Eskom	Detailed Design	Nuclear Engineering

Title:	**Detailed Design of the Koeberg TISF - First Spent Fuel Cask Storage Pad (Redacted)**	Unique Identifier:	**12010TISF-0017**
		Alternative Reference Number:	**N/A**
		Area of Applicability:	**Nuclear Engineering**
		Functional Area:	**Design Engineering**
		Documentation Type:	**Detailed Design**
		Revision:	**3**
		Total Pages:	**678**
		Next Review Date:	**N/A**
		Disclosure Classification:	**Public**

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Date:	Date: 2024-11-14	Date: 2024-11-14	Date: 2024-11-14	Date: 2024-11-14

Nuclear Additional Classification Information

Business Level:	**4**
Working Document:	**3**
Importance Classification:	**SR**
NNR Approval:	**Yes**
ALARA Review:	**Yes**

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1. INTRODUCTION

1.1 The Existing Design

The Transient Interim Storage Facility (TISF) at Koeberg Nuclear Power Station (KNPS) is presently used for the interim storage of the Original Steam Generators (OSGs) in the Original Steam Generators Interim Storage Facility (OSGISF) within the TISF area.

1.2 Problems with the Existing Design

There is currently no national “off-site depository” and related disposal infrastructure available for the management of spent nuclear fuel in the Republic of South Africa (RSA), except for an “on-reactor site” storage infrastructure. The National Radioactive Waste Disposal Institute (NRWDI) focuses on the establishment of a national Centralised Interim Storage Facility (CISF) by 2030 for the safe storage of Koeberg’s spent fuel and other high-level waste.

Currently Koeberg is evacuating the spent fuel pools (SFPs) by loading spent fuel into dry storage casks. The station license grants permission to store dry storage casks in the Cask Storage Building (CSB) which has a maximum capacity of 16 casks. To-date 15 casks have been loaded and are stored in the CSB and therefore additional storage capacity is required. If no additional space is created before 2024 this would lead to the premature shutdown of the Koeberg reactors.

1.3 The New Design

The proposed TISF design consists of a Storage Area that includes a reinforced Concrete Pad with seven Auxiliary Shielding Modules (ASMs). The general view of the TISF is shown in Figure 2. The concrete pad will be constructed modularly in three phases. The ASM is designed for additional shielding so as to comply with the NNR controlled zone boundary dose rate requirements. The ASMs have a capacity to each house two loaded HI-STAR 100 casks and each module has a lockable access door to allow for Radiation Protection (RP), Inspection and Maintenance plant operations within the modules. The inside of each ASM will be fitted with lighting to provide visibility within the structures. The Storage Area is shown in Figure 1.

The TISF Storage Area will accommodate a maximum of 14 HI-STAR 100 casks. The construction of the Concrete Pad and ASM for the first four casks shall be completed before Outage 227.

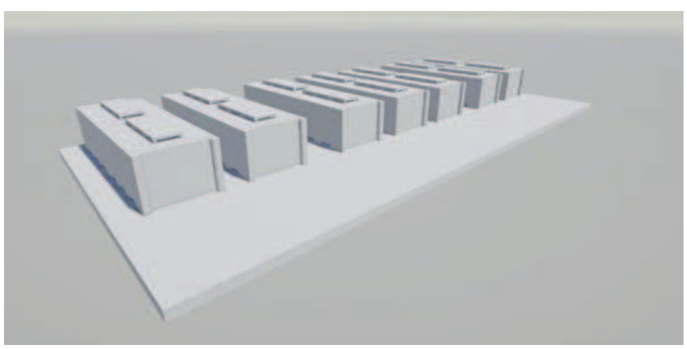

Figure 1: Storage Area (Concrete Pad + ASM) with Approach Aprons

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The figure has been removed as it provides specific details of the Koeberg TISF location.

Figure 2: General View of the TISF

2. SUPPORTING CLAUSES

2.1 Scope

2.1.1 Purpose

The purpose of this report is to provide the detailed design of the Koeberg TISF for the storage of 14 HI-STAR 100 casks. The report is divided as follows:

- Part A – Design Change
- Part B – Manufacturing and Installation Specification
- Part C – Procurement Specification
- Part D – Other Attachments

2.1.2 Applicability

This document shall apply throughout Eskom Holdings Limited Divisions.

2.1.3 Effective date

This document is effective once authorized.

2.2 Normative/Informative References

The edition of the code, standard or document referenced to be utilised is determined considering the following order of priority:

1. Republic of South African legal requirement.
2. Latest edition required by the National Nuclear Regulator (NNR).
3. Latest edition approved by Eskom.
4. Latest edition approved by the NRC and/or the IAEA.
5. Latest approved edition available.

2.2.1 Mandatory References

2.2.1.1 Mandatory International References

[1] 10 CFR Part 72 - Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-Level Radioactive Waste, and Reactor-Related Greater Than Class C Waste.

[2] ACI 349-13 – Code Requirements for Nuclear Safety Related Concrete Structures (ACI 349-13) and Commentary.

[3] ACI 349.3R – Evaluation of Existing Nuclear Safety-Related Concrete Structures.

[4] ANSI N14.6 Radioactive Materials - Special Lifting Devices for Shipping Containers Weighing 10000 Pounds (4500 kg) or More, ANSI.

[5] ASCE 7-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

[6] ASCE/SEI 4-16 Seismic Analysis of Safety-Related Nuclear Structures.

[7] ASME NQA-1 – Quality Assurance Requirements for Nuclear Facility Application

[8] IAEA SSR-6 – Regulations for the Safe Transport of Radioactive Material.

[9] NRC Regulatory Guide 1.132 Geologic and Geotechnical Site Characterization Investigations for Nuclear Power Plants, 2021.

[10] NRC Regulatory Guide 1.198 Procedures and Criteria for Assessing Seismic Soil Liquefaction at Nuclear Power Plant Sites, 2003.

[11] NRC Regulatory Guide 1.61 Damping Values for Seismic Design of Nuclear Power Plants.

[12] NRC Regulatory Guide 1.76 – Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants.

[13] NRC Regulatory Guide 1.92 Combining Modal Responses and Spatial Components in Seismic Response Analysis.

[14] NRC Regulatory Guide 3.76 – Implementation of Aging Management Requirements for Spent

Fuel Storage Renewals, Revision 0.

[15] NUREG/CR-5741 - Technical Bases for Regulatory Guide for Soil Liquefaction, 2000.

[16] NUREG/CR-6865 - Parametric Evaluation of Seismic Behavior of Freestanding Spent Fuel Dry Cask Storage Systems, 2005.

[17] NUREG-0612 Control of Heavy Loads at Nuclear Power Plants, US NRC.

[18] NUREG-0800 Section 3.7.1 - Seismic Design Parameters.

[19] NUREG-1927 - Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Revision 1.

[20] NUREG-2152- Computational Fluid Dynamics Best Practice Guidelines for Dry Cask Applications, 2013.

[21] NUREG-2174 - Impact of Variation in Environmental Conditions on the Thermal Performance of Dry Storage Casks, 2016.

[22] NUREG-2214 - Managing Aging Processes in Storage (MAPS) Report.

[23] NUREG-2215 – Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities.

[24] NUREG-1927 - Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel, Revision 1.

2.2.1.2 Mandatory Domestic References

[25] 12010-D0001 - Establishment of a Transient Interim Storage Facility at Koeberg - Licensing Strategy.

[26] 238-36 - Operational Radiation Protection Requirements

[27] 238-54 - Radiological Protection Licensing Requirements for Koeberg Nuclear Power Station.

[28] 240-120994091 - Specification for Modifications and Equipment Required for External Flooding Applications

[29] 240-121005755 - Specification for Modifications and Equipment Required for High Speed Wind and Tornado Applications.

[30] 240-121010217 - Specification for Modifications and Equipment Required for Seismic Event Applications.

[31] 240-121013197 - Specification for Modifications and Equipment Required for Severe Ambient Temperature Applications.

[32] 240-155785643, Rev 1 - Control of the Site Plan and Site Development Plan at KNPS

[33] 240-89294359 - KSA-010 - Nuclear Safety, Seismic, Environmental, Quality, Importance and Management System Level Classification Standard

[34] KAA-501 - Modifications to Plant, Plant Structures or Operating Parameters that affect the Design Base.

[35] KAA-637 - Access Control to Radiological Controlled Zones.

[36] KAA-709 - Safety Evaluation Process.

[37] KEP 088 - Transfer and Storage of Fuel Casks.

[38] KGA-018 - Safety Case Preparation.

[39] KGA-025 - Safety Evaluation Process Guide.

[40] KGF-001 - Guidelines for the Independent Review of Fuel Related Codes, Methods and Applications.

[41] Koeberg Safety Analysis Report.

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

[43] NIL-01 - Nuclear Installation Licence.

[44] NIL-44 - Nuclear Installation Licence.

[45] PP-0014 - Considerations of External Events for New Nuclear Installations.

[46] RD-0022: Radiation Dose Limitation at Koeberg Nuclear Power Station.

[47] RD-0024 - Requirements on Risk Assessment and Compliance with Principal Safety Criteria for Nuclear installations.

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

[49] RG-0011 Interim Guidance on the Siting of Nuclear Facilities.

[50] RG-0016 - Guidance on the Verification and Validation of Evaluation and Calculation Models used in Safety and Design Analyses.

[51] SANS 10100-1 - The structural use of concrete Part 1: Design.

[52] SANS 10100-2 - The structural use of concrete Part 2: Materials and execution of work.

[53] SANS 10144 - Detailing of Steel Reinforcement for Concrete.

[54] SANS 10162-1 - The structural use of steel Part 1: Limit-state design of hot-rolled steelwork.

[55] SANS 12100 - Safety of Machinery - General Principles for Design - Risk Assessment and Risk Reduction

[56] SANS 2001-CC1 - Concrete Works: Structural.

[57] SANS 31010 - Risk Management - Risk Assessment Techniques

2.2.1.3 Informative References

[58] 07147DPDRR014 - Spent Fuel Transient Interim Storage Facility Specification Rev.1.

[59] 240 86880760, Revision 2, Pre-Feasibility Study on the TISF Facility, Eskom.

[60] 240-123880544, Revision 2: Decommissioning Strategy for Koeberg Nuclear Power Station Alternative Reference Number: EYB-643.

[61] 240-166149425, Revision 1, Basis and Scope for Non-License Binding Civil Surveillances at Koeberg Nuclear Power Station.

[62] ANSYS, Inc., Ansys Mechanical, Release 21.2.

[63] C0007/24C Transient Interim Storage Facility Classification

[64] Certificate of Compliance Renewal Application for the Standarized Advanced NUHOMS System (CoC No.1029, Docket No. 72-1029)

[65] Environmental Impact Assessment of the Used Fuel Transient Interim Storage Facility at Koeberg Nuclear Power Station - Environmental Impact Assessment Report, 2016.

[66] Eskom, 07092M7-B: OSGISF Civil Services Minor Modifications Report Rev.0.

[67] Eskom, Site Safety Report for Duynefontyn - Site Characteristics.

[68] Fluent, Inc., FLUENT Computational Fluid Dynamics Software, Centerra Resource Park, 10 Cavendish Court, Lebanon, NH 03766.

[69] G.S. Bjorkman Jr., Influence of ISFSI Design Parameters on the Seismic Response of Dry Storage Casks, PATRAM, 2010, London, U.K.

[70] HALFEN, HALFEN DEMU Fixing System - Technical Product Information.

[71] HALFEN, HALFEN HD Socket Lifting System - Technical Product Information.

[72] HI-2012610 - Final Safety Analysis Report on the HI-STAR 100 MPC Storage System Revision 4 (Holtec International)

[73] IAEA TECDOC-1341 - Extreme external events in the design and assessment of nuclear power plants.

[74] JN683-MSJ-NSE-R-7053 Factual Geotechnical Report for CSB and ISFSI at Koeberg Nuclear Power Station, 2017.

[75] JN722-NSE-ESKB-R-7157 Steam Generator Haul Report, 2017.

[76] KEP-088, Revision 7: Emergencies Affecting Spent Fuel Storage Casks

[77] Livermore Software Technology Corporation (LSTC), LS-DYNA Keyword User'S Manual Volume I.

[78] NEI 14-03 - Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management, Revision 2, Nuclear Energy Institute.

[79] Public Information Document for the Long-Term Operation of Koeberg Nuclear Power Station Rev.2, 2022.

[80] Saint-Gobain, duragrout - Product Data Sheet

[81] Sika, SikaGrout-212 - Product Data Sheet

[82] Spent Fuel Storage at Fukushima Daiichi NPP, International Conference on Management of Spent Fuel from Nuclear Power Reactors - An integrated Approach to the Back End of the Fuel Cycle.

[83] U.S. Nuclear Regulatory Commission, P-CARES Version 2.0.0.

2.3 Definitions

2.3.1 Anchor – A device so installed as to provide a firm point of attachment for resisting upliftment.

2.3.2 Approval – Process of obtaining approval from the NNR to provide services based on compliance with specified requirements.

2.3.3 Auxiliary Shielding Module – Reinforced concrete structure designed for additional shielding of HI-STAR 100 casks so as to comply with the controlled zone boundary dose rate requirements.

2.3.4 Backfill – Soil or other material placed in an excavation after the installation of the foundation, when the original soil is unsuitable.

2.3.5 Boundary Area – It is the total available area for the development of the installation.

2.3.6 Controlled Zone – Restricted, discrete areas containing radiological hazards where the integrated dose equivalent to a person may exceed 1000 μSv per annum (According to KAA 637).

2.3.7 Disposal – Disposal is the final step in the management of radioactive waste. Its aim is to provide safety through emplacement of waste in facilities designed for appropriate levels of containment and isolation.

2.3.8 In-situ testing – Testing done under live conditions in a non-intrusive way to verify the accuracy of a metering installation.

2.3.9 Inspection – Visual or audible (or both) examinations that can be assisted by mechanical or electrical (or both) means, that will detect obvious unsatisfactory conditions or discrepancies (International Electrotechnical Commission (IEC) modified)

2.3.10 Item – Any part, component, device, subsystem, functional unit, equipment, or system that can be individually considered (IEC)

2.3.11 Owner Controlled Area – Restricted, discrete areas containing radiological hazards where the integrated dose equivalent to a person may exceed 250 μSv per annum.

2.3.12 Quality assurance – A systematic process implemented to ensure the quality of a product and/or service.

2.3.13 Recycling – The action or process of converting waste into reusable material.

2.3.14 Regulation – Document providing binding legislative rules, that is adopted by an authority.

2.3.15 Responsible disposal – The action of getting rid of waste in a responsible manner and ensure the rubble (concrete and steel) is processed as far as reasonably possible.

2.3.16 Retire in-situ – Material which is retired and stored in site.

2.3.17 Risk – Chance of loss, or the probability that an undesired event may occur, multiplied by the cost of that event if it does occur.

2.3.18 Risk management – Managerial function which has the objective of protecting people, assets and profits of a business, by eliminating or minimizing the potential for loss from pure risk and the provision of funds to recover from losses that do occur.

2.3.19 Safety Related – Systems, structures, components, procedures, and controls (of a facility or process) that are relied upon to remain functional during and following design-basis events. Their functionality ensures that key regulatory criteria, such as levels of radioactivity released, are met.

2.3.20 Shield – Barrier or enclosure provided for mechanical protection, which may also have the function of a screen.

2.3.21 Standard – Document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

2.3.22 Storage Area – It is the area inside the boundary area which is used for the storage of dry cask storage systems and includes a reinforced Concrete Pad with seven Auxiliary Shielding Modules (ASMs).

2.3.23 Work permit – Document(s) for the authorization of all work to be done on any supply system or apparatus.

2.4 Abbreviations

Abbreviation	Explanation
ACP	Access Control Points
ALARA	As Low As Reasonably Achievable
AMP	Ageing Management Programs
ASM	Auxiliary Shielding Module
CBR	California Bearing Ratio
CISF	Centralised Interim Storage Facility
CoC	Certificate of Compliance
CSB	Cask Storage Building
CTP	Cask Transfer Pit
DEC	Design Extension Conditions
DSC	Dry Shielded Canister
DSSR	Duynefontyn Site Safety Report
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EOP	Emergency Operating Procedure
EP	Emergency Plan
FEL	Front End Loader
FHD	Forced Helium Dehydrator
FRM	Fire Risk Management
FSAR	Final Safety Analysis Report
Hazloc	Hazardous Locations
HSM	Horizontal Storage Module
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
ISFSI	Independent Spent Fuel Storage Installation
ISI	In-Service Inspection
KCC	Koeberg Civils Consortium
KCS	Chemistry Specifications
KNPS	Koeberg Nuclear Power Station
LS	Linked to Safety
LSTC	Livermore Software Technology Corporation
MAB	Módulo Auxiliar de Blindaje, in Spanish
MAPS	Managing Aging Processes in Storage
MAVRIC	Monaco with Automated Variance Reduction using Importance Calculations
MDD	Maximum Dry Density
NEMA	National Environmental Management Act
ND	Non-Destruct

Abbreviation	Explanation
NNR	National Nuclear Regulator
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (United States)
NRWDI	National Radioactive Waste Disposal Institute
NSF	Not Safety Function
OSG	Original Steam Generator
OSGISF	Original Steam Generators Interim Storage Facility
OTS	Operating Technical Specifications
PRA	Probabilistic Risk Assessment
QA	Quality Assurance
RP	Radiation protection
RSA	Republic of South Africa
SAMG	Severe Accident Management Guide
SAR	Safety Analysis Report
SFAs	Spent Fuel Assemblies
SFPs	Spent Fuel Pools
SNF	Spent Nuclear Fuel
SR	Safety Related
SRSM	Safety Related Surveillance Manual
SSC	Structures, Systems and Components
SSE	Safe Shutdown Earthquake
SSR	Site Safety Report
TISF	Transient Interim Storage Facility
TRS	Technical Requirements Specification
WMP	Waste Management Plan
ZPA	Zero Peak Acceleration

2.5 Roles and Responsibilities

See KAA-501 [34] for roles and responsibilities.

