modification work plan.

3.13.13 Test procedure changes shall by incorporated by:

- Updating the original test procedures and attaching them to the DFC. OR
- A new test procedure shall be written in the DFC form.

3.13.14 The revised test procedures shall contain all pertinent information for effectively addressing the test requirement that the designer has specified. It should include:

- Step by step instructions.
- Required measurement tools.
- Risks.
- Precautions.
- Interaction with control room/others.
- Communication.
- Clear acceptance criteria with reasonably achievable tolerances.

3.13.15 The completed DFC shall be reviewed by QC in order to allow for QC hold points.

3.13.16 The completed DFC shall be reviewed by Operating in order to check for impact on:

- Operating procedures.
- Operator training.
- Isolation plan.
- Testing procedures.

3.13.17 The work plan and testing procedure shall be reviewed by the design engineer in order to ensure the specified requirements are complied with.

3.13.18 The DFC is approved for implementation by the NPM manager or delegate. For large projects/outages, it is recommended that the NPM manager delegates this authority to a senior member/s of his staff.

All the existing signatures can be signed off by the contractor's authorized resources, but the following hold points shall be signed by Eskom:

- Notification of the problem (Eskom project engineer/leader/supervisor).
- Eskom DE manager or delegate (design engineer/project engineer) to approve design change.
- Test results to be accepted by Eskom design engineer/project engineer.
- Approval to implement to be signed by Project Engineering manager or delegate.

3.13.19 The contractor or Eskom project leader/supervisor is responsible for ensuring that the DFC is processed from start to finish. This includes ensuring all document updates are processed, the design is updated and the DFC is included into the QADP.

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Ravid Goldstein	Design Engineering Manager
Noloyiso Mtoko	NTP Manager
Stef Kriel	Design Engineer (Process Custodian)
Deon Kruger	Senior Engineer

5. Revisions

Date	Rev.	Compiler	Remarks
July 2021	11	R Maapola	Revised to address the following CAs: CR 121535-007 CA- Update existing procedures to ensure TLAA Configuration Management. SE 38545-015 CA- Update Plant Modification Processes to comply with RG-0027 CR120843-002 CA: OE from DEG chiller installation
September 2020	10	S Linose	Document revised to address CA 110060-003, the updated document includes Appendix G – Design Engineering Product Approval Guide. Detailed design review report (331-433) was also updated. Replaced the scanned format of Appendix B with an editable version of the same content. Contents of Appendix B has not changed. Updated the list of references to align the numbering of the reference documents with the current document numbering, (K** documents changed to 240-**).
December 2018	9	M Scholtz	Full review. New nuclear engineering document number assigned to detailed design template. Revised to address RC 21395 and RC 21396 – Guidance was added to Appendix F on how to create spare digital inputs on the KIT system. Revised to address CR 103662 – Section 3.13.9 (previously Rev 8 section 11.4.9) was expanded to include the intent of incorporating DFCs into the original design and guidance as to what should happen at the end of installation on all units or batches.
February 2017	8	R Maapola	Revised to address CR 93590-001: SDE to review and update the standard, 331-308, Preparation of Technical Requirement Specifications and 331-087, Design Engineering Guide to include a statement that during development of a design the specifications and classifications are compiled in the approved Eskom format.

January 2016	7	R Maapola L Khan	Revised to address CR-090910, CA number 007. 331- 87 to be revised to ensure that KSA (331-97) is corrected to KSA-016 (331-308) and to remove any reference to 331-135. Correct in text reference to Appendix A – Design Review Guide, in paragraphs 5.1.3.1 and 5.3.8. Added Appendix F: Process for New KIT System Point Allocations.
December 2014	6	M Williams	Full revision. Revised to address concerns raised in ESE-007/14: Inaccessible Fire Dampers on Unit 1 and 2 DVF.
July 2014	5	E Williams	Revised to address CA 32989, RC 21481, RC 21478.
April 2014	4	M Williams	Revised to address CA 30055 and RC 20398.
November 2013	3	M Williams	Revised to address CA 75100 and RC 20266.
August 2013	2	M Williams	Revised to address CA 31083.
May 2013	1	M Williams	Revised to address CA 26072. Amended section 10, Design Field Changes and revised to include Factory Acceptance Test guidelines.
November 2012	0	R Maapola	Original.

6. Development Team

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

- Jacques Dreyer

7. Acknowledgements

None.