2.6 Process for Monitoring

The detailed design is valid from the date authorised for the planned operating life of the station, till 2045. The loaded casks may be stored on the TISF for a further 10 years before being transported to the off-site CISF.

2.7 Related/Supporting Documents

Not applicable.

PACKAGE CONTENTS

3. PART A – DESIGN CHANGE

3.1 Requirements

3.1.1 License Conditions

Nuclear Installation License No. NIL-44 (Variation 3) [44] is granted to Eskom for the siting, construction, operation and decommissioning of the nuclear installation known as the OSGISF, located on the site earmarked for the Transient Interim Storage Facility, and situated on the site of Cape Farm No. 34, also known as Duynefontyn, in the magisterial district of Malmesbury in the Western Cape.

This detailed design is for the design, licensing and installation of the first Storage Area on the TISF location as proposed in Section 1.3 of this document. Eskom will submit an application for the amendment of NIL-44 on the NNR approval of the detailed design. The following conditions apply:

- "12.1. Modifications to the plant must be carried out in accordance with the requirements of the LD-1012: "Requirements in Respect of Proposed Modifications to the Koeberg Nuclear Power Station" [42].
- 12.2. The licensee must comply with the provisions specified in 36-197: "Koeberg Licensing Basis Manual" regarding the following:

  a) Control of Plant Design and Configuration.

  b) Modifications made to the plant or any other change which may impact on nuclear safety."

The NIL-44 [44] update will also require an update of the Site-Plan for NIL-01 [43] and NIL-44 [44]. This will be done per procedure *240-155785643 Rev 1 Control of the Site Plan and Site Development Plan at KNPS [32].*

3.1.2 List of Requirements from TRS

The design requirements for the TISF are included in the Spent Fuel Transient Interim Storage Facility Technical Requirements Specification 07147DPDRR014 [58], and compiled as a checklist in Table 1.

Table 1: List of Requirements from TRS

TRS Section	Requirement	Compliance
§ 4.1.2.1	The Koeberg TISF storage pad shall be located on the Koeberg TISF site.	FULLY COMPLIED (See §1.3)
§ 4.1.2.2 § 5.1	The Koeberg TISF storage pad shall be designed in accordance with requirements of an internationally recognised nuclear licensing authority's spent nuclear fuel storage requirements such as 10 CFR 72 or equivalent licensing requirement(s). Compliance with spent nuclear fuel storage requirements of 10 CFR 72 off-site transport requirements of IAEA SSR-6 [8] or a document demonstrating equivalent licensing requirement(s).	FULLY COMPLIED See §3.1.3 and §3.2)

TRS Section	Requirement	Compliance
§5.2	Compliance with all the relevant national and local South African legislation as well as the requirements of the documents in §2.2, Mandatory Codes and Standards and §2.3, Other Mandatory Documents, of this specification.	FULLY COMPLIED (See §2.2)
§ 4.1.2.3 § 5.11.3.4 § 5.11.3.5	The Koeberg TISF storage pad shall be designed and located on the site so as not to interfere with future added storage pads and casks on the site. Optimising the TISF pad location while complying with Koeberg dose requirements. Allowing for the modular construction of future TISF pads on the TISF The initial pad will accommodate the HI-STAR 100 casks or similar, future pads will consider other design options of spent fuel dry storage as required by Eskom.	PARTIALLY COMPLIED (See §3.5.4)
§ 4.1.2.4	The Koeberg TISF storage pad shall accommodate up to fourteen (14) metal casks (HI-STAR 100 casks or similar design).	FULLY COMPLIED (See §3.8.1)
§ 4.1.2.5 § 5.11.3.6	The Koeberg TISF storage pad shall ensure the ability to manoeuvring of all related equipment. Allowing for the movement of construction and cask handling (e.g., ten-axle transporter, lifting hydraulic gantry system, and cranes etc.).	FULLY COMPLIED (See §3.8.9)
§ 5.4	Include the Environmental Impact Assessment (EIA) requirements. - Take congnisance of all relevant measures in the EMPr and ensure integration thereof in the detailed design (§ 2.1 of the Appendix Q EMPr [65]) - Reference the environmental management measures applicable to the construction and operational phases of the project (§ 2.1 of the Appendix Q EMPr).	FULLY COMPLIED (See §3.18)
§ 5.5	Accommodate the highly corrosive marine environment at Koeberg; the design life of the TISF shall be until the end of 2055.	FULLY COMPLIED (See §3.13.1)
§ 5.6	Fuel retrievability for normal, abnormal, accident and severe accident conditions.	FULLY COMPLIED (See §3.7 and §3.16)

TRS Section	Requirement	Compliance
§ 5.7 § 7.1.1 § 7.1.2 § 7.1.3	Suitability of the haul path from the Koeberg Fuel Buildings and on the TISF site including, but not limited to, considering the above and below ground civil structures along the haul path. The Contractor will identify the cask haul paths from the Koeberg Fuel Buildings, to and on the TISF site by means of visual inspections, plant drawings and other means specified by the Contractor. Buried and above ground obstacles in the areas of the haul paths will be identified and their impact on the cask movements discussed. The Contractor will confirm if the underground features can handle the heavy loads and/or if the roads require improvements. Available Koeberg information describing the buried services will be made available to the appointed Contractor. The Contractor will identify potential hazards along the haul paths and compile a risk mitigation plan. A brief description of the proposed haul path to and on the TISF site will be prepared. Drawings of the haul path will be created showing the route, road grading and drainage. Recommended upgrades or relocations of underground or above ground utilities that are adversely impacted by the haul path will be shown on the drawings. Any new mitigation features to protect the casks from hazards will be shown on the drawings.	FULLY COMPLIED (See §3.8.8)
§ 4.1.3 § 5.11.3.2	A cask preparation/laydown area will be available. A cask preparation area will be available where a single new cask, including the required ancillary equipment, may be maintained and prepared prior to being transferred to the spent fuel pool in the spent fuel building.	PARTIALLY COMPLIED (See §3.8.3)
§ 4.1.4 § 5.11.3.3	The proposed TISF storage pad design will consider the required cask handling equipment. The ability to lift and move the casks on the TISF.	FULLY COMPLIED (See §3.1.4)
§ 4.1.5	The Contractor will design to maximise the use of the existing utilities, site features and equipment and to minimise the need for additions or modifications to the existing features and equipment, to the extent possible.	FULLY COMPLIED See §3.1.4 and §3.8.9)
§4.1.6	The Contractor will identify all electrical power required for the HI-STAR 100 dry storage system required at the TISF. Electrical services available for use are 230V AC 1P 50Hz and 380V AC 3P 50Hz supplies.	PARTIALLY COMPLIED (See §3.8.6)
§4.1.7	Software used for analyses by the Contractor will be approved by the NNR or an internationally recognised nuclear licensing authority. The Contractor will also demonstrate that the software is compliant with the NNR requirements as specified in RD-0016, Requirements for Authorisation Submissions involving Computer Software and Evaluation Models for Safety Calculations.	FULLY COMPLIED (See §3.1.5) RG-0016 is considered.

TRS Section	Requirement	Compliance
§4.1.8	The Contractor will demonstrate that dose rates measured by Radiation Protection (RP) on the TISF after the placement of the loaded spent fuel casks will not exceed the plant or Regulatory limits in accordance with KAA-637 [35].	FULLY COMPLIED (See §3.16.5)
§4.1.9	The proposed plant changes will not introduce additional risk to the plant integrity or conventional/nuclear risk to personnel and the general public.	FULLY COMPLIED (See §3.11 and §3.12)
§4.4.1	Calculated dose rates based on a TISF fully loaded with metal casks (HI-STAR 100 or similar), will not exceed the Koeberg or Regulatory limits. The TISF calculated dose rates must consider the dose rate contribution from all radiation sources that have an influence including but not limited to, the CSB and OSGISF.	FULLY COMPLIED (See §3.16.5)
§4.4.2	The dose rates measured by RP at the TISF boundary and Access Control Points (ACP) will not exceed 0,5 μSv/h in accordance with KAA-637 [35].	FULLY COMPLIED (See §3.16.5)
§4.4.3	The "As Low As Reasonably Achievable" (ALARA) principle must be adhered to. The TISF storage pad and related equipment design and operation will ensure that occupational and public exposures are maintained ALARA.	FULLY COMPLIED (See §3.6)
§4.4.4	Information must be provided about methods for radiation protection and about anticipated radiation exposures to personnel during operation and facility maintenance. The following ALARA topics will also be addressed: - Policy considerations - Design considerations - Operational experience regarding anticipated on-site radiation exposures during cask handling storage, facility operation and maintenance on the TISF storage pad.	FULLY COMPLIED (See §3.16.6.4)

3.1.3 10 CFR 72 Requirements

The Final Safety Analysis Report on the HI-STAR 100 MPC Storage System [72] is a compilation of information and analyses to support a US NRC licensing review as a spent nuclear fuel dry storage cask under the requirements specified in 10CFR72 [1].

In accordance with 10CFR72.212, Subpart K, site-specific implementation of the generically certified HI-STAR 100 System requires that the licensee perform a site-specific evaluation, as defined in 10CFR72.212.

The HI-STAR 100 System FSAR [72] identifies a limited number of conditions that are necessarily site-specific and are to be addressed in the licensee's 10CFR72.212 evaluation. These conditions are included in Table 2. Note that in the NRC documentation, 'ISFSI' (Independent Spent Fuel Storage Installation) is used instead of 'TISF'.

Table 2: List of Requirements from 10CFR72.212 according to HI-STAR 100 FSAR and Site Specific Parameters and Analyses according to HI-STAR 100 CoC

Requirement	Compliance
Siting of the ISFSI and design of the storage pad and security system. Site-specific demonstration of compliance with regulatory dose limits. Implementation of a site-specific ALARA program. Cask storage pads and areas have to be designed to adequately support the static and dynamic loads of the stored casks, considering potential amplification of earthquakes through soil-structure interaction, and soil liquefaction potential or other soil instability due to vibratory ground motion.	FULLY COMPLIED (See §3.16)
An evaluation of site-specific hazards and design conditions that may exist at the ISFSI site or the transfer route between the plant's cask receiving bay and the ISFSI. It is necessary, to determine whether or not the reactor site parameters, including analyses of earthquake intensity and tornado missiles, are enveloped by the cask design bases considered in the HI-STAR 100 FSAR.	FULLY COMPLIED (See §3.7)
Determination that the physical and nucleonic characteristics and the condition of the SNF assemblies to be dry stored meet the fuel acceptance requirements of the Certificate of Compliance [64].	NOT INCLUDED (See §3.2)
An evaluation of interface and design conditions that exist within the plant's fuel building in which canister fuel loading, canister closure, and cask handling operations are to be conducted in accordance with the applicable 10CFR50 requirements and technical specifications for the plant.	NOT INCLUDED (See §3.2)
Detailed site-specific operating, maintenance, and inspection procedures prepared in accordance with the generic procedures and requirements provided in Chapters 8 and 9 [72], and the technical specifications provided in the Certificate of Compliance. Pre-operational tests are excluded because operations have already been developed at KNPS for the loading of the HI-STAR 100 casks that are stored in the CSB, and the same procedures are applicable	PARTIALLY COMPLIED (See §3.9, §3.10 and §3.2)
Performance of pre-operational testing.	NOT INCLUDED (See §3.2)
Implementation of a safeguards and accountability program in accordance with 10CFR73. Preparation of a physical security plan in accordance with 10CFR73.55.	NOT INCLUDED (See §3.2)
Review of the reactor emergency plan, quality assurance (QA) program, training program, and radiation protection program	NOT INCLUDED (See §3.2)

<table>
<tr><th>Requirement</th><th>Compliance</th></tr>
<tr><td>The temperature of 80º F (299.817K) is the maximum allowed average yearly temperature.</td><td>FULLY COMPLIED
(See §3.7.4.1)</td></tr>
<tr><td>The allowed temperature extremes, averaged over a three day period, shall be greater than -40º F (233.15K) and less than 125º F (324.817K).</td><td>FULLY COMPLIED
(See §3.7.4.1)</td></tr>
<tr><td>The horizontal and vertical seismic acceleration levels are bounded by the values listed below in Table 1-4.

Table 1-4

<u>Design-Basis Earthquake Input on the Top Surface of an ISFSI Pad</u>
<table>
<tr><th>Horizontal g-Level in Each of Two Orthogonal Directions</th><th>Horizontal g-Level Vector Sum</th><th>Corresponding Vertical g-Level (Upward)</th></tr>
<tr><td>0.222 g</td><td>0.314 g</td><td>1.00 x 0.222 g = 0.222 g</td></tr>
<tr><td>0.235 g</td><td>0.332 g</td><td>0.75 x 0.235 g = 0.176 g</td></tr>
<tr><td>0.24 g</td><td>0.339 g</td><td>0.667 x 0.24 g = 0.160 g</td></tr>
<tr><td>0.25 g</td><td>0.354 g</td><td>0.500 x 0.25 g = 0.125 g</td></tr>
</table></td><td>FULLY COMPLIED
(See §3.16.7, with specific 3D time history analysis)</td></tr>
<tr><td>For HI-STAR 100 casks stored horizontally, the following inequality shall be satisfied:

$\frac{H_{CGH}}{B} \leq \frac{(1-\varepsilon G)}{2G}$

where HCGH is the center of gravity height of the horizontal cask above the ISFSI pad, B is the width of the supporting structure, G is the zero period acceleration seismic amplifier in horizontal direction, and ε is ratio of the vertical acceleration multiplier.

If the above inequality cannot be satisfied for a particular site, then a 3-D time history analysis may be performed to demonstrate stability of HI-STAR 100 overpack in horizontal storage configuration.

In all cases, HCGH must not exceed 72 inches (1.82 m).</td><td>FULLY COMPLIED
(See §3.16.7, with specific 3D time history analysis)</td></tr>
<tr><td>The analyzed flood condition of 13 fps (3.96 m/s) water velocity and a height of 656 feet (199.9 m) of water (full submergence of the loaded cask) are not exceeded.</td><td>FULLY COMPLIED
(See §3.7.8)</td></tr>
<tr><td>The potential for fire and explosion shall be addressed, based on site-specific considerations.</td><td>FULLY COMPLIED
(See §3.16.5.2)</td></tr>
</table>

The cask storage pads shall be verified by analysis to limit cask deceleration during both the design basis drop and the non-mechanistic tipover event to ≤60 g's at the top of the MPC fuel basket. Analyses shall be performed using methodologies consistent with those described in the HI-STAR 100 FSAR.	FULLY COMPLIED (See §3.13.1 and §3.13.2)
In cases where engineered features (i.e., berms, shield walls) are used to ensure that the requirements of 10CFR72.104(a) are met, such features are to be considered important to safety and must be evaluated to determine the applicable Quality Assurance Category.	FULLY COMPLIED (See §3.11.1)

3.1.4 Equipment Requirements

The cask handling equipment existent at Koeberg is the Goldhofer Heavy-duty self-propelled trailer and the 500 t Power Tower Gantry System, described as follows.

3.1.4.1 Goldhofer

The Goldhofer Heavy Duty self-propelled trailer is the model type PST/SL 6-12-08. The dimensions and configuration for the transport from the Fuel Building to the TISF site is shown in the drawings for the CSB HI-STAR 100 loading operations included in Figure 3 . This configuration includes the following parts:

- Powerpack, as shown in Figure 4.
- 6-Axle Heavy Duty Module, as shown in Figure 5.
- 4-Axle Heavy Duty Module, as shown in Figure 6.

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 3: On-Site Transport Combination

The following considerations shall be addressed:

- In the interest of nuclear safety, it is necessary to allow the Goldhofer to enter the Auxiliary Shielding Modules to where the cask is to be placed. Then, the cask will be lifted with the Gantry Crane and the Goldhofer will be removed from the ASM. Finally, the cask will be lowered in the ASM.
- The Goldhofer 10-Axle configuration is necessary for the loading operation at the Fuel Building. Once at the TISF area, the Goldhofer 6-Axle configuration can be used as to allow the Goldhofer enter the Auxiliary Shielding Module.
- The handling procedure for the placement of HI-STAR 100 casks onto the TISF storage pad and the subsequent placement of ASMs will be provided separately in the Method Statement of the TISF Implementation Safety Case to be submitted for approval by both Eskom and the NNR.

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 4: Goldhofer Powerpack

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 5: Goldhofer 6-axle Heavy Duty Module

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 6: Goldhofer 4-axle Heavy Duty Module

3.1.4.2 Gantry Crane

The Gantry Crane is the MODEL 34PT5400WT POWER TOWER Gantry System (see Figure 7). The technical data sheet includes the relevant information. Drawing AR 00025 from Vanguard includes the information about the Header Beam (see Figure 8). The Gantry Crane is the equipment that has been used inside the CSB for the loading of the HI-STAR 100 casks. Same procedures are applicable for the TISF operations, particularizing the operations to the specific layout at the TISF area proposed.

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 7: Gantry Crane Data Sheet

PAIA Chapter 4 Section 37

The figure has been removed as it is the Transport Contractor intellectual property

Figure 8: Gantry Crane Header Beam

3.1.5 Software Requirements

RG-0016 [50] provides Guidance on the Verification and Validation of Evaluation and Calculation Models used in Safety and Design Analysis. KGF-001 [40] describes the method for the systematic independent review by Eskom of computer codes, methods and Koeberg specific analyses, submitted by a nuclear fuel supplier or specialist groups in support of the licensing of fuel design changes, changes in the Koeberg fuel management strategy or changes related to fuel transport containers. Revision 4 of KGF-001 [40] incorporates the requirements of NNR guide RG-0016 [50].

- §3.16.2 includes the List of Review Reports for Codes used in the calculations and analyses presented in this detailed design, following the guidelines and format as specified in KGF-001 [40], so compliance with RG-0016 [50] is guaranteed.
- §3.16.3 includes the List of Review Reports for Methods used in the calculations and analyses presented in this detailed design, following the guidelines and format as specified in KGF-001 [40], so compliance with RG-0016 [50] is guaranteed.

3.2 Design Limitations

This design does not cover the following requirements which need to be covered and resolved in future modifications or which are treated in separate documentation from Eskom:

- Determination that the physical and nucleonic characteristics and the condition of the SNF assemblies to be dry stored meet the fuel acceptance requirements of the Certificate of Compliance.

- Evaluation of interface and design conditions that exist within the plant's fuel building in which canister fuel loading, canister closure and cask handling operations are to be conducted. Performance of pre-operational testing. These operations have already been developed at KNPS for the loading of the HI-STAR 100 casks that are stored in the CSB as documented in the NNR approved Eskom Safety Case for loading, transfer, placement, and storage of HI-STAR 100 spent fuel casks at Koeberg. The same procedures are applicable.

- The Storage Area shall be constructed to store a maximum of fourteen (14) horizontally orientated HI-STAR 100 casks.

- This document includes the site-specific operating, maintenance, and inspection procedures to be included in the specific Eskom procedures, when applicable. No specific detailed procedures have been prepared apart from the provisions included in this document since they should be integrated within Eskom current documentation.

- The TISF physical security plan will be addressed in a separate detailed design.

- IAEA Safeguards will be dealt separately, but the design will include the necessary provisions to allow the installation.

- NSF structures such as the Auxiliary Building will be included in a future revision of this document, if applicable.

- The design of the TISF does not include off-site transport, so IAEA SSR-6 requirements are not considered.

3.3 Assumptions

3.3.1 Seismic Input

According to Specification for Modifications and Equipment Required for Seismic Event Applications [30], the seismic spectra to be used for new safety related systems, structures and components required to withstand the effects of design basis safe shutdown earthquake and mitigate the design extension conditions seismic event are as follows:

- Design basis: Dames and Moore derived 0.3 g Zero Period Acceleration (ZPA) earthquake spectra as referenced in 240-121010217 [30].
- Design extension: 0.5 g ZPA earthquake spectra.

The acceptance criteria for the analysis of concrete and steel systems, structures and components subjected to design extension conditions seismic event is based on TECDOC-1341 [73] and consists in the verification that the demand shall be lower than the code ultimate strength.

As this acceptance criteria are the same than the one used for the design basis safe shutdown earthquake, the design extension conditions seismic event is the only one considered in the seismic qualification of the TISF because it bounds the safe shutdown earthquake.

A bounding seismic earthquake is defined using Dames and Moore (1981) response spectra linearly scaled to reach, conservatively, 0.5 g horizontal and vertical accelerations at bedrock level according to the seismic conditions defined in section 4.3.4 of the TISF Technical Requirements Specification [58].

The seismic input obtained is shown below in Figure 9 and Figure 10 compared with the Seismic Design Input considered for the OSGISF design. The seismic input for the OSGISF is based on a graded approach, which is not applicable to the TISF, and it is used only for comparison reasons.

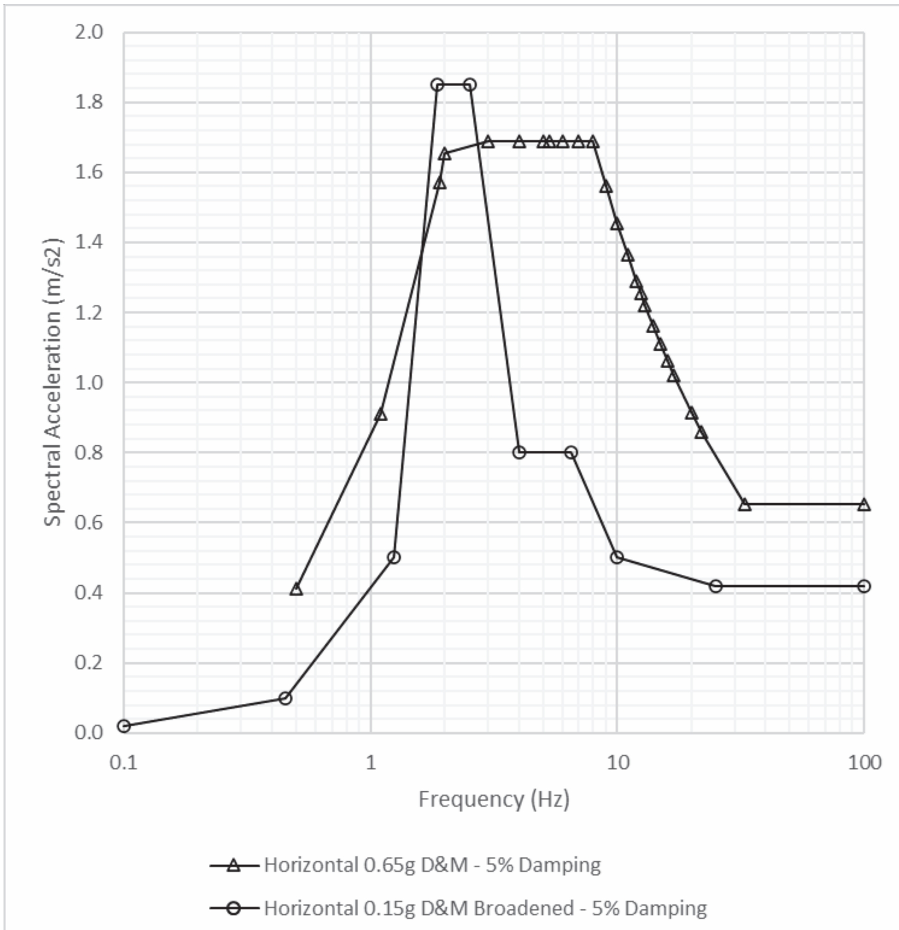


Figure 9: Horizontal Seismic Input TISF (0.65g D&M) – CSB/OSGISF (0.15g D&M Broadened)

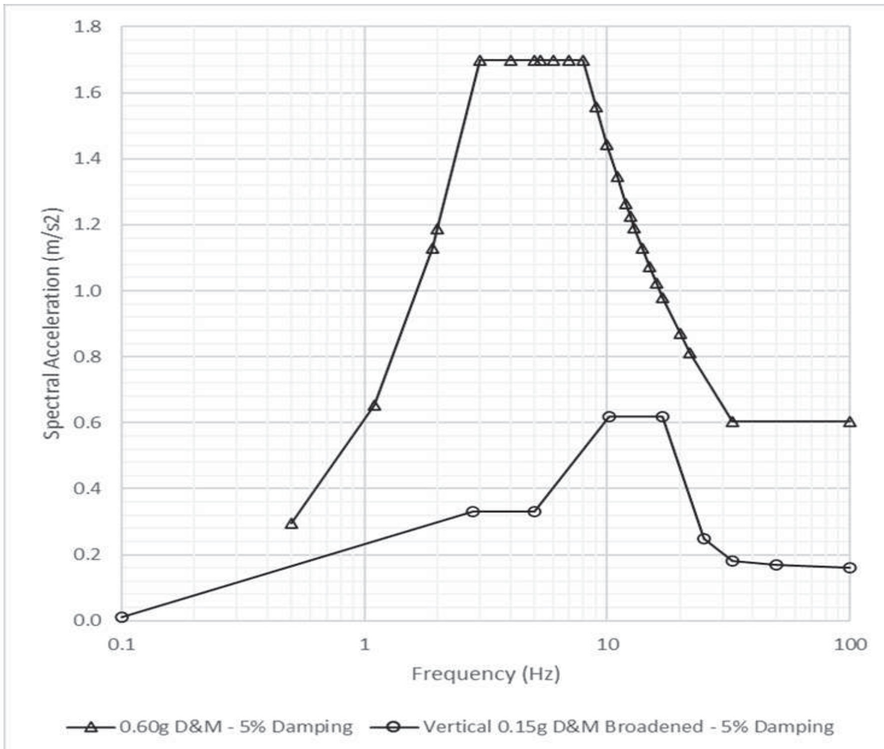


Figure 10: Vertical Seismic Input TISF (0.6g D&M) – CSB/OSGISF (0.15g D&M Broadened)

3.3.2 Design Life

The design life of the TISF shall be at least until the end of 2055.

3.4 Investigation

3.4.1 Justification for Not Performing Feasibility

A TISF pre-feasibility study is documented in the Eskom report 240 86880760, Revision 2, Pre-Feasibility Study on the TISF Facility [59]. The purpose of the study was to identify the types of TISF design and perform a high evaluation of a suitable solution for Koeberg without considering the technical detail. The evaluation concludes that an open concrete pad offers the best passive ventilation and the least retrievability concerns, especially post external events. Furthermore, the pad presents a widely practiced manner of storing dry storage spent fuel casks globally and is thus well understood by cask manufactures.

Section 3.4.2 describes why the open concrete pad option was found to be inadequate for the Koeberg TISF.

3.4.2 Preliminary Dose Assessments

3.4.2.1 Open Storage Pad Evaluation

The initial concept design for the TISF, as stated in the TISF TRS [58] was to design an open storage pad within the available TISF area. The initial design efforts focused on performing the radiological calculations necessary to assess the doses obtained for an open storage pad loaded with 14 HI-STAR 100 casks stored in horizontal position. The requirement states that the dose at the TISF boundary and Access Control Points (ACP) will not exceed 0.5 μSv/h in accordance with KAA-637.

Numerous analyses and calculations (see Table 3) were conducted evaluating different positions within the available area in an open storage pad using Monaco with Automated Variance Reduction using Importance Calculations (MAVRIC), a program included in the calculation system SCALE 6.2.4.

Table 3: Description and Objective in Each Scenario in Open Storage Pad

Scenario	Description	Objective
(1)	Casks close to the CSB building	Determine if outdoor storage of the 7x2 array is feasible
(2)	Casks close to the CSB building with wall	Determine if storage is feasible with additional shielding: concrete wall
(3)	Casks close to the fence with wall	Determine if it is feasible to use a smaller additional shielding: concrete wall around casks
(4)	Casks close to the CSB building with wall and roof	Determine whether a roof over the casks significantly reduces the contribution by skyshine.
(5)	Casks close to the CSB building with wall (void)	Evaluate the skyshine contribution
(6)	Casks close to the fence with wall (vertical position)	Determine if storage is feasible in vertical position
(7)	Casks close to the fence with wall (vertical position with Tilting Plate)	Determine if storage is feasible in vertical position by using a Tilting plate on the top of the casks

In models of scenarios (2) to (7), a 3 m high and 0.5 m thick concrete wall between the fence and the casks was considered for dose reduction.

In model of Scenario (4), a 5.18 cm thick steel and 2.54 cm thick polyethylene roof was considered at 2 m above the casks for skyshine contribution reduction.

From the results obtained for the dose rate in each cell, a dose map was obtained in the vicinity of the casks and the distance at which the 0.5 μSv/h dose rate limit is met was determined. The dose maps obtained are shown in Figure 11

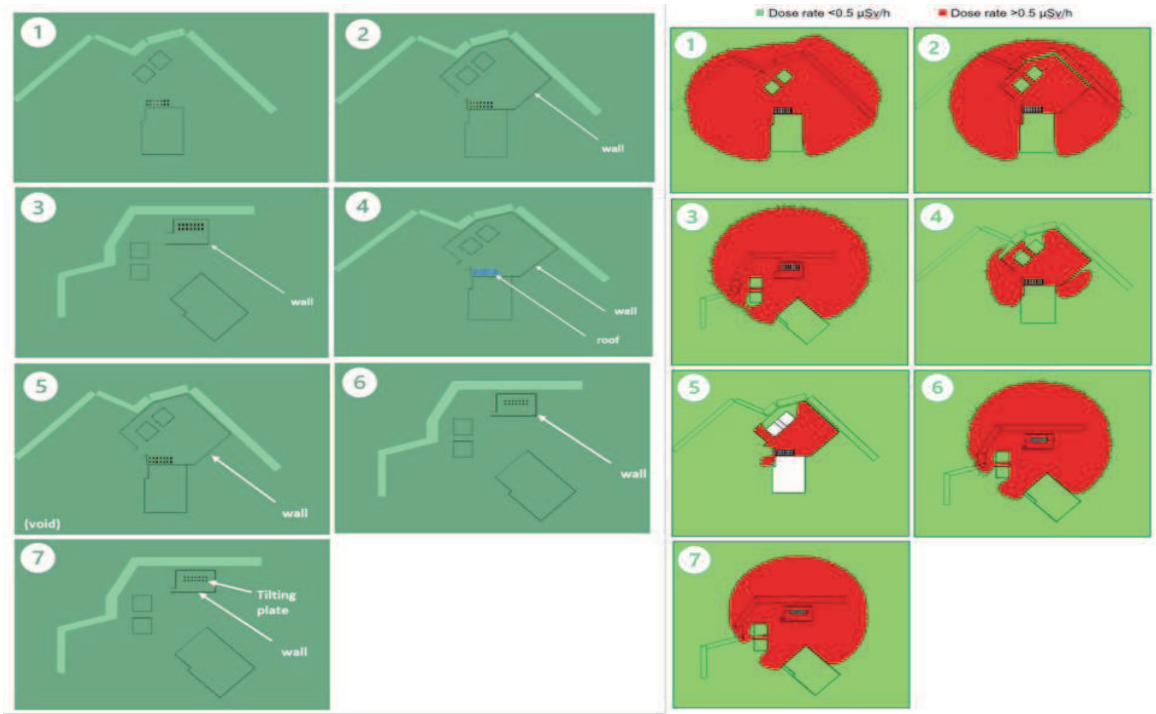


Figure 11: Preliminary Calculations for Open Storage Pad with Additional Shielding

The main conclusion resulting from these calculations was that it was necessary to provide additional shielding to comply with the dose requirements and not only perimeter walls as an open storage of the 14 casks is not feasible.

Based on previous conclusions, two different solutions were evaluated to comply with the radiological requirements in the storage of a total of 14 HI-STAR 100 casks: a single building in which to store the casks or an auxiliary shielding module to be placed over each cask.

3.4.2.2 Building

A dose rate evaluation considering the HI-STAR 100 casks inside a building was developed to analyse the feasibility of meeting dose requirements (see Table 4).

Table 4: Description and Objective with the Building Scenario

Scenario	Description	Objective
(B1)	Casks inside a building	Determine whether the storage of casks inside a building would be feasible.

In model of scenario (B1) a building with 12 m high and with 0.5 m concrete walls and roof has been considered. The dose map obtained is shown in Figure 12.

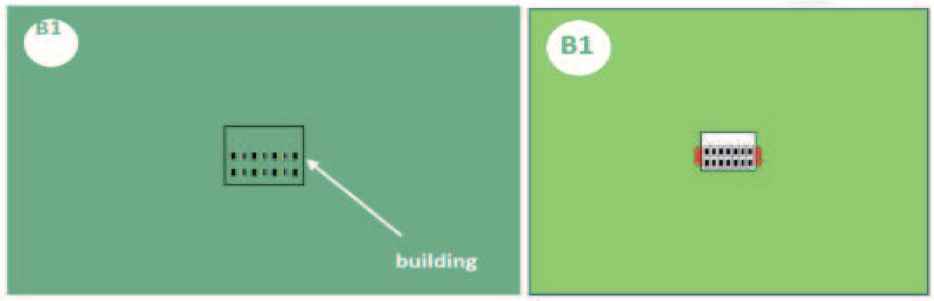


Figure 12: Preliminary Calculations Inside a Building

The main conclusion resulting from this calculation was that storing the casks in a building reduces doses in the surrounding area significantly, causing the dose limit of 0.5 μSv/h to be exceeded only in areas very close to the walls of the building.

3.4.2.3 Auxiliary Shielding Module

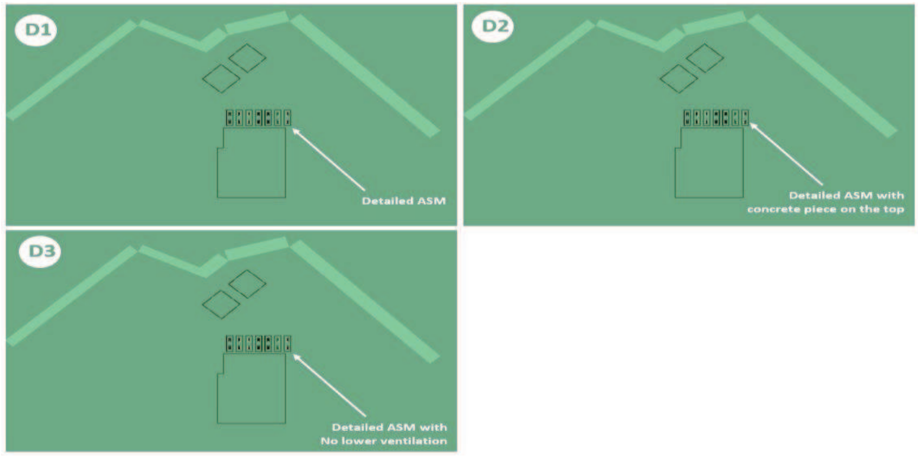
A dose rate evaluation considering the HI-STAR 100 casks using an Auxiliary Shielding Module was developed to analyse the feasibility of meeting dose requirements (see Table 5).