Appendix A – Design Review Guide

1. Review the relevant system description manuals (DSE) including relevant maintenance and operating documentation.

   Particular attention must be paid to interfaces with other systems and the related consequential impact the installation could have on interfacing systems.
2. Review the detailed design document.

   This is performed to gain an understanding of the Installation Specification objective.

   If the design involves changes made to the control room or plant and incorporates HFE factors, the review should include/address those elements as specified in Appendix D.
3. Validate the drawings and DDRs in relation to the implementation plan contained in the KFA-002 Quality Control Plan (QCP).

   The “as designed” drawings should complement the KFA-002 QCP and permit implementation of the design by any artisan. The review should be conducted on a step-by-step basis.
4. Determine whether the referenced procedures are adequate.

   The procedures listed on the KFA-002 form must be inclusive of all the procedures required to perform this installation.
5. Verify that the trigramme allocations are reflected accurately on the affected drawings.

   Ensure that the trigramme allocation letter has been included in the design package and that the numbers are not duplicated anywhere else on the system. Are the allocated trigrammes identical for both units?
6. Validate the isolations specified for the installation design.

   Review the isolation points specified to ensure that all the required isolations have been included.
7. Verify any requirements to enter into an OTS Limited Conditions of Operation (LCO) as a result of this implementation design?

   Ensure that KAA-690 supporting documentation has been compiled and are acceptable for use when needed.
8. Has proper methodology been ascribed to de-energise the isolated section?

   Proper methodology must be provided to ensure the system is de-energised prior to work being conducted.
9. Perform a plant walk down (if possible).

   Ensure that the design is implementable on site.
10. Compile a detailed set of review comments.
11. Schedule a review meeting.
12. Collate all the review comments from the user review team members.
13. Table all review comments raised.

    This is to allow for a common understanding of the concern raised in the review comment and to allow the compiler to defend the package contents.

Appendix A (continued) – Design Review Guide

14. Compile a review report, containing all review comments
    This can be in the form of review comment sheets.
15. Review the Installation Specification review comments and incorporate into the package.
    The compiler has one of two actions on review comments:
    - Incorporate into the design document.
    - Do not incorporate with justification.

    For each comment indicate specific action taken in the review report.

Appendix B – Design Time Estimation Tool

	Designer				Reviewer			
			Hours (Est)				Hours (Est)	
	Activity		Estimate	Actual	Activity	Estimate	Actual	
1	**DEFINITION**				5 **REVIEWS**			
	Problem Evaluation				Feasibility Study			
	Meetings				Concept Design			
	Site Walkdowns				Design			
	Documentation				Stress Analysis			
	Feasibility Study				Safety Screening			
	Costing/Budget Pricing				Safety Evaluation			
	Conceptual Design				Safety Justification			
					DDRs			
2	**DESIGN**				6 **REWORK**			
	Detailed Design				Feasinility Study			
	Stress Analysis				Concept Design			
	Draughting				Design			
	Assembling Package				Stress analysis			
	Cocurrence Signatures				Safety Screening			
	Implemantation Support				Safety Evaluation			
					Safey Justification			
3	**SAFETY**				7 **APPROVALS**			
	Study SAR				Feasibility Study			
	Study OTS and RPS				Cost Benefit Analysis			
	Safety Screening				Design			
	Safety Evaluation				Safety Screening			
	Safety Justification				Safety Evaluation			
					Safety Justification			
4	**DOCUMENTATION**							
	Identity Aff'd Documents				SUB-TOTAL			
	Markup DDRs				CONTINGENCY (Set at 30%)			
	Raise DDR on DDT							
					TOTAL (Hours)			
					TOTAL (Days)			

NOTES

Appendix C– Guidance on Changes to Set Points

1. Is the set point related to a Safety Analysis limit?

   Refer to the Fuel Management Strategy Protection Design Files 1 – 6.

   The set point must ensure that the Safety Analysis limit is not exceeded before the set point actuates, even with probable channel inaccuracies. These set points require a detailed design in order to effect any changes.

2. Is it a process control system set point?

   Control system set points must ensure that the controlled variable does not reach a related protection system actuation set point, even with probable channel tolerances on both the control channel and the protection channel and considering the transient response and dead band of the controlled variable.

   Refer to system DSE and/or Functional Restoration Procedure (FRP) footnote values book, Emergency Operating Procedures (EOPs) and background documents. These set points on SR systems require a detailed design in order to effect any changes. Set points on AR systems might not require a detailed design to effect changes.