Table 5: Description and Objective with the ASM Scenario

Scenario	Description	Objective
(D1)	Casks with detailed ASM close to the CSB building	Determine if storage is feasible with an optimized design of an ASM
(D2)	Casks with detailed ASM close to the CSB building with a concrete piece in the upper ventilation system	Determine if storage is feasible with an optimized design of an ASM reducing the contributions from the upper ventilation system
(D3)	Casks with detailed ASM close to the CSB building with no lower ventilation system	Determine if storage is feasible with an optimized design of an ASM reducing the contributions from the lower ventilation system

In model of Scenario (D2), a modification has been included in the upper ventilation of the module to increase the shielding, as a 25 cm thick and 55 cm high concrete piece has been placed in front of the upper ventilation system hole. No modifications have been made in the lower ventilation design, which is considered.

In model of Scenario (D3), the lower ventilation hole has been closed, so no lower ventilation is considered in the design. No modifications have been made in the upper ventilation design, which is considered. The dose maps obtained are shown in Figure 13



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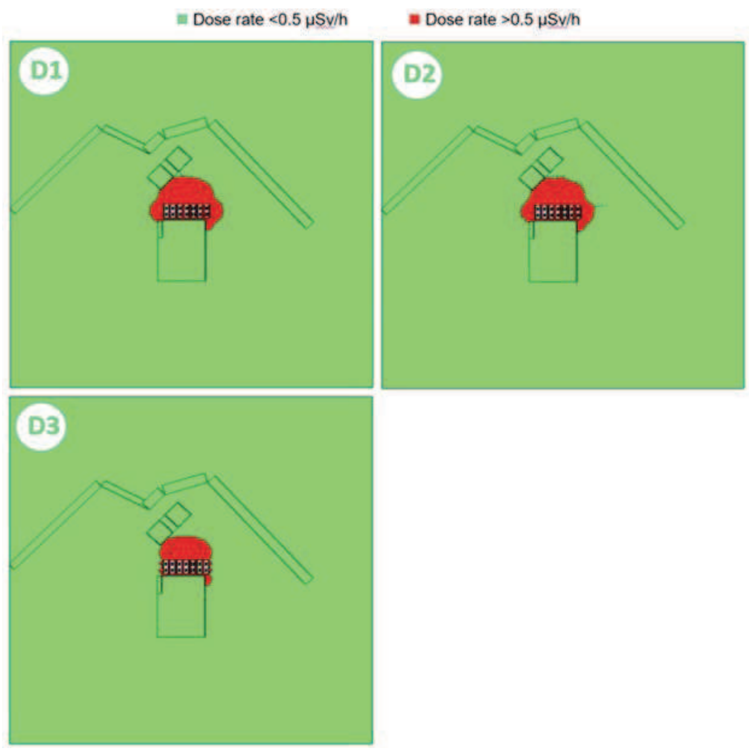


Figure 13: Preliminary Calculations Using an Auxiliary Shielding Module (ASM)

The main conclusion resulting from this calculation was that the use of auxiliary shielding modules located over the casks reduces doses significantly and could be a possibility to meet the dose requirements, even more so considering the constraints in terms of schedule given that it is required to have the first four casks loaded before Outage 227 and licensing a building would make it unfeasible.

3.4.3 Operational Experience

3.4.3.1 CSB at Koeberg

The best operational experience for the TISF design is the experience from the loading of HI-STAR 100 casks at the CSB, since the same spent fuel storage system horizontally stored and with the same transport and handling equipment is proposed for the design of the TISF loaded with 14 HI-STAR 100 casks.

3.4.3.2 NUHOMS System

The Standardized Advanced NUHOMS® System is a modular canister-based system for the dry storage of irradiated spent fuel assemblies (SFAs) consisting of a dry shielded canister (DSC) and a reinforced concrete horizontal storage module (HSM) (see Figure 14).

The HSM is a low-profile, modular, reinforced concrete structure whose primary functions are to provide a means for passively removing spent fuel decay heat, provide structural support and environmental protection to the loaded DSC, and provide radiation shielding protection. Heat removal is achieved by a combination of radiation, conduction, and convection. Ambient air enters the HSM through ventilation inlet openings located in the lower region of the front or side walls and circulates around the DSC. Air exits through outlet openings in the top regions of the HSM walls. Thermal monitoring or visual inspections are used to provide indication of HSM performance or a blocked vent condition. Structural support of the loaded DSC is provided by a structural steel frame/rail structure anchored to the HSM. Environmental protection and radiation shielding are provided by massive, thick side walls and roof of the HSM, supplemented by thick wall units attached at the ends of the array and at the rear walls of the HSM if the array is of single row configuration.

Figure 14: NUHOMS HSM (Orano Group Website)

3.4.3.3 MAB

The MAB (*Módulo Auxiliar de Blindaje*, in Spanish), shown in Figure 15, is an auxiliary shielding that was originally designed and patented by INGECID to solve a similar situation to the existing situation at Koeberg. The Santa María de Garoña ISFSI was designed and licensed to store up to 32 ENUN 52B metallic casks, in vertical position, distributed in two different concrete pads.

This auxiliary module (MAB) allowed to increase the capacity of the ISFSI from the initial 32 casks up to 60 casks complying with the dose limits at the ISFSI boundary (0.5 μSv/h) and at the Owner Controlled Area (250 μSv/year). This shielding had to be designed as to guarantee the safety functions of the ENUN 52B cask during normal, off-normal and accidents. It was designed as to be handled with the same equipment as the used for the handling of the ENUN 52B at the ISFSI.

After developing the initial calculations and drawings, ENSA, the ENUN 52B manufacturer, acquired the patent and integrated the MAB as part of the spent storage system within the ENUN 52B FSAR. Then, INGECID was contracted by ENSA to develop the licensing thermal and structural calculations. Structural calculations for normal and accidental conditions are more complex than the civil engineering design necessary for the TISF at Koeberg, but the thermal calculations methods used for the licensing calculations accepted by the Spanish regulator are the same as proposed in this case for the thermal calculations at Koeberg.

Figure 15: Vertical Auxiliary Shielding Module (MAB) for Metallic Cask ENUN 52B

3.4.3.4 Fukushima Temporary Cask Custody Area

At Fukushima Daiichi NPP, a Temporary Cask Custody Area has been developed including concrete modules to reduce the high doses obtained from the loaded casks that are being transferred from the common pool building to this area (see Figure 16). This Temporary Cask Custody Area has been developed to make space in the common pool to accommodate the spent fuel removed from the different Units.

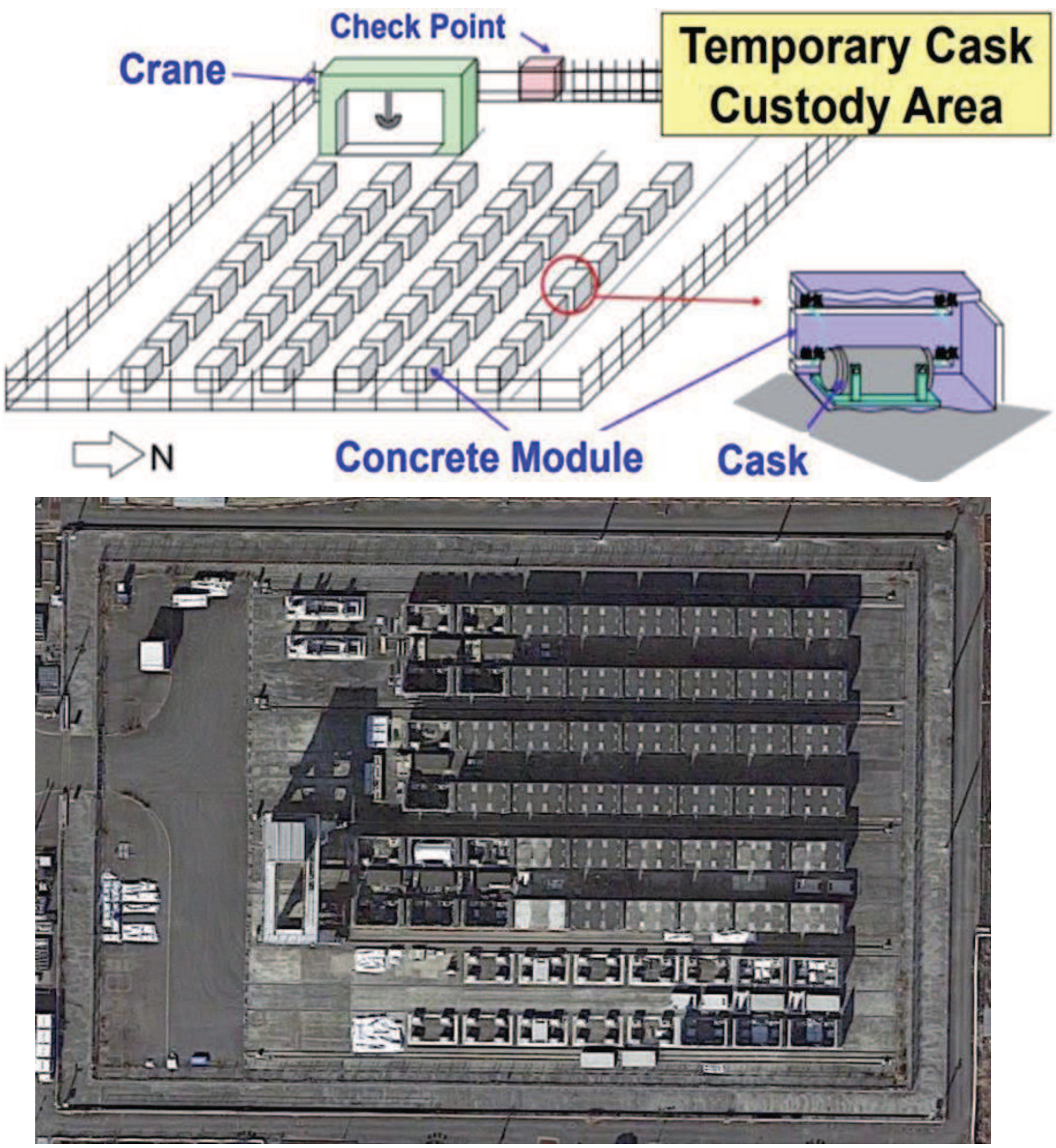


Figure 16: Temporary Cask Custody Area at Fukushima Daiichi with Concrete Modules to Reduce Dose

3.4.4 Software

Investigations about the software used in calculations and analyses included in this detailed design are included in Section 5.2, Benchmarking and Testing of the Review Reports of Appendix A2.7, Appendix A2.8 and Appendix A2.9:

Appendix A2.7 – REVIEW REPORT FOR CODE MAVRIC SCALE 6.2.4 (00857IV001)

Appendix A2.8 – REVIEW REPORT FOR CODE ANSYS (00857IV002)

Appendix A2.9 – REVIEW REPORT FOR CODE P-CARES (00857IV003)

Review reports for methods are included in the following Appendixes:

Appendix A2.10 – REVIEW REPORT FOR METHOD FOR SHIELDING (00857IV004)

Appendix A2.11 – REVIEW REPORT FOR METHOD FOR SEISMIC RESPONSE (00857IV005)

Appendix A2.12 – REVIEW REPORT FOR METHOD FOR LIQUEFACTION (00857IV006)

Appendix A2.13 – REVIEW REPORT FOR METHOD FOR STRUCTURAL (00857IV007)

Appendix A2.14 – REVIEW REPORT FOR METHOD FOR THERMAL (00857IV008)

Appendix A2.15 – REVIEW REPORT FOR METHOD FOR SIDE DROP (00857IV009)

The Codes and Applied Method Reports for the TISF Detailed Design have been redacted as they are KCC Intellectual Property. Refer to Appendix A2.

3.5 Negative Consequences of this Modification

3.5.1 Environmental Consequences

The negative consequences to the environment have been identified in the Environmental Impact Assessment for the TISF [65]. In accordance with the impact assessment, all the prescriptions as identified by the Environmental Impact Assessment will be complied with during the design (see §3.18), but largely during the construction of the facility.

3.5.2 Consequences to the HI-STAR 100 Storage

The HI-STAR 100 FSAR design bases consider open storage of the casks. The addition of an Auxiliary Shielding Module introduces the following negative consequences that shall be assessed by the design:

- Burial under debris: The HI-STAR 100 FSAR considers that burial under debris is a highly unlikely accident, but still it is analysed in the FSAR. The ASM modifies this statement, since burial under debris is more likely in this case than for an open storage pad. The ASM is designed to continue its operation after all the possible design-basis accidents for KNPS, reducing the probability of this occurrence.
- Thermal behaviour: The HI-STAR 100 FSAR includes the safety analyses to demonstrate acceptable margins to the allowable limits under all design basis conditions and operational modes for storage in an open storage pad. The ASM affects these analyses, and the design shall verify that the ASM installation prevent any negative impact on the acceptable margins to the allowable limits of the HI-STAR 100

- Air flow blockage: The ASM results in the possibility of an additional accident which is the blockage of the ventilation openings of the ASM. This accident condition is bounded by the burial debris accident introducing a maximum time to clear vent openings. The ASM introduces the necessity of additional surveillance procedures to assure that the ventilation openings remain unblocked and the HI-STAR 100 operates under normal conditions.

- The installation of the ASM results is the possibility of an additional accident, i.e., top cover drop over the cask while installing this item on the ASM. The design of the top covers reduces or eliminate the credibility of this accident, by including high margin in lifting anchors design, as demonstrated in Appendix A2.3 – STRUCTURAL CALCULATIONS. The Gantry Crane is single failure proof in compliance with NUREG-0612 [17] and ANSI N14.6 [4].

3.5.3 Operations at the TISF Area

To allow the entrance of the Goldhofer to the ASM it is necessary to place the HI-STAR 100 cask on the Goldhofer 6-axle configuration instead of the Goldhofer 10-axle configuration. It is demonstrated that the haul route and the TISF turning circle could withstand the loads from the Goldhofer 6-axle configuration loaded with the HI-STAR 100 cask, as justified in §3.8.5.

However, the HI-STAR 100 cask is loaded onto the 10-axle Goldhofer during loading activities at the Fuel Building. It is considered that the Approach Apron and turning circle is an appropriate area within the TISF area to execute the operation for transferring the cask from the Goldhofer 10-axle configuration to the Goldhofer 6-axle configuration. The operation is performed with the support of the Gantry Crane, with no additional activities in respect to the applicable procedures that were developed during the CSB loading operations, except for the possible increase of operational doses due to the increase of the duration for the loading of the casks at the TISF.

Other option could have been to design the ASM as to allow complete entrance for the Goldhofer 10-axle configuration. However, this option was discarded since it led to a higher footprint for the TISF area, which totally impeded the compliance with the future development of the TISF and the environmental requirements about minimising the footprint.

It is considered that this operation can be accomplished in similar times as those employed in other ISFSIs with metallic casks. In those cases, the cask needs to be transferred from the self-propelled transporter where is placed in horizontal position to the Cask Transporter that will place the cask in its final vertical position on the storage pad.

3.5.4 Interference with Future TISF Storage Pads

The solution proposed for the storage of 14 HI-STAR 100 casks at Koeberg has a large footprint that reduces considerably the available space for the future development of the TISF.

It may seem that the occupied area is very large, especially when compared to the expectation of storing the casks in an open storage pad occupying the same space as that occupied in the existing CSB at Koeberg. However, the reality is that the area required to store metallic casks outdoors is always very high when compared to other solutions with a concrete overpack. Metallic casks always need additional shielding (perimeter walls, additional shielding modules or buildings) to comply with dose limitations. The concrete storage systems have been designed to comply with these limitations including the necessary concrete shielding and allowing for footprint optimization. An example of this can be seen in the ISFSIs that have been designed in Spain to store metallic casks (Almaraz NPP in Figure 17, Santa María de Garoña NPP in Figure 18 and Cofrentes NPP in Figure 19).

ALMARAZ ISFSI

Approximate area including shielding wall, perimeter pavement and storage pad = 80 x 50 m = 4000 m^2

20 metallic casks -> **200 m^2 per cask**

Figure 17: ISFSIs Footprint with Metallic Casks – Almaraz ISFSI

SANTA MARÍA DE GAROÑA ISFSI-32	SANTA MARÍA DE GAROÑA ISFSI-60
	
Approximate area including shielding wall, MAB, perimeter pavement and storage pad = 100 x 80 m = 8000 m^2 32 metallic casks -> **250 m^2 per cask**	Design Modification including the MAB, which is an auxiliary shielding to allow increasing the capacity of the ISFSI from 32 to 60 casks. Approximate area including shielding wall, MAB, perimeter pavement and storage pad = 100 x 80 m = 8000 m^2 60 metallic casks + concrete shielding (MAB) -> 133 m^2 per cask

Figure 18: ISFSIs Footprint with Metallic Casks – Santa María de Garoña ISFSI

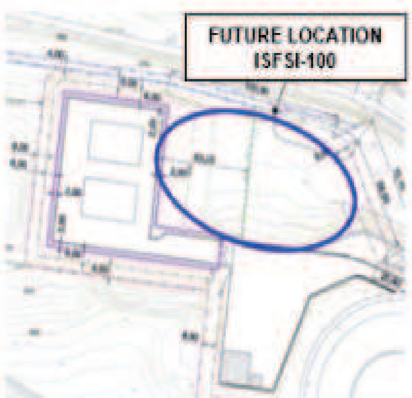
COFRENTES ISFSI-24	COFRENTES ISFSI-100
	
Approximate area including shielding wall, perimeter pavement and storage pad = 70 x 50 m = 3500 m^2 24 metallic casks -> **145 m^2 per cask**	Approximate area including Approach Aprons, storage pads and Cask Transfer Pit (CTP) = 80 x 70 m = 5600 m^2 89 concrete casks -> 63 m^2 per cask

Figure 19: ISFSIs Footprint with Metallic Casks – Cofrentes ISFSI

In the case of Santa María de Garoña, it has only been possible to increase the capacity by introducing a design of the Auxiliary Shielding Module designed by INGECID, which was later acquired by the cask manufacturer ENSA for including it as one more component of the cask in the ENUN 52B FSAR. The original design and license of the ISFSI only allowed to store 32 containers, occupying an area of 4,000 m^2 in order to include the maneuvering of the equipment, the casks and the perimeter shielding wall. This means that there is a footprint of 250 m^2 per cask. Including the auxiliary shielding (MAB) that allowed to increase the capacity of the existing ISFSI, the footprint improved to 133 m^2 per cask.

In the case of Cofrentes shown in Figure 20, the ISFSI-24 has two pads to store a total of 24 HI-STAR 150 casks. The dimensions including manoeuvring area, perimeter wall and storage pads are 3500 m^2. This means that there is a footprint of 145 m^2 per cask. The Environmental Impact Assessment has just been published and the NPP has submitted to the regulator the request for the construction of a second Storage Area. In this case, it will store 89 HI-STORM casks (with concrete overpack), with an approximate area of 5600 m^2. In this case there was not much available space, but it has been possible to design two concrete pads for the storage of the 89 casks, thus allowing to accommodate all the spent fuel from the plant.

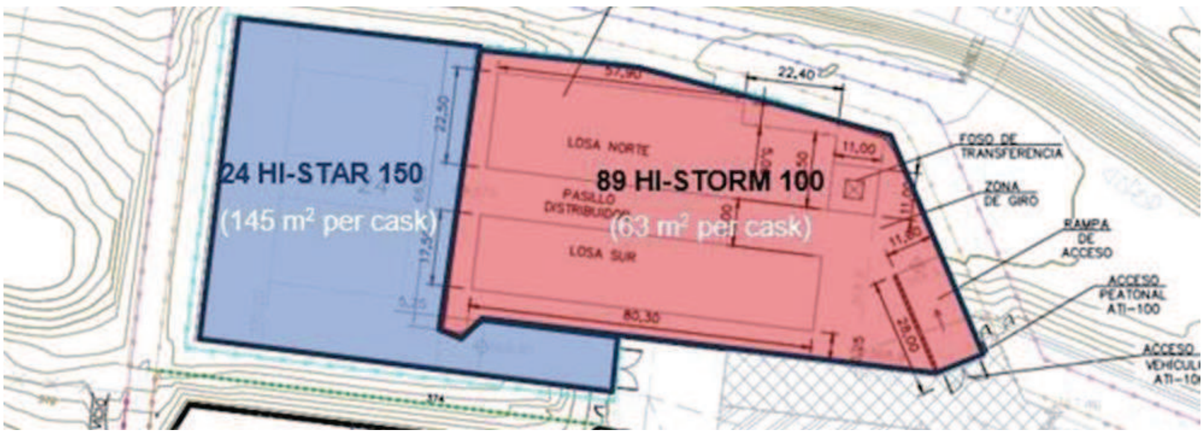


Figure 20: Comparison between Footprint for HI-STAR 150 (Metallic) and HI-STORM 100 (Concrete) at Cofrentes ISFSI in Spain

At Koeberg, the design proposed includes an Storage Area for the 14 HI-STAR 100 casks of 74 m x 25 m = 1850 m^2. This means that there is a footprint of 132 m^2 per cask. This footprint is lower than the values obtained for the mentioned similar experiences in Spain.

The proposed TISF storage design area uses the same turning circle area as the OSGISF. This option minimizes the area occupied by the turning circles for both the OSGISF and the HI-STAR 100 Storage Area and provides an area for the future development of 4500 m^2. The other possible location for the HI-STAR 100 Storage Area occupied more space for the turning circles leading to an area of 3000 m^2 for future development divided in two separate portions. Both alternatives are shown in Figure 21.

As a conclusion, it is demonstrated that even if this justification is included as a negative consequence of the design, it is considered as the best alternative to comply with all the necessary requirements and the footprint is similar to other similar installations. Note that for the future development of the TISF there are spent fuel storage cask solutions based on horizontal or vertical concrete modules or overpacks with a much more reduced footprint than the metallic casks that could make possible to include open storage pads within the remaining area.

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The figure has been removed as it identifies the exact location of the storage of spent fuel on the Koeberg TISF

Figure 21: Alternatives for the HI-STAR 100 Storage Area and Area for the Future Development of the TISF

3.5.5 Decommissioning

The TISF design introduces additional concrete and reinforced steel for decommissioning.

3.6 Benefits of this Modification

The HI-STAR 100 FSAR design bases consider open storage of the casks. The addition of an Auxiliary Shielding Module introduces the following benefits:

- TISF will assist in ensuring that the Koeberg SFPs are decongested thereby preventing the premature shutdown of the station reactors.
- The modular construction of the TISF will ensure that the Koeberg Outage requirements are met until Outage 228 currently scheduled for July 2027.
- The ASM is designed to provide shielding in accordance with ALARA principles and to allow compliance to KAA 637 [35] and 238-36 [26] at the TISF boundary.
- The TISF storage pad and related equipment design has been developed ensuring that occupational and public exposures are maintained in accordance with ALARA principles. The ASM reduces operational doses, since personnel around the casks will have this additional shielding while installing the rest of the casks, avoiding the operation inside a building with higher doses.
- The ASM acts as a barrier during design basis accidents as tsunami, tornado winds and tornado missiles.
- The ASM protects the HI-STAR 100 casks from the highly corrosive environment of KNPS.

3.7 Location and Environmental Conditions

According to RG-0011 [49], in the evaluation of the suitability of a site for a nuclear facility, the following aspects should be considered:

- Effects of external events occurring in the region of the particular site (natural or human induced).
- Characteristics of the site and its environment which could influence the transfer of released radioactive material to persons.
- Population density and distribution, as well as other characteristics in relation to the possibility of implementing emergency measures and the need to evaluate the risk to individuals and the population.

This section includes the necessary information to confirm that the site has no deficiencies that cannot be compensated for by means of design features, site protection measures or administrative procedures.

According to 10 CFR 72.212 it is necessary to develop an evaluation of site-specific hazards and design conditions that may exist at the ISFSI site or the transfer route between the plant's cask receiving bay and the ISFSI. This section includes the normal, off-normal and accidental environmental conditions and indicate the compatibility with the HI-STAR 100 cask, and the impact on the modification indicating the necessary additional evaluations, when applicable.

The Duynefontyn site has been extensively evaluated over the years in terms of all the site characteristics that could affect the safety of Koeberg and influence the transfer of radioactive material released to people and the environment. Site evaluation studies performed previously showed that no disqualifiers had been found that would render the site unsuitable for continued nuclear use [67].

3.7.1 Human-Induced Events

According to Section 2.3.6 of the HI-STAR 100 FSAR [72], "there are no combustible or explosive materials associated with the HI-STAR 100 System. No such materials would be stored within an ISFSI". The only credible fire accident is caused by the cask transporter vehicle. This possible external fire accident is analysed in the FSAR and described in §3.16.5.2.

According to the DSSR [67], the TISF is not situated in areas with industries presenting high physical risks.

3.7.2 Natural External Events

According to PP-0014 [45], the external events of natural origin, are events that originate outside the machinery and operation of the plant and arise from forces of nature and not from human activities. It is fundamental nuclear safety requirement that credible events of natural origin that may have an impact on nuclear safety should be identified and selected as design basis events in the site evaluation process.

Table 6: Screening of Natural External Events

Natural External Event as per PP-0014	Screening of events
Natural seismicity	See §3.7.7
Extreme meteorological conditions: Temperature	See §3.7.4.1
Extreme meteorological conditions: Snow	See §3.7.4
Extreme meteorological conditions: Hail	Phenomenon which in itself has no significant impact on the operation of the TISF.
Extreme meteorological conditions: Frost	See §3.7.4
Extreme meteorological conditions: Subsurface freezing	Phenomenon which in itself has no significant impact on the operation of the TISF.
Extreme meteorological conditions: Hurricanes, tornadoes, cyclones, tropical typhoons.	See §3.7.4.4 and §3.7.4.5
Extreme meteorological conditions: Straight winds	
Extreme wet and dry seasons (drought)	Phenomenon which in itself has no significant impact on the operation of the TISF.
Floods (due to tides, tsunamis, seiches, storm surges, precipitation, waterspouts, dam forming and dam failures, snow melt, landslides into water bodies, channel changes and work in the channel).	See §3.7.8

Natural External Event as per PP-0014	Screening of events
Abrasive dust and sand storms	Phenomenon which in itself has no significant impact on the operation of the TISF
Lightning	See §3.16.5.2
Volcanism	Koeberg NPS is sufficiently distant from this phenomenon to mitigate its effects.
Biological phenomena	Phenomenon which in itself has no significant impact on the operation of the TISF.
Collision of floating debris (ice, logs, etc.) with accessible safety related structures such as water intake structures and ultimate heat sink components	Not credible at TISF location.
Meteorite impact	A phenomenon which by itself has a probability of occurrence less than the 10^{-8} per year.

Since the design of the HI-STAR 100 assures that there are no credible design basis events that would result in a radiological release to the environment, the information related to atmospheric diffusion characteristics of the site area is not included.

3.7.3 Geography and Demography of Site Selected

a) Site Location

Koeberg is situated in the Western Cape in the Blaauwberg District of the City of Cape Town Metropolitan Municipality, about 27 km north of Cape Town. Figure 22 shows the regional and local site context.

It is situated on the Cape Farm Duynefontyn 1552 (the consolidation of Cape Farm Duynefontyn 34 and Farm 1375) and the adjacent farm Kleine Springfontyn 33. The site is fully owned by Eskom and is surrounded by a private nature reserve, namely, the Witzands Aquifer Nature Reserve on the north-east side, the Duynefontyn residential area in the south, and the Atlantic Ocean on the west side.

The R27, known as the West Coast Road, is a regional route that runs in a north-south to north-west direction on the eastern boundary of the site. The main access road leads from the R27 to Koeberg, and an alternative access road is via Duynefontyn to the south.

The Duynefontyn site hosting Koeberg has been zoned appropriately for generating nuclear electricity and associated activities.

A 400 kV power line connects the area to the national grid and the main source of electricity from Mpumalanga, with Koeberg feeding electricity into the grid for local use and exporting nationally via the grid system, depending on demand.

The City of Cape Town supplies potable water to Koeberg and areas of Bloubergstrand, Melkbosstrand, Van Riebeeckstrand, and Duynefontyn via various pipelines from the Voëlvlei Dam between Hermon and Tulbagh and the 40 000 m3 capacity Melkbos Reservoir.

There are no rivers on the site itself, but there are ecologically important wetlands to the south of Koeberg and on the northern part of the site.

The closest major airport to the site is Cape Town International Airport, which is located 40 km to the south-south-east. The railway line to Namaqualand, which runs approximately 24 km east of the site, is the closest railway line to the site.

Cape Town Harbour (25 km south) is the largest commercial harbour in the region, with Yzerfontein Harbour, a small craft harbour, located 25 km to the north-west.

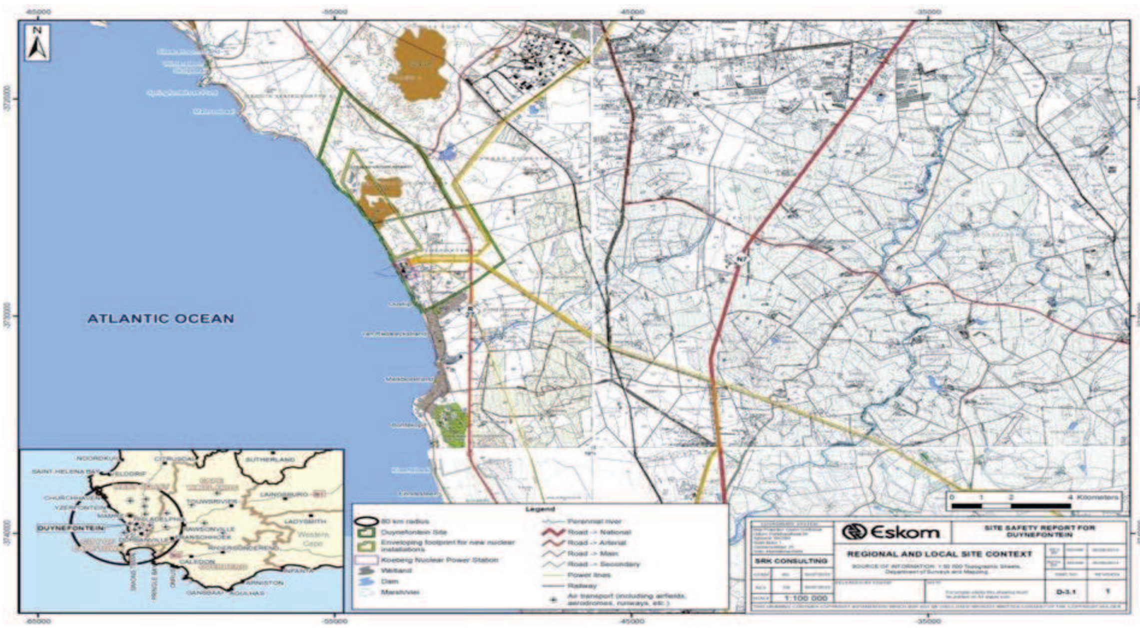

Figure 22: Regional and Local Site Context

There are a variety of land uses surrounding KNPS including the Duynefontyn residential area to the south (~ 1.4 km from KNPS), the Koeberg Nature Reserve to the north, south and east, and the R27 along the property's eastern boundary (~ 1.8 km from KNPS) with agricultural activities further east.

KNPS is located within a predominantly natural environment, although there are existing built elements throughout the property including powerlines, office buildings, a visitor's centre, weather station, roads and parking areas.

b) Site Description

The TISF is located within the Security Protected Area (SPA) of KNPS, a flat area disturbed by previous construction activities and by current operational activities at KNPS.

c) Population Distribution and Trends

According to Section 7.1 of HI-STAR 100 FSAR [72], the design of the HI-STAR 100 assures that there are no credible design basis events that would result in a radiological release to the environment. The HI-STAR 100 overpack is designed to provide physical protection to the MPC during normal, off-normal and postulated accident conditions to assure that the integrity of the MPC is maintained.

Therefore, a quantification of the consequence of leakage from the MPC is not required, and it is not necessary to identify the maximally exposed real individual located at or beyond the controlled area boundary and its consistency with local meteorology and patterns of land and water use.

d) Land and Water Use

Since the design of the HI-STAR 100 assures that there are no credible design basis events that would result in a radiological release to the environment, information about land use and bodies of water or aquifers used by humans, livestock or farms within the region surrounding the site is not included in this document.

3.7.4 Meteorology

The Western Cape has a semi-arid Mediterranean climate, which is strongly influenced by the cold Benguela Current and coastal winds. The Cape Town area is characterized by dry warm summer months (October to April) and wetter cool winter months (from May to September).

- Rainfall: The average annual rainfall recorded at KNPS from 1980 to 2014 is 382 mm per annum, whilst a maximum of 640 mm was recorded in 1987 and a minimum of 242 mm in 2000. Maximum monthly rainfall measured during this period occurred during June 1994 (157.4 mm), July 2001 (162.4 mm) and August 2013 (160.7 mm). According to Koeberg SAR , the maximum rainfall for plant safety is 200 mm/h, which is bounding for the rainfall data compiled in the EIA Report [65].
- Snow: Not to date, as per Koeberg SAR [41].
- Frost: Occasionally, 4 years out of 10, as per Koeberg SAR [41]

3.7.4.1 Ambient Temperatures

The latest DSSR, Revision 1(a), [67] information and the Specification for Modifications and Equipment for Severe Ambient Temperature Applications [31] establish the design requirements for the design and manufacture of SSCs that are required to mitigate or withstand DEC ambient temperature conditions. These temperatures can be considered as a single point over the course of the day as displayed in Table 7.

Table 7: Severe Ambient Temperatures for DECs (Table 1 of [31])

Minimum ambient air temperature (°C)	Maximum ambient air temperature (°C)
- 3	50

Table 8 includes the design basis ambient temperatures projected for 2044, for the TISF and the compatibility with the design basis temperatures included in the HI-STAR 100 which shall bound the site-specific design bases.

Table 8: Design Bases Temperatures – Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
NORMAL CONDITIONS	8.2 ºC / 27.2 ºC	27 ºC Table 2.0.2 [72]	NO
OFF-NORMAL CONDITIONS	3.5 ºC / 45.3ºC	-40 ºC / 38 ºC Table 2.0.2 [72]	NO
ACCIDENT	-6.1 ºC / 55.1 ºC	50 ºC Table 2.0.2 [72]	NO

It has to be noted that the temperatures defined for the TISF design are not enveloped by the definitions given in the HI-STAR 100 FSAR [72] and therefore an analysis is required to evaluate the impact of the Koeberg site specific ambient temperatures.

Traditionally, the NRC has acknowledged the use of the annual average temperature as the standard for normal conditions in spent fuel cask safety analyses. However, according to NUREG 2174 [21], this approach may be insufficient in locations where temperatures exceed the annual average for extended periods during the hottest months. At Koeberg, we consider the daily maximum temperature during the hottest month as the normal condition, aligning with the considerations outlined in NUREG 2174 [21].

NORMAL CONDITIONS:

- Temperatures for normal conditions at Koeberg TISF are defined with the mean daily maximum in hottest month and mean daily minimum in coldest month.
- Temperatures for normal conditions in HI-STAR 100 FSAR [72]are based on the annual average ambient temperatures for the continental United States. According to NUREG 2174 [21], this temperature is not conservative for some locations at the US where this temperature is exceeded for long periods during the hottest months, so a monthly average is preferable.

OFF-NORMAL CONDITIONS:

- Temperatures for off-normal conditions at Koeberg TISF are defined with the highest and lowest values recorded in 18 years.
- Temperatures for off-normal conditions in HI-STAR 100 FSAR are based on the minimum and maximum of the 72-hour average of the ambient temperature at an ISFSI (or TISF) site.