3. Is it an alarm set point?

   Set points should set the alarm so as to allow reasonable time for the corrective operator action before protection set points are actuated or equipment is damaged, even with probable channel tolerances and the measured variable changing at the highest rate normally expected. This, however, is not possible for rapidly changing variables. Refer to system DSE and/or FRP footnote values book, EOPs and background documents.

4. Is this an equipment protection set point?

   The set point must ensure that the necessary automatic action, tripping of the motor, closing of a valve, etc., occurs before the protected equipment is damaged. Refer to maintenance manuals, system DSEs, operating procedures and alarm cards.

5. It is an arbitrary set point.

   When no clear basis is found through steps 1 – 4, it is likely that no rigorous basis exists for the specific value. The set point should be selected on the principle to protect the equipment involved in the process or process limiting values with reasonable time margins post reference value attainment to correct the undesired plant response.

   The value that includes the required margins, channel inaccuracies and reference values is the footnote value or set point. Account should be taken of design code, standard, regulation and industry best practice values used for specific equipment and process types. See steps 6

   – 16 for further guidance.

6. Identify the components in the channel that can contribute to uncertainties in the operation of the set point. This can include process sensors, process instrumentation, calibration accuracy, etc.

7. Identify the inaccuracy introduced by each element in the channel. This is based on the manufacturers' specifications and consideration of the operating environment. Typically, the manufacturer specifies a basic accuracy and additional uncertainties, which are a function of

operating temperature range, power supply voltage, drift and possibly, other variables.

Appendix C (continued) – Guidance on Changes to Set Points

8. Determine the additional inaccuracies as a result of the equipment type used.

Differential pressure transmitters have an additional uncertainty, which is a function of the static pressure applied to the transmitter. This uncertainty is often specified as a separate effect on the zero adjustment and the span. The zero effect can be eliminated by adjusting the zero with static pressure applied. It is normally not practical to eliminate the static pressure effect on span. Digital instrumentation normally introduces no significant inaccuracies after the signal has been digitised.

9. Identify the inaccuracies introduced by the calibration process. This will include inaccuracy in the calibration input and the uncertainty in the reading and adjustment of the output.

10. Identify the inaccuracy introduced by the set point comparator. This will have a basic accuracy and may be subject to environmental influences and calibration errors.

11. Evaluate the probable overall channel uncertainty. To avoid excessive conservatism, which would unreasonably restrict plant design, uncertainties in individual elements are normally considered to be independent and random. Such errors are summed statistically, so that that overall uncertainty is the square root of the sum of the squares of the individual uncertainties. Errors that are not both independent of one another and random with a mean value of zero should be added algebraically after the statistical summation. Only elements that can affect uncertainty of this trip point should be considered. Any modules that do not affect the operation of the set point, e.g. output amplifiers to indicators, should not be included.

12. Review the client URS. Review to gain an understanding of the undesired plant response along with the client output requirements.

13. Determine the design requirements for the set point to be changed. This is achieved through Activities 1.0 and 2.0.

14. Ensure that the chosen set point is operationally acceptable. The set point selected should not introduce unnecessary actions as a result of operation within normal boundaries, taking into account channel errors.