ACCIDENT CONDITIONS:

- According to NUREG 2215 [24], accident conditions do not include ambient temperatures. Conservatively, temperatures for accident at Koeberg TISF are defined with the DEC conditions at Koeberg.

- Accident condition temperature in HI-STAR 100 FSAR [71] is the short-term temperature which may exist during a transition state or a transient event (examples of such instances are short-term temperature excursion during canister vacuum drying and backfilling operations (transition state) and fire (transient event).

Tables 8(a) and 8(b) show the results of the maximum HI-STAR 100 component temperatures calculated in the FSAR for vertically orientated HI-STAR 100 cask with an MPC-24 (conservative as it is a smaller basket) under normal storage conditions (27 ºC). In all cases the calculated maximum temperatures are less than the design temperature limits with adequate margin.

Note that:

- The most effective mode of heat evacuation in vertically stored systems is due Helium thermosiphon circulation which alleviates thermal stresses on the MPC and lowers the fuel temperatures. This mode of heat transport is neglected in the analysis.

- The maximum value of the calculated temperature for fuel cladding under long-term normal conditions of storage must remain below 400ºC. The maximum fuel cladding temperature as a result of an off-normal or accident event must not exceed 570ºC.

For Koeberg site specific temperatures the results were extrapolated for normal (27.2ºC), off-normal (44.3 ºC) and accident conditions (55.1 ºC).

- Except under accident conditions, all the HI STAR 100 component design temperatures are well below the design temperature limits. The neutron shield design temperature is exceeded under accident conditions.

  Therefore, under accident conditions, there is a possible consequence of a slight loss of the neutron shield effectiveness. Upon detection of an extreme environmental temperature accident, the cask shall be radiologically inspected for any damage. This requirement and associated corrective actions are included in the station emergency procedure KEP-088 [37].

Table 8(c) shows that, the maximum internal pressure values are below HI-STAR 100 design pressure limits. for normal, off normal, and accident conditions. Pressure calculations are performed using the ideal gas law.

Table 8 (a): Maximum Temperatures Caused by Off-Normal Environmental Temperatures in Vertically Orientated Systems

Temperature Location	FSAR Normal Temperature @27ºC (ºC)	TISF Normal Temperature @27.2ºC (ºC)	TISF Projected Off-Normal Temperature in 2044 @45.3ºC (ºC)	Off-Normal Design Temperature Limit (ºC)
Fuel Cladding	394	394.2	412.3	570
MPC basket	385	385.2	403.3	510
MPC Outer Shell Surface	167	167.2	185.3	413
MPC Overpack (Helium Gap Outer Surface)	144	144.2	162.3	260
Neutron Shield Inner Surface	134	134.2	**152.3**	149
Overpack Shell Outside Surface	109	109.2	127.3	535

Table 8(b): Maximum Temperatures Caused by Accident Environmental Temperatures in Vertically Orientated Systems

Temperature Location	FSAR Normal Temperatur e @27ºC (ºC)	TISF Normal Temperature @27.2ºC (ºC)	Projected TISF Accident Temperature in 2044 @55.1ºC (ºC)	Accident Design Temperature Limit (ºC)
Fuel Cladding	394	394.2	422.1	570
MPC basket	385	385.2	413.1	510
MPC Outer Shell Surface	167	167.2	195.1	413
MPC Overpack (Helium Gap Outer Surface)	144	144.2	172.1	260
Neutron Shield Inner Surface	134	134.2	**162.1**	149
Overpack Shell Outside Surface	109	109.2	137.1	535

Table 8(c): MPC Confinement Boundary Pressures Vertical Orientation Long-Term Storage

Condition	FSAR Pressure @27°C (kPa)	TISF Pressure @27.2°C (kPa)	Threshold limit (kPa)	FSAR Margin @27°C (%)	TISF Margin @27.2°C (%)
Initial Helium backfill @ 21°C	153				
Normal condition	302	304	689	56	56
With 1% fuel assembly rod rupture (Normal)	305	307	689	56	55
With 10% fuel assembly rod rupture (Off-Normal)	339	342	689	51	50
With 100% fuel assembly rod rupture (Accident)	671	676	860	22	21

3.7.4.2 Humidity

The relative humidity at KNPS, measured as the mean hourly value in May, June & July, is **83 %.** No mention to humidity is made in the HI-STAR 100 FSAR [72].

3.7.4.3 Insolation

Table 9 includes the design basis insolation for the TISF and the compatibility with the design basis insolation included in the HI-STAR 100 which shall bound the site-specific design bases.

Table 9: Design Basis Insolation - Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
NORMAL CONDITIONS	Insolation in accordance with 10CFR71.71 averaged over 24 hours		YES
OFF-NORMAL CONDITIONS	Insolation in accordance with 10CFR71.71 averaged over 24 hours		YES

3.7.4.4 Tornado

According to Specification for Modifications and Equipment Required for High Speed Wind and Tornado Applications [29] and Koeberg SAR [41], the tornado conditions to be used for new safety related systems, structures and components required to withstand the effects of design basis and mitigate the design extension conditions are included in Table 10 and Table 11, respectively.

Table 10: Design Basis Tornado Characteristics

Region	Region Maximum wind speed (m/s)	Translational speed (m/s)	Maximum rotational speed (m/s)	Radius of maximum rotational speed (m)	Pressure drop (mb)	Rate of pressure drop (mb/s)
I	103	21	82	45.7	83	37

Table 11: Design Extension Tornado Characteristics

Tornado intensity (Enhanced Fujita Scale)	Maximum wind speed - 3 second gust (km/h)	Tornado translational speed (km/h)	Pressure drop (kPa)	Rate of pressure drop (kPa/s)
EF2	200	36	2.7	0.1

The values adopted for TISF Koeberg are the most severe from high winds and tornados specifications. In this case, those values do not correspond to DEC design basis, since the values included in the Koeberg SAR [41] are bounding.

Table 12 includes the design bases tornado wind velocities for the TISF and the compatibility with the HI-STAR 100 which shall bound the site-specific design bases.

Table 12: Design Bases Tornado Wind Velocities – Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
ROTATIONAL WIND SPEED	82 m/s	470 km/h (131 m/s) Table 2.2.4 of [72]	YES
TRANSLATIONAL SPEED	21 m/s	110 km/h (31 m/s) Table 2.2.4 of [[72]	YES
MAXIMUM WIND SPEED	103 m/s	580 km/h (161 m/s) Table 2.2.4 of [72]	YES

Appendix A2.3 – STRUCTURAL CALCULATIONS includes the consideration of tornado wind velocities for the design of the ASM, according to Specification for Modifications and Equipment Required for High Speed Wind and Tornado Applications [29].

3.7.4.5 Tornado Missiles

According to Specification for Modifications and Equipment Required for High Speed Wind and Tornado Applications and Koeberg SAR], the tornado conditions to be used for new safety related systems, structures and components required to withstand the effects of design basis and mitigate the design extension conditions are included in Table 13 and Table 14, respectively.

Table 13: Tornado Design Basis Missiles

Missile type	Dimensions (m)	Mass (kg)	Horizontal velocity (m/s)	Vertical velocity (m/s)
Steel sphere	Diameter = 0.0254	0.0669	8	6
Rigid Sch. 40 pipe	Diameter x Length = 0.168 x 4.58	130	41	28
Deformable 5 m automobile	Length x Width x Height = 5 x 2 x 1.3	1810	41	28

Table 14: Tornado Design Extension Missiles

Missile type	Dimensions (m)	Mass (kg)	Horizontal velocity (m/s)	Vertical velocity (m/s)
Steel sphere	Diameter = 0.0254	0.0669	35	26
Rigid Sch. 40 pipe	Diameter x Length = 0.168 x 4.58	130	40	26
Deformable 5 m automobile	Length x Width x Height = 5 x 2 x 1.3	1810	52	26

Table 15 includes the design bases tornado missiles for the TISF and the compatibility with the HI-STAR 100 which shall bound the site-specific design bases.

Table 15: Design Bases Tornado Missiles (FSAR) – Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
AUTOMOBILE	H: 52 m/s V: 26 m/s	200 km/h (56 m/s) Table 2.2.5 of [72]	YES
RIGID SOLID STEEL CYLINDER (200 mm diameter)	H: 40 m/s V: 26 m/s	200 km/h (56 m/s) Table 2.2.5 of [72]	YES
SOLID SPHERE (25 mm diameter)	H: 35 m/s V: 26 m/s	200 km/h (56 m/s) Table 2.2.5 of [72]]	YES

The HI-STAR 100 FSAR [72]] demonstrates that the HI-STAR 100 resists the design bases tornado missiles. Since the HI-STAR 100 resists the action of the design bases tornado missiles, it is not necessary to provide additional protection by the ASM, but it is necessary to verify that the ASM will not collapse. The steel sphere and the rigid solid steel cylinder missiles could cause penetration result in concrete local damage without any consequence in the global ASM response. The maximum force acting on the HI-STAR 100 due to an automobile tornado missile is 117.3 kN according to Section 3.4.8 of the HI-STAR 100 FSAR [72]]. Assuming that the ASM is protecting the HI-STAR 100, the automobile tornado missile would impact the ASM. The seismic load on the ASM is 14388 kN (Appendix A2.3 – STRUCTURAL CALCULATIONS), 123 times higher than the automobile tornado missile load. Due to this significant margin, the verification is not considered to be included in the structural qualification of the ASM.

3.7.5 Surface Hydrology

KNPS falls within quaternary catchment G21B and in the Berg Water Management Area. The Sout River (and its tributary, the Donkergat River) and Diep River drain the broader area. These rivers all flow in a south- westerly direction towards the coast but are generally ephemeral in nature. The mouth of the Sout River is at Melkbosstrand, approximately 3.8 km south of the Koeberg Nature Reserve.

The only area in the vicinity of KNPS where the terrain is sufficiently low-lying to support significant areas of wetland habitat occurs 1.5 km south of the site. The slack areas between a series of low lying east-west oriented dunes give rise to a mosaic system of alkaline dune-slack wetlands. These dune wetlands are fed primarily by seasonal fluctuations in the water table, forming pools of shallow, brackish water during winter. These wetlands are dry in summer when the water table drops. The wetlands are considered of high local and regional importance, although their similarity to other wetlands north of KNPS has not yet been established. A few other seasonal wetlands occur in isolated areas to the north and east of KNPS.

In addition to the natural wetlands that occur within the nature reserve, the property also includes a number of artificial wetland areas, which are the product of activities associated with the construction of KNPS, e.g., borrow pits.

A series of coastal infiltration basins, which have been excavated between the dunes 3 km north of the site for disposal of wastewater are highly artificial habitats, comprising deep, permanent, open water bodies, vegetated by species that thrive under conditions of nutrient enrichment. The coastal infiltration basins are unnatural water features of low quality, but locally rare, permanent freshwater habitat, artificially contributing to plant and animal diversity in the area. They play an important role in terms of providing a hydraulic barrier for the protection of the Atlantis Aquifer from seawater intrusion. Figure 23 shows wetlands ecosystems at Duynefontyn described in this section.

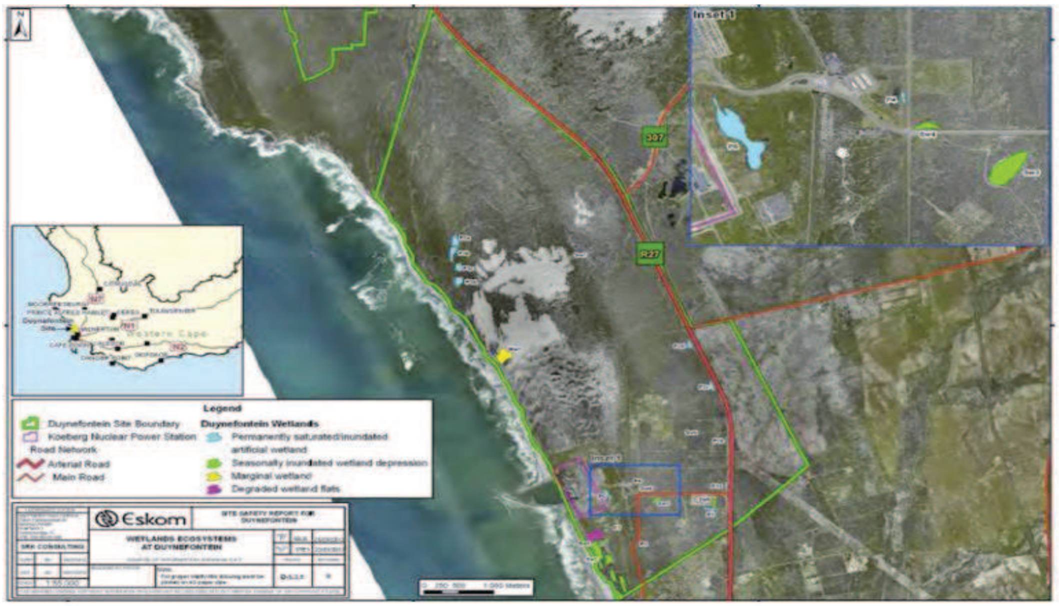

Figure 23: Wetlands Ecosystems at Duynefontyn

3.7.6 Subsurface Hydrology

KNPS falls within the Duynefontyn Groundwater Resource Unit (GRU) which extends from the edge of the Atlantis industrial area southwards to the Sout River near Van Riebeeckstrand. The western and eastern boundaries of the GRU are formed by the coastline and outcrops of the Tygerberg Formation rocks, respectively. The GRU is predominantly covered by geologically younger sediments of the Witzand and Springfontyn formations.

The main concepts of the hydrogeological model at Koeberg are summarized below [65]:

- There is no downstream use of groundwater.
- Groundwater at KNPS is near/at the end of its flow path.
- Depth to the groundwater table at KNPS ranges between 3 and 4 meters measured below ground level. It is predicted that global warming will cause a future increase in sea levels worldwide. Modelling of potential sea level rise at KNPS indicates a possible rise in sea level of about 1.2 m over the next 50 years. Groundwater levels at TISF location could rise between 0.9 and 0.8 m, with effects (0.1 m) being propagated up to about 1000 m inland.

- The receiving environment/downstream receptor of any contamination will be the shore zone/sea.
- There is a two aquifer system present, with an upper intergranular aquifer (Sandveld Aquifer) and a lower fractured rock aquifer (Malmesbury Aquifer). Only the upper Sandveld Aquifer may potentially be impacted by the TISF construction.
- Local direct recharge only affects the Sandveld Aquifer - the Malmesbury Aquifer is recharged inland, far from KNPS. There may be upward leakage of groundwater from the Malmesbury Aquifer into the Sandveld Aquifer (and vice versa) depending on relative groundwater heads in each aquifer.
- Groundwater flow is from the interior, across KNPS, in a south-westerly direction towards the coast, with discharge into the ocean.
- Hydraulic conductivity values of the Sandveld Aquifer at and around KNPS range from 0.9 to 5.6 m/d.
- Groundwater flows under a relatively low gradient at a calculated flow rate of c.2.6 m/d, which indicates a relatively quick migration across KNPS, towards the coastline.
- There is an inferred interface between ‘fresh’ groundwater from inland and saline groundwater in the shore-zone. This interface may be shifted by groundwater control measures and sea level rise. However, down-hole salinity probing did not detect this zone and so it is unlikely to be a significant boundary at KNPS.
- Natural groundwater quality is marginally saline and of a mixed NaCl and CaHCO3 character.

3.7.7 Geology and Seismology

a) Basic Geologic and Seismic Information

According to SSR for Duynefontyn [67], considerable investigative efforts went into the investigation and commissioning of KNPS. Although extensive, this pre-existing information has been supplemented with further detailed site-specific geotechnical investigations data analysis, monitoring and the construction of a three-dimensional geotechnical model. The additional investigations were carried out to meet modern expectations with respect to geotechnical site characterization. The key conclusions applicable to the TISF design, based on the outcomes of the geotechnical characterization investigations in the SSR for Duynefontyn [67]are detailed below, and compared with the results obtained from the Factual Geotechnical Report [74].

- The site is underlain by a poorly graded fine sand profile of c.25 m thickness consisting predominantly of aeolian deposits with a shallow groundwater table – this upper intergranular aquifer (the Sandveld Aquifer) is, in turn, underlain by rocks of the Malmesbury Group consisting primarily of greywacke and sandstone with interbedded siltstone, shale and mudstone units. These metasedimentary rocks have been upturned in the past and the bedding dips towards the coastline at c.75° with a strike of c.325°. Shearing/faulting and brecciated zones exist randomly with unknown orientations.
- Characteristics of the sand profile are well investigated (historically and in the current investigation), and consist of an upper Bredasdorp formation, underlain by the Springfontein Formation and finally the Vaarswater Formation. These strata are poorly consolidated and the bulk of this horizon is saturated, resulting in these soils not presenting consistency of better than medium dense throughout the profile.

- The bedrock surface is a wave-cut platform, and due to the steep bedding dip, the bedrock surface manifests as regularly alternating variably metamorphosed greywacked/sandstone, and interbedded shale layers. Investigating this buried surface in detail is not possible until the sands have been removed and the bedding surface is mapped (as was the case when KNPS was developed). A secondary fractured rock aquifer (the Malmesbury Aquifer) exists in the site rocks.

The site geology at the TISF area is consistent with the aforementioned conclusions for Duynefontyn, according to the Factual Geotechnical Report [74]. The site investigated is underlain by the unconsolidated sands of the Witsand Formation (aeolian origin, Quaternary stage) which unconformably overlie the Tygerberg Formation mudrocks and sandstones at depth. These aeolian sands can be described as dry, cream to off-white and grey, medium to dense calcareous silty sand with mudstone and calcrete pebbles and inclusions. Shell fragments are generally abundant in the upper parts of the profile.

Below depths of between 18.50 and 23.45 m below existing ground level, the shales or siltstones of the Tygerberg Formation of ‘the Malmesbury Group were encountered in boreholes BH01 through BH03 (see Figure 24). The sales or siltstones can be described as grey highly to medium weathered closely jointed of soft to medium hard rock strength. Below depths of between 19 and 24 m depth, sandstone was encountered in these boreholes and can be described as being grey highly to medium weathered closely jointed and soft to medium hard rock in strength.

Figure 24: Boreholes Positions [74]

A soil profile at the TISF area is inferred from the information available at boreholes BH07, BH09, BH03 and BH02, that clearly shows the consistency with the previous available geotechnical studies at Duynefontyn. This soil profile is shown in Figure 25.

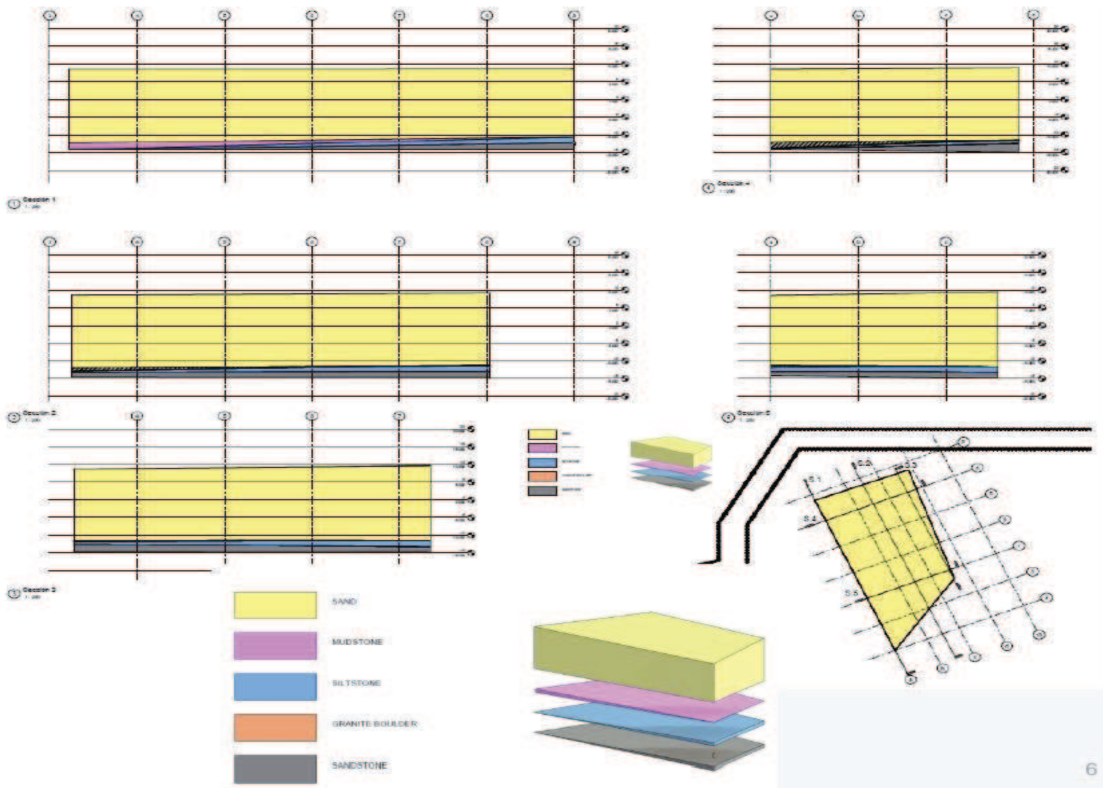

Figure 25: Soil Profile

b) Ground Vibration

Seismic input is described in §3.3.1.

The HI-STAR 100 must withstand loads arising due to a seismic event and must be shown not to tipover during a seismic event. Subsection 3.4.7 of the HI-STAR 100 FSAR [72]contains calculations based on conservative static "incipient tipping" calculations which demonstrate static stability. The calculations in Subsection 3.4.7 result in the value specified in Table 2.2.8, which provide the maximum horizontal ZPA versus vertical acceleration multiplier above which static incipient tipping would occur. This conservatively assumes the peak acceleration values of each of the two horizontal earthquake components and the vertical component occur simultaneously.

Table 16 includes the design bases earthquake for the TISF and the compatibility with the HI-STAR 100 which shall bound the site-specific design bases. In this case, the HI-STAR 100 does not bound the TISF design basis earthquake. However, according to the HI-STAR 100 FSAR [72], if the earthquake required cannot be satisfied for a particular site, then a 3-D time history analysis may be performed to demonstrate the stability of the HI-STAR 100 overpack in the horizontal storage configuration.

Table 16: Design Basis Earthquake – Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
EARTHQUAKE	0.5g ZPA at bedrock (w/1.0 vertical)	0.566g ZPA (w/1.0 vertical) 0.622g ZPA (w/0.75 vertical) 0.651g ZPA (w/0.667 vertical) 0.707g ZPA (w/0.5 vertical) Section 3.4.7.1.2 of [72]	Specific analysis needed (See §3.16.7)

c) Stability of Subsurface Materials

According to Site Safety Report for Duynefontyn [67], wide distributions of soils investigated on the site have a high liquefaction potential, so specific analysis has been developed based on the specific data available for the TISF area, as described in §3.16.7.

3.7.8 Flooding

Flooding as a result of tsunamis, storm surges and seiches are considered in the Specification for Modifications and Equipment Required for External Flooding Applications [28]. The mechanisms of damage by these phenomena to be considered are:

- Water damage.
- Hydrostatic loads.
- Hydrodynamic loads.
- Debris Impact loads.
- Erosion Effects on foundations of structures.
- Silting.

According to Specification for Modifications and Equipment Required for External Flooding Applications [28], the flooding conditions to be used for new safety related systems, structures and components required to withstand the effects of design basis and mitigate the design extension conditions are as follows:

- Design basis: None.
- Design extension:
    - Probable maximum tsunami maximum inundation depths of 6 m.
    - Probable maximum tsunami maximum current speeds of 7 m/s.

These values are defined from Figure 26 and Figure 28 showing the maximum inundation and current velocity at different locations at KNPS that are expected to be flooded by a wave with a 13.95 m run-up.

Probable maximum tsunami maximum inundation depth for the TISF area is shown in Figure 28. Probable maximum tsunami maximum current speed for the TISF area is shown in Figure 26. Additional images are obtained contouring in white the current speeds for the TISF area in Figure 27. Most area is covered by 5-6 m/s, with small areas showing values between 6-7 m/s. Conservatively, a current speed of 7 m/s is defined for the TISF area.

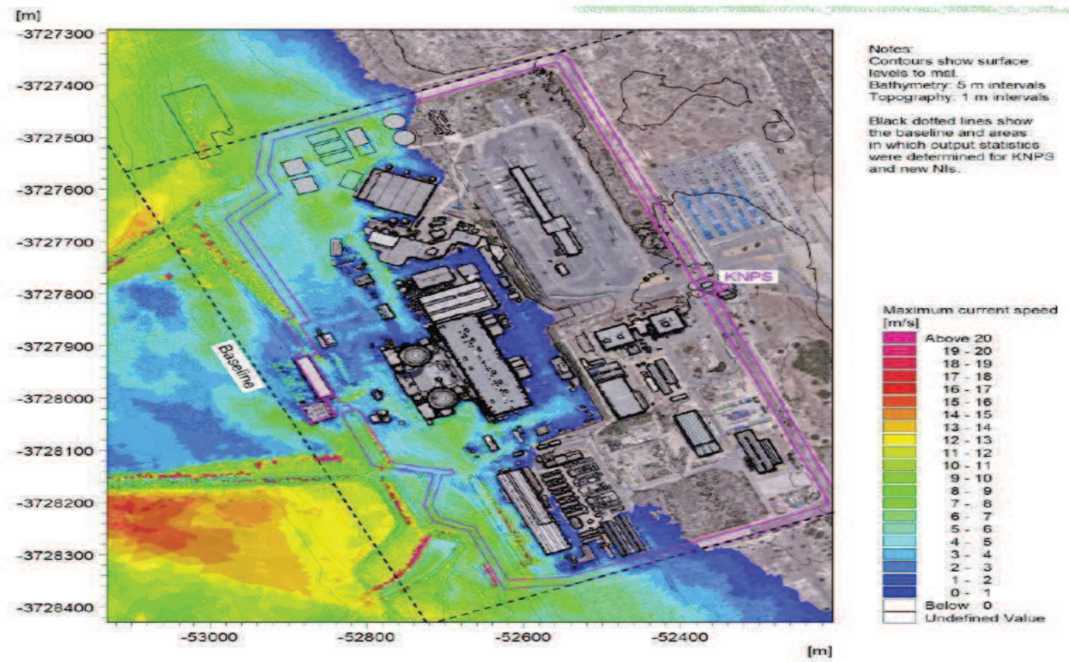

Figure 26: Probable Maximum Tsunami Maximum Current Speeds for KNPS (Figure 2 of [28])

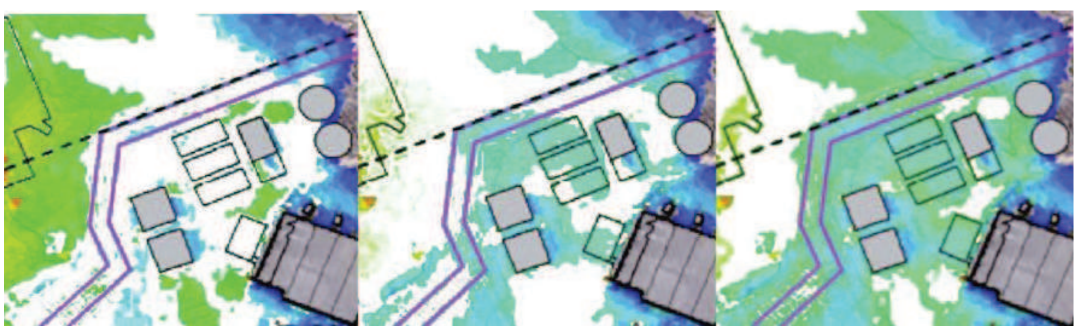

Figure 27: Contours in white for 5-6 m/s (left), 6-7 m/s (center), 7-8 m/s (right))

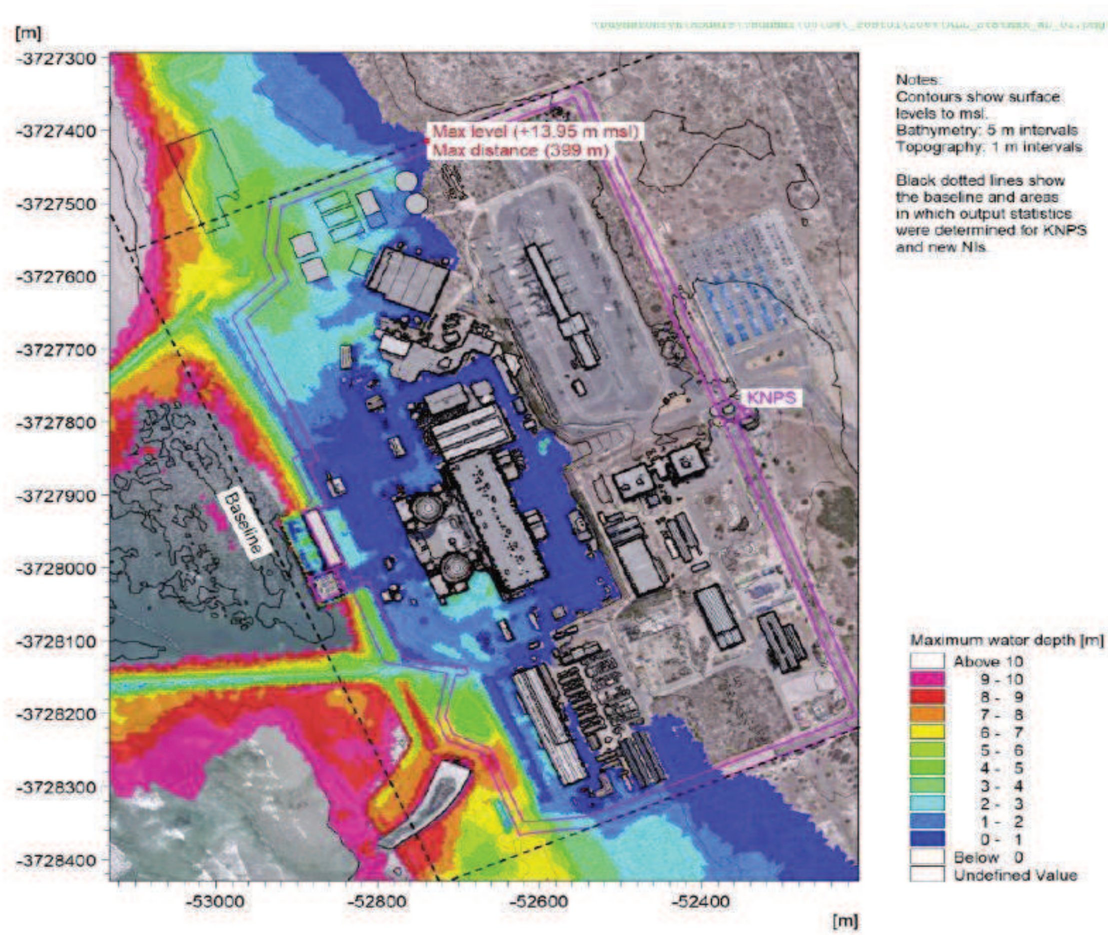

Figure 28: Probable Maximum Tsunami Maximum Inundation Depths for KNPS (Figure 1 of [28])

The type and effect of waterborne missiles shall be considered, determined from 6.11 of ASCE 7-16 [5]. The simplified debris impact static load may be used as presented in 6.11.1 of ASCE 7-16 [5]. As KNPS is not within the debris hazard region of piers and wharves the extraordinary debris impacts as presented in 6.11 of ASCE 7-16 [5], need not to be considered.

The deposition of sediment consisting of beach-sand including shells and coral, by a tsunami, may affect the access to connection points and doorways. This effect shall be considered in the design for modifications and existing or new SSC that are required to withstand DEC tsunamis.

Areas that are susceptible to silting shall consider the mitigation of this phenomena in the design and implementation strategy. It is demonstrated in the DSSR that the effect of silting may be significant. The following passage is extracted to demonstrate the potential effect:

Historic cases of deposition from tsunami events from the 1998 Papua New Guinea tsunami, 2001 Peru tsunami and the most recent 2004 Indonesian tsunami were reviewed. According to the sediment surveys undertaken for these events, a maximum value of 1 m for tsunami sediment deposition was determined."

"According to this statement, a sediment deposition of 1 m will be considered as design basis for the design of the TISF and related procedures.

Table 17 includes the design basis flooding for the TISF and the compatibility with the HI-STAR 100 which shall bound the site-specific design bases.

Table 17: Design Basis Flooding – Site-specific Evaluation

Condition	TISF Koeberg	HI-STAR 100 FSAR	FSAR bounds TISF
MAXIMUM SUBMERGENCE DEPTH DUE TO FLOOD	6 m	200 m Table 2.2.8 of [72]	YES
FLOOD WATER VELOCITY	7 m/s	4 m/s	Additional justification included below.

The HI-STAR 100 FSAR [72]includes in Section 3.4.6 a verification of the kinematic stability under flood conditions. Horizontal loads on the HI-STAR 100 System may cause sliding or rotation. It is shown in this verification that the maximum permitted flood water velocity is limited by sliding of the cask.

The water velocity associated with flood produces a horizontal drag force, which may act to cause sliding or tip-over. Since the HI-STAR 100 is stored inside the ASM, the horizontal drag force will act over the ASM, and not over the HI-STAR 100. The ASM acts as a barrier during this design basis accident. As a result of the flooding, the HI-STAR 100 could finally be submerged, by water entering through the vent inlet and outlet openings, with a maximum submergence depth of 6 m, which is bounded by the FSAR [72]conditions (200 m).

Additionally, it should be noted that, according to the FSAR [72], the acceptable upper bound flood velocity must provide a minimum factor of safety of 1.1 against sliding and overturning, but the design basis flood velocity of 4 m/s defined in the FSAR leads to a factor of safety of 3.07 against sliding. Calculations in the FSAR are made with an empty HI-STAR 100 without considering the spent fuel weight, which is highly conservative. This means that there is margin of safety.

The maximum flood velocity to provide a minimum factor of safety of 1.1 (instead of 3.07) obtained with the same methodology as the FSAR is 6.4 m/s.

Since only small areas show values between 6-7 m/s inside the TISF boundary, it is considered acceptable without specific flood velocity analyses inside the ASM.

The ASM is designed as to withstand an accidental load due to the horizontal drag force from the design basis flooding (7 m/s), as demonstrated in Appendix A2.3 – STRUCTURAL CALCULATIONS.

3.8 Functional Description

3.8.1 General Description

To define the TISF proposed for Koeberg the following parts shall be considered (see Figure 29):

- Storage Area: It is the area defined to store the 14 HI-STAR 100 casks. It includes the concrete storage pads and the ASMs.
- Approach Aprons: Reinforced concrete area in front of the Storage Area and within the Turning Circle that allows to perform the operations at the TISF with the transport and handling equipment, and serves as preparation/laydown area, if necessary.
- Turning Circle: Area that shall allow the manoeuvring of the OSGs and HI-STAR 100 casks transport equipment.
- Stormwater Drainage: System to manage the stormwater run-off from the Approach Aprons, Storage Area and existing soil, avoiding the accumulation of water in the TISF area.
- Haul Route: Path to be followed by the HI-STAR 100 cask transport equipment from the Reactor Buildings to the TISF area.