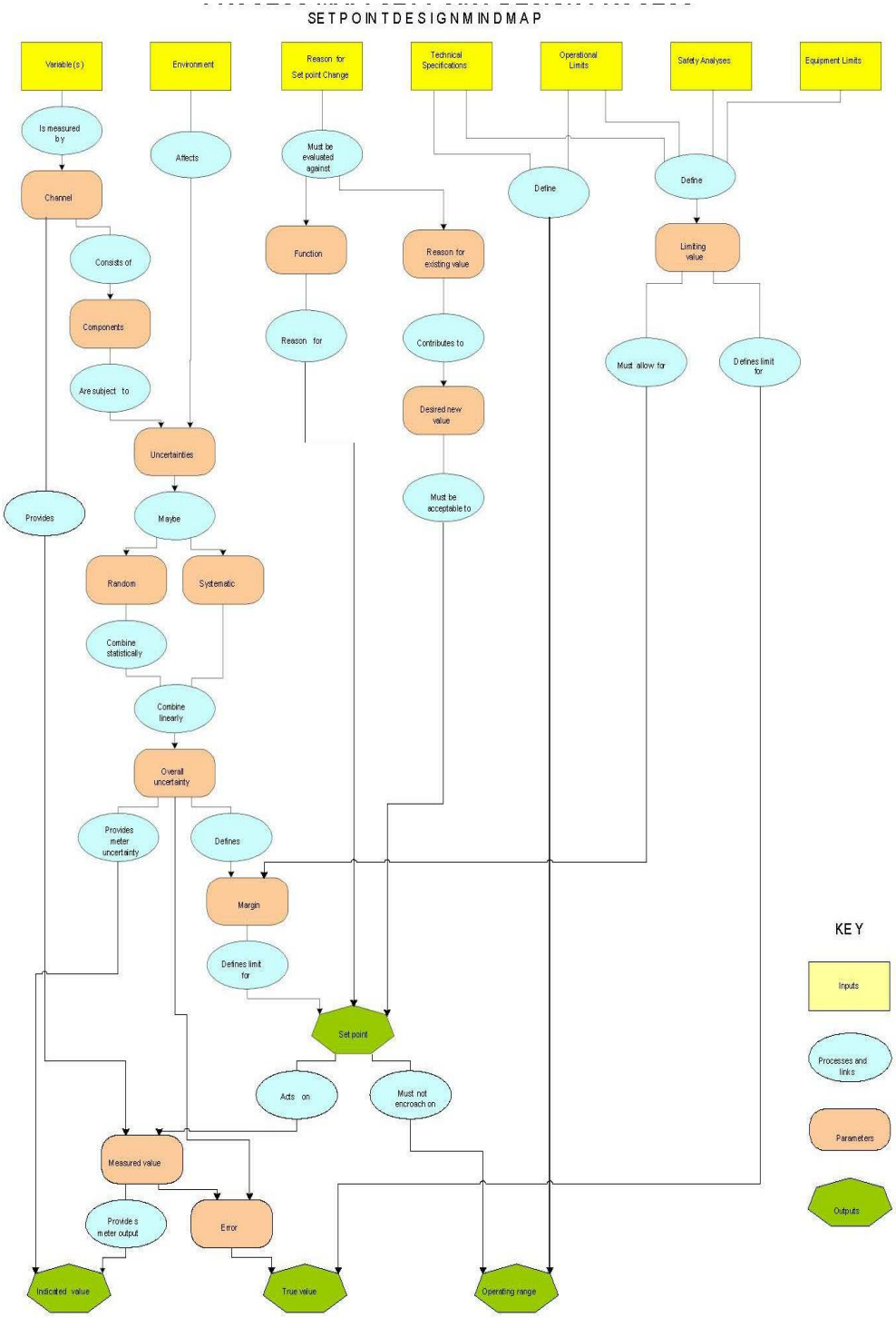
15. Determine what the operational and design margins are for the existing plant design.

This can be performed through a review of the SAR, accident analysis reports, maintenance manuals, FRP footnote values, etc. Available margins must be indicated in your detailed design document.

16. Compile a detailed design for the set point change. Comply with SECTION E design requirements and complete the sections appropriate for the set point change. Include all calculations and re-analysis performed in the detailed design.

Appendix C (continued) – Guidance on Changes to Set Points

PROCESS MAP: SET POINT DESIGN PROCESS



Appendix D– HFE Design Review Guide

1. The human factors engineering aspects of the control room and relevant plant are to be reviewed in accordance with the *Standard Review Plan* (NUREG-0800). Detailed design review procedures are provided in the *HFE Program Review Model* (NUREG-0711). These guides and the ones mentioned below can be found in G:\Nuclear Engineering\Design Eng\Masters\HFE Guides.
2. The interface between plant personnel and plant systems and components are to be evaluated for conformance with HFE guidelines using Human-System Interface Design Review Guidelines (NUREG-0700).
3. Verify that the plant design does not adversely affect the performance of personnel (conduct training and implement procedure modifications if necessary).
4. Verify that the plant design change does not increase the workload of control room operating staff during transient and accident operations without an impact analysis and justification.
5. Evaluate operator performance of relevant control room tasks both prior to and after the installation of a modification that impacts the main control room to ensure that operator response remains acceptable after the modification.
6. Verify that the plant design change does not introduce additional human-system interfaces (HSI) without due consideration of the consequential impact on other activities performed in the control room at the times when the interfacing is required.
7. Review the physical and functional characteristics of the HSI. Evaluate basic HSI elements such as displays, user-interface interaction and management, and controls.
8. Review HSI systems like alarm system, group-view display system, soft control system, computer-based procedure system, computerised operator support system and communication system. Review HSI support, i.e., maintainability of digital systems.
9. Verify that if procedures are modified, their content, format, and integration accurately reflect changes in the plant, human actions, and HSIs.
10. Verify that due consideration be given to workstation design (workstation features such as control-display integration and layout, labelling, and ergonomics, e.g. vision and reach). Plant design change outputs to the control room operators should be aesthetically consistent with the format of similar information sources viz. alarms templates, colours, enunciators, instrument faces, etc.
11. Verify that due consideration be given to workplace design (overall layout of workstations and other equipment such as group-view displays within the workplace, provision for support equipment such as ladders, and environmental characteristics including ambient temperature or pressure, relative humidity, ventilation, illumination, auditory background - noise, vibration or radiological).
12. Verify that the plant design change does not result in barriers to communication in the control room, and that HSI modifications support operating crew coordination.

Appendix D (continued) – HFE Design Review Guide

13. Ensure that 12 elements of HFE program (HFE Program Management, Operating Experience Review; Functional Requirements Analysis and Function Allocation, Task Analysis, Staffing, Human Reliability Analysis, Human-System Interface Design, Procedure Development, Training Program Development, Human Factors Verification and Validation, Design Implementation and Human Performance Monitoring) are addressed.

14. Make a safety determination of the designs acceptability.

15. Ensure that design uses acceptable HFE program plan; resulted from appropriate HFE studies and analysis that provide accurate and complete inputs to the design process and provide verification and validation assessment criteria.

16. Ensure that plant meets applicable regulatory requirements, that changes are designed using proven technology based on human performance and task requirements incorporating accepted HFE standards and guidelines.

17. Verify that the design supports operating personnel in the fulfilment of their responsibilities and the performance of their tasks, and limits the effects of operating errors on safety. Ensure that attention is paid to plant and equipment layout, procedures, including procedures for maintenance and inspection, to facilitate interaction between the operating personnel and the plant.

18. Ensure that the HSIs provide the operators with comprehensive but easily manageable information, in accordance with the necessary decision times and action times. The information necessary for the operator to make a decision should be simply and unambiguously presented.

19. Ensure that the operator is provided with the necessary information

- To assess the general state of the plant in any condition;
- To operate the plant within the specified limits on parameters associated with plant systems and equipment (operational limits and conditions);
- To confirm that safety actions for the actuation of safety systems are automatically initiated when needed and that the relevant systems perform as intended;
- To determine the need and time for manual initiation of the specified safety actions.

20. Ensure that the need for intervention by the operator on a short time scale is kept to a minimum, and that it is demonstrated that the operator has sufficient time to make a decision and a sufficient time to act.

21. Verify that the design ensures that, following an event affecting the plant, environmental conditions in the control room or the supplementary control room do not compromise the protection and safety of the operating personnel.

22. Ensure that verification and validation of features relating to human factors are included at appropriate stages to confirm that necessary actions by the operator have been identified and can be correctly performed.

23. Verify that the information displays conforms to KOU identification conventions.

Appendix E– Factory Acceptance Test Guidelines

The intention of this guideline is not to provide an exhaustive list of duties that an employee shall adhere to when tasked with attending a FAT, but rather to serve as an informative document, which will add value to the effectiveness of FATs performed by the engineering staff of the KOU.

1.1 Prior to the FAT, the employees tasked with attending the FAT should:

1.1.1 Ensure that they clearly understand the importance of the FAT to ensure that Eskom's interests are protected.

1.1.2 Be certain that they are confident enough and qualified to attend the FAT.

1.1.3 Ensure that they clearly understand the overall system that contains the equipment they are accepting, and what the system acceptance criteria are for the equipment.

1.1.4 Source the TRS used to purchase the equipment and familiarise themselves with it.

1.1.5 Source the Eskom schedules A & B, if they exist, and familiarise yourself with them. The A & B schedules are the equipment technical specifications agreed to by both Eskom and the manufacturer at the tender phase of the procurement process. It also contains a list of tests with acceptance criteria that both parties have agreed to after completion of the manufacturing process.

1.1.6 Source the relevant SANS, International Electrotechnical Commission (IEC) or other agreed upon standards (Eskom and the OEM) and familiarise themselves with the acceptance criteria to be used to qualify the equipment. These should already be mentioned in the TRS or AB schedule.

1.1.7 Source all Eskom guides and standards relevant to the equipment and familiarise themselves with the Eskom acceptance criteria.

1.1.8 Seek the advice of the Eskom corporate consultants on the acceptance criteria they want to add, in addition to the relevant standards, and whether there are criteria that can be waived based on Eskom experience.

1.1.9 Prepare a list of telephone numbers of relevant Eskom personnel that can be of assistance when issues arise that need clarification, especially when the FAT is abroad.

1.1.10 Prepare a spreadsheet that contains as a minimum:

- The tests required, which should include testing for correct functionality, performance and compatibility. Other than the normal equipment functional operation, functionality testing should also include:
  - inputs and outputs are connected according to the drawings;
  - trip points operate according to the requirements;
  - logic solver and associated software operate according to requirements;
  - reset functions operate correctly;
  - alarms operate correctly;
  - operator functions operate according to the requirements;
  - bypass functions operate according to the requirements;

Appendix E (continued) – Factory Acceptance Test Guidelines

- manual shutdown functions operate according to the requirements;
- diagnostic alarm functions operate according to the requirements.

- Testing for failure modes and effects. The idea is that the contractor demonstrate that his failure modes and effects analysis (FMEA) as provided in the design is tested and delivers the predicted results;
- Test methods, correct test sequences and acceptance criteria as stipulated in the SANS, IEC or other agreed upon standards;
- A list of the hardware, firmware and software identification codes and versions to be verified.

1.1.11 Request a test schedule from the OEM in advance and ensure that the OEM test schedule and procedures are acceptable to Eskom.

1.1.12 Ensure that the OEM has adequate test facilities to carry out the testing, and if not, request that the OEM makes alternative arrangements to do this testing.

1.2 During the FAT the employees should:

1.2.1 Use the spreadsheet to confirm that all the listed acceptance criteria are met.

1.2.2 Ensure that the correct hardware, firmware and software identification codes, and versions are available.

1.2.3 Ensure that valid calibration certificates are available for the test equipment used.

1.2.4 Ensure that the equipment is correctly connected for the test procedure to be carried out.

1.2.5 Ensure that the agreed tests are carried out in accordance with the schedule and acceptance criteria are met.

1.2.6 When there is a disagreement with the OEM, the employee should arrange a teleconference with the relevant Eskom personnel to resolve such issues.

1.2.7 The employee should not waive tests or previously agreed upon acceptance criteria with the OEM unless this is resolved by consensus with the relevant Eskom personnel, preferably by teleconference arrangement.

1.2.8 The employee shall only sign that they have witnessed a test if the test was performed correctly and that the acceptance criteria have been met.

1.2.9 The employee may not sign concurrence with the OEM on any test performed or test results obtained that are in non-conformance with the test procedure agreed to by Eskom or when the test criteria have not been met. Use the spreadsheet you prepared for the recording of actual test measurements and compare them with the acceptance criteria.

1.2.10 In the event that a problem arises with the test performance of the equipment, decide if the issue is:

- minor and can be resolved quickly by adjustments or minor intervention/s. In this case the employee should raise a defect with the OEM;
- major and requires design change or remanufacture; in this case the employee should raise a non-conformance report (NCR) with the OEM.

Appendix E (continued) – Factory Acceptance Test Guidelines

Ensure that on completion of the testing, that the OEM provides you with the test certificates for the equipment tested; these shall record the test values obtained and clearly indicate that these values are acceptable according to the relevant standard. Whenever possible, all test certificates should bear the signatures of the tester, the laboratory manager and authorized by the OEM representative. Test certificates are to note the test equipment serial number, make and last calibration date of the equipment.

1.3 On completion of the FAT the employee should:

1.3.1 Report back to the project manager as to whether the FAT was successful or not and if there are any contentious issues to be dealt with. The reporting should be both verbal and contained in a written report with copies of the test certificates as attachments. The written report allows for dissemination of the FAT information to the rest of the project team and is useful when problems arise with the equipment at the installation, testing and commissioning phases of the project.

1.3.2 If there are any concerns or abnormalities about the manner in which the testing was conducted, these should be included as part of the reporting process.

1.3.3 Test certificates that are accepted by the Eskom project team must be included in the relevant maintenance manuals as a permanent record. It provides a reference for the future should problems arise.

Appendix F– Process for New KIT System Point Allocations

1. Identify the requirements of the new KIT system points relating to:
    - Number of I/O points.
    - Point types.
2. Submit requirements to the DE KIT system custodian. A suitable drop (controller), node number (local/remote), branch number and slot number will be identified. Verify availability of points with the aid of walkdowns and KIT system termination drawings.

7.1 NOTE:

Spare digital inputs may be created by exploiting the following legacy issue left behind by the original KIT system (more specifically, by the Alstom T20 digital input card) configuration:

The original KIT system architecture looped the polarity unit (UP) validation signals to each individual input card that had alarms associated with that particular UP. The KIT Interblock Wiring Diagrams (KBA 1216 D04 1014, 1015, 1016, 1017, 1021, 1022, 1023, 1024) document

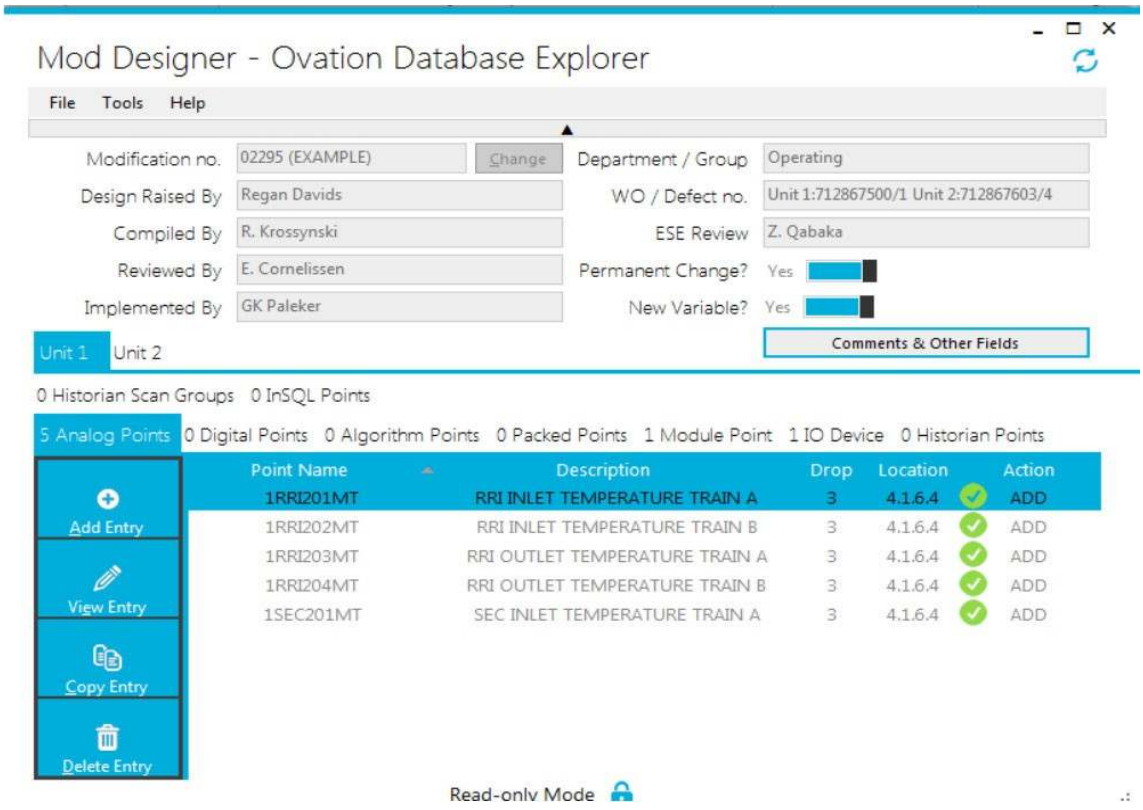
this wiring of the UP validation signals between the original UP KIT system input and the interblocks that were connected to the Alstom T20 digital input card installed at position 1 in each rack. This was a requirement specific to the Alstom T20 data acquisition system and resulted in two (or more in some cases) KIT system inputs being used for each UP validation signal.

When the Ovation system was installed the same input configuration was used but with only the last input used for the UP validation signal (Ovation only requires a single UP validation input). The other intermediary inputs were not used and were listed as spare in the KIT system. However, these intermediary inputs are not spare as they are still looped from the first UP input. Hence, it cannot be merely disconnected as it provides the intermediate connections to the last UP input. These intermediary inputs may however be freed up and used as spare KIT system inputs by performing the following:

- In the KIT system configuration software, change the applicable KIT UP validation signal to point to the first (original) input connected to the plant.
- Remove the jumper to the interblock and free up that input for use. It is possible to do this on-line, but a UP alarm will be generated when the link is temporarily pulled.
- Update the KIT Interblocks Wiring Diagrams as well as KBA 1215 K06 098, 099, 100, 101, KBA 0116 J06 578, KBA 0216 J06 578 and KBA 1215 K06 130 as applicable.

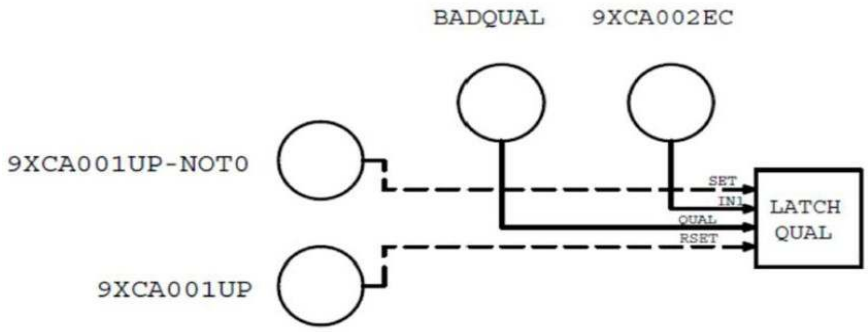
Appendix F (continued) – Process for New KIT System Point Allocations

3. Complete the new point request via the Ovation Database Explorer Software (available on the NAL). A printout of the new points is to be attached to the design package.



4. Validation of the digital signals acquired by the KIT system is done in the event of field power supply (UP failure). This is done in the control logic of the KIT system.

5. The following is an example of logic that is to be provided for each hard wired digital signal on the KIT system:



Appendix F (continued) – Process for New KIT System Point Allocations

In addition, the following information needs to be supplied for each validation:

- The controller drop on which the logic needs to be created.
- The task area for the logic.
- The existing sheet number on which the logic needs to be created, or
- The new sheet number to be created.

Drawing Number	Drop	Task	Sheet
CTL 1	1	2	60480

6. The documentation for the new point allocation is to be submitted to DE, Instrumentation Maintenance Services Digital (ICD) and Electrical System Engineering (ESE) for review.
7. The following guides can be used to complete fields with required information:
   - Controller (OCR400) and Controller Diagnostics User Guide for Ovation (KBA 1216 D00 2018).
   - Developer Studio User Guide for Ovation (KBA 1216 D00 2017).
   - Ovation Process Historian User Guide (OH320_70)

Appendix G– Design Engineering Product Approval Guide

The Design Engineering Manager (or a delegate) must approve all formal Design Engineering products. These include Equivalency Packages, Specifications (procurement and technical requirement specifications), Classifications, and Designs (both minor and non-minor).

Approval of the package represents that the package has been prepared and reviewed in accordance with the relevant Engineering Change Process and the Engineering quality assurance programme.

The approver is expected to apply his/her experience, knowledge, judgement and discretion when approving products. However, the approver should at a minimum check the following items prior to approving any engineering change:

1. The engineering change process used is appropriate to the change (i.e. that the correct process such as a memo, equivalency package, minor design or non-minor design was used)
2. The compilers and reviewers of the package are appropriately qualified
    a. for internal designs, this entails ensuring the individuals' authorisation for the importance category of the change is captured in writing – either in the Design Engineering Authorisation Matrix, or by confirming that the Design Manager has deemed the individuals qualified and captured such in writing)
    b. For external designs, the persons taking responsibility for the design should be appropriately registered with ECSA, or a foreign Professional Engineering body providing similar assurance of professionalism, or have demonstrated experience determined by the Design Engineering Manager to achieve the same goals (for example an expert in a field that may not be a registered engineer)
3. Sufficient discipline reviews have been performed (i.e. multiple reviews where more than one engineering discipline is impacted by the change),and sufficient expert reviews (e.g. where the package impacts on specialist fields such as nuclear fuel, fire protection, HAZLOC, or other specialist fields)
4. A Safety Screening (and associated Safety Evaluations or Safety Justifications) have been completed, and appropriately approved
5. The package identifies changes to (or creates new, or removes defunct) document configuration
6. For minor designs, a design review report has been completed and signed by the reviewer
7. For non-minor designs, a Detailed Design Review Report has been completed and signed by an independent reviewer
8. All concurrence reviewers names must be clearly legible, and their signatures included in the change package
9. The approver must check (and deal with) if the reviewers have indicated any remaining open issues, or have specifically stated that their review was not complete. (i.e. the approver must be satisfied that all aspects of the change have been appropriately independently reviewed)

10. The approver must be satisfied that the level of detail in the documentation is sufficient for future operation and modification of the plant (where future generations may not have the knowledge of currently topical discussions, issues or meetings)
11. The approver should also be satisfied that the overall quality of the package is appropriate to the quality expected of the Design Engineering Department at the NOU.