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The figure has been removed as it identifies the exact location of the storage of spent fuel on the Koeberg TISF

Figure 29: TISF layout

The Auxiliary Shielding Modules (ASMs) has been conceived as an intermediate solution between an open storage pad and a storage building (see Figure 30). The ASM has been designed as a structure consisting of a concrete shield with capacity to house two loaded HI-STAR 100 casks.

It is designed to provide shielding while ensuring the normal operation of the cask, maintaining its thermal behaviour within the limits established in the HI-STAR 100 Final Safety Analysis Report (FSAR) [72]. Additionally, it must be capable of withstanding the design basis accidents to ensure the recoverability of the casks housed inside.

At the bottom of the ASM there are inlet vent openings and at the roof there are outlet vent openings to ensure natural circulation and cooling of the HI-STAR 100. Each of these openings will be securely covered by a grille, effectively preventing the ingress of external elements and debris.

The ASM allows for the modular construction of the Storage Area for the 14 casks in a way that the target date for loading the first two casks can be met. Ultimately, a design similar to the CSB could be adopted, although this would mean that the target date will not be meet.

Additionally, this solution reduces the operational doses, since the personnel around the casks will have this additional shielding while installing the rest of the casks, avoiding the operations inside a building with higher doses.

For inspection and maintenance tasks, the ASM includes an inspection opening which consists of a labyrinthic entrance for personnel to easily access the ASM. The ASM entrance will have a lockable door to prevent unauthorised access to the modules. The modules will be classified and sign-posted in accordance with the Koeberg RP requirements. The operational doses could be reduced if cask inspections are performed by robotic systems similar to those used for inspections of Holtec HI-STORM System, ORANO MATRIX System or other similar solutions for storage of spent including a concrete overpack.

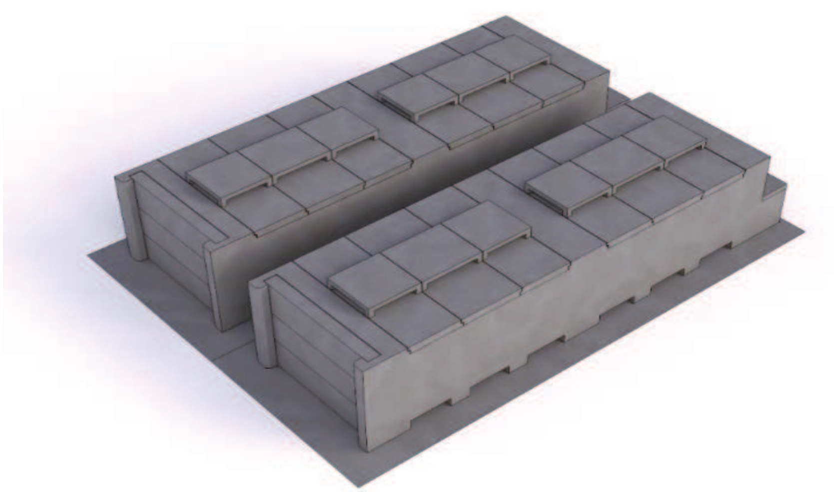


Figure 30: Auxiliary Shielding Module Concept View

The Storage Area is located in front of the OSGISF, sharing the turning circle for the maneuver of the Kumag 25 transporting the Old Steam Generators (37 m) and the turning circle for the maneuver of the Goldhofer transporting the HI-STAR 100 casks (25 m).

This location complies with the two main design criteria:

- It optimizes the available space for the future development of the TISF and it avoids the interferences with the existing structures.
- It ensures radiation dose compliance at the TISF boundary for the storage of the 14 HI-STAR 100 casks.

The ASM has vertical walls that are constructed on site jointly with the pad, while the top covers and the front cover are designed as precast elements that can be installed using the Gantry Crane. They can also be handled with other auxiliary equipment existent at Koeberg (see Figure 31 and Figure 32).

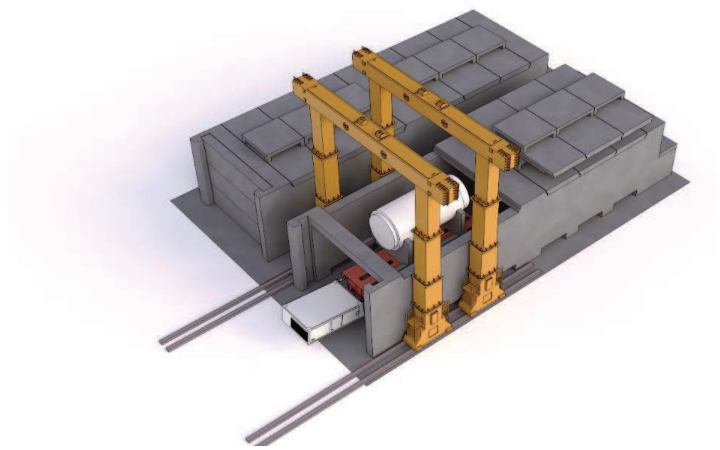


Figure 31: Installation of the Cask with the Gantry Crane and the Goldhofer Inside the ASM

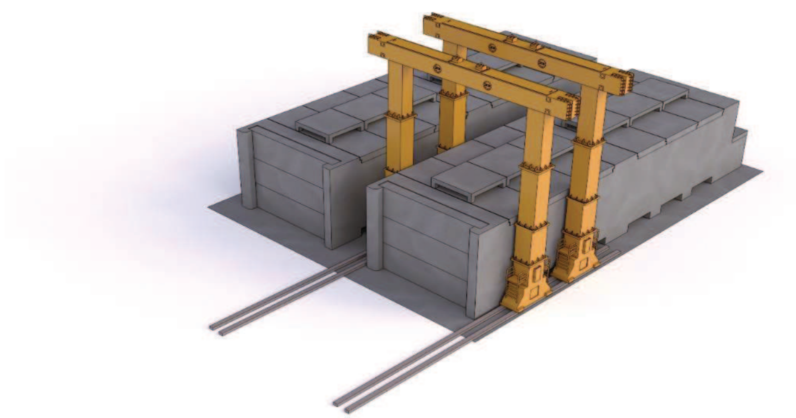


Figure 32: Installation of the ASM Top Cover and Front Cover with the Gantry Crane

3.8.2 Storage Area (Concrete Pad + ASM)

The Storage Area consists of three reinforced Concrete Pads with general dimensions of 74 m x 25 m and an thickness of 0.9 m (see Figure 33). Two Concrete Pads are designed to store 4 casks in 2 ASMs (25m x 21.50 m) and the third one is designed to store 6 casks in 3 ASMs (25m x 31 m). The approximate design elevation will be 8.14 mmasl (meters measured above sea level), as detailed in Appendix A2.16 – TISF KOEBERG DETAILED DESIGN DRAWINGS. It will be constructed with a 1 % slope to allow rainwater drainage that will be guided to the existing drainage discharge by the stormwater drainage channel defined in Section 3.8.4 and detailed in Appendix A2.16 – TISF KOEBERG DETAILED DESIGN DRAWINGS.

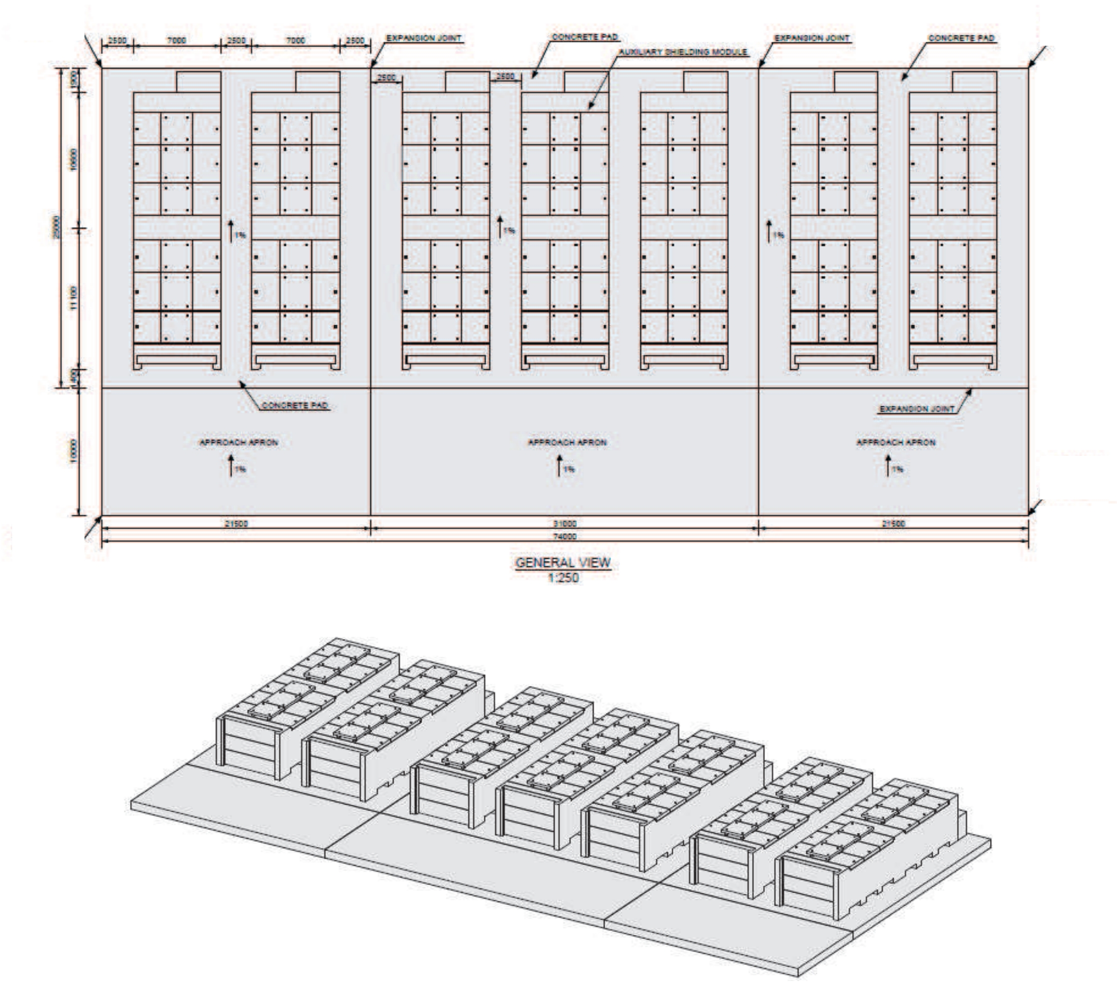
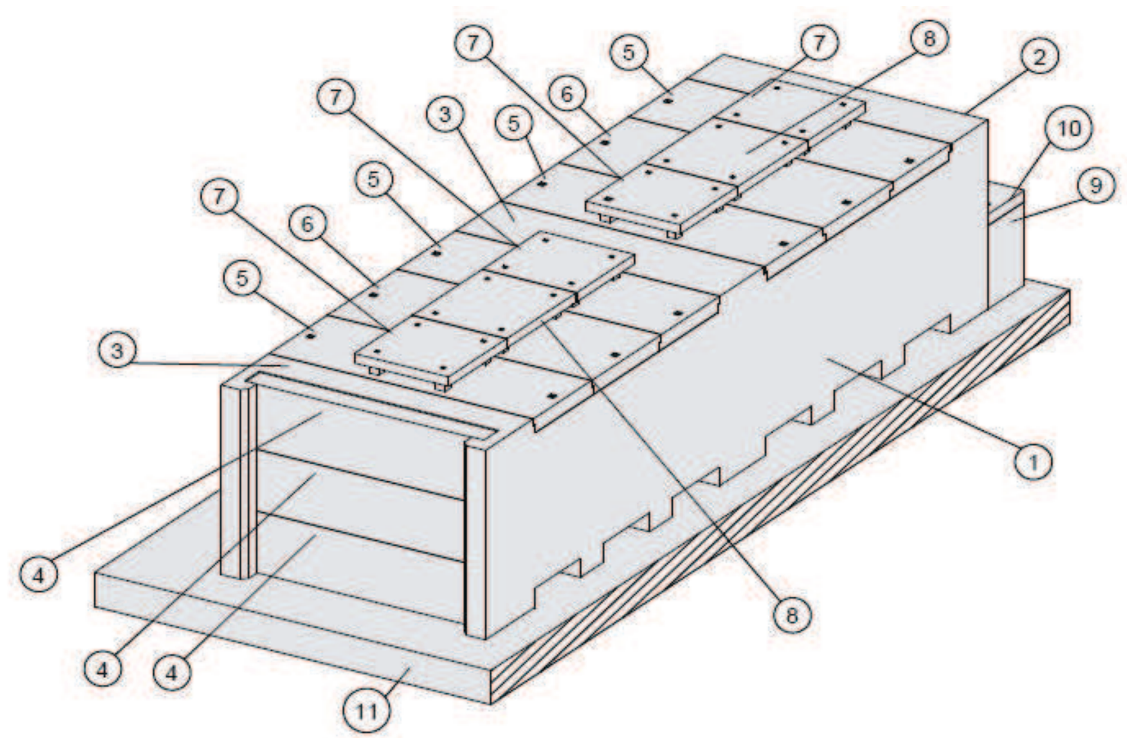


Figure 33: General Dimensions of the Storage Area

The casks will be housed inside 7 reinforced concrete ASMs. Each ASM has the general dimensions of 23.3 m x 7.0 m x 5 m. Lateral walls are designed with a thickness of 0.6 m. The roof is designed with a general thickness of 0.5 m, with auxiliary roof cover of 0.25 m thickness for the outlet vent openings. The spacing between ASMs has been defined as to allow access with the Gantry Crane (see Section 3.8.9) and to allow the construction of the Storage Area in two or three different phases (see Figure 34).



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PART NUMBER AND NAME:

1 - EAST AND WEST WALLS
2 - REAR WALL
3 - ROOF (WALLS)
4 - FRONT SHIELDNG DOOR
5 - ROOF SHIELDING TYPE 1
6 - ROOF SHIELDING TYPE 2
7 - TOP COVER TYPE 1
8 - TOP COVER TYPE 2
9 - INSPECTION OPENING WALLS
10 - INSPECTION OPENING ROOF
11 - CONCRETE PAD

Figure 34: ASM Parts

3.8.3 Approach Aprons

The HI-STAR 100 cask is transported with the Goldhofer (6 axle+4 axle) from the reactor to the TISF area. For the installation of the cask inside the ASM it is necessary to modify the Goldhofer configuration from (6 axle + 4 axle) to 6 axle. To perform this operation, it is necessary to install the Gantry Crane rails in front of the ASM. The main function of the Approach Aprons is to provide an adequate support for this operation.
The Approach Aprons are extended 10 m in front of the Concrete Pads, with a thickness of 0.35 m. The approximate design elevation will be 8.25 mmasl (meters measured above sea level). They will be constructed with a 1 % slope to allow rainwater drainage that will be guided to the existing drainage discharge by the Stormwater Drainage Trapezoidal Channel.

The Approach Aprons can be used as preparation/laydown area if needed.

3.8.4 Drainage System

The rainwater falling on the concrete surface of the TISF is collected in a trapezoidal concrete ditch with a slope of 0.5% arranged at the perimeter of the pad. The pad area is 35x74=2590 m^2. The rainwater falling on the adjacent terrain is also collected in this ditch. The catchment area of the adjacent terrain is overestimated as 2800 m^2 and the runoff coefficient is conservative defined to 1.

Maximum rainfall at the Koeberg Nuclear Power Plant is 200 mm/h according to Technical Requirement Specification.

$$Qr = 200 mm/h \cdot (2590 m^2 + 2800 m^2) = 1078 m^3/h = 300 l/s$$

Manning's equation is used to determine the capacity and the maximum velocity in the ditch:

$$Q_{max} = \frac{J^{1/2} R^{2/3} S}{n}$$

where:
Qmax: Maximum flow rate of ditch.
J: ditch slope.
R: hydraulic radius (R=cross area/wetted perimeter).
n: Manning's coefficient=0.014 for concrete structures.
S: Cross-sectional area.
Maximum recommended water velocity for concrete surfaces is 6 m/s. Manning's equation is evaluated in Table 18 for a trapezoidal ditch with 0.3 m base and 1H:2V side slope.

Table 18: Water Velocity (m/s) – Maximum Flow Rate (l/s)

h(m) \ Slope	0.5%		1.0%		1.5%		2.0%		2.5%		3.0%		3.5%		4.0%		4.5%		5.0%		5.5%	
0.1	0.8	29	1.2	41	1.4	50	1.7	58	1.9	65	2.0	71	2.2	77	2.4	82	2.5	87	2.6	92	2.8	97
0.14	1.0	50	1.4	71	1.7	87	1.9	101	2.2	113	2.4	123	2.6	133	2.8	142	2.9	151	3.1	159	3.2	167
0.18	1.1	76	1.5	108	1.9	132	2.2	153	2.4	171	2.7	187	2.9	202	3.1	216	3.3	229	3.4	241	3.6	253
0.22	1.2	107	1.7	151	2.1	185	2.4	214	2.7	239	2.9	262	3.1	283	3.4	303	3.6	321	3.8	339	3.9	355
0.26	1.3	143	1.8	202	2.2	247	2.6	285	2.9	319	3.1	349	3.4	377	3.6	403	3.8	428	4.0	451	4.2	473
0.3	1.4	183	1.9	259	2.3	317	2.7	366	3.0	409	3.3	448	3.6	484	3.8	518	4.1	549	4.3	579	4.5	607
0.34	1.4	229	2.0	323	2.5	396	2.9	457	3.2	511	3.5	560	3.8	605	4.0	647	4.3	686	4.5	723	4.7	758
0.38	1.5	279	2.1	395	2.6	484	3.0	559	3.4	625	3.7	684	4.0	739	4.2	790	4.5	838	4.7	884	5.0	927
0.42	1.6	336	2.2	475	2.7	581	3.1	671	3.5	751	3.8	822	4.1	888	4.4	950	4.7	1007	5.0	1062	5.2	1113
0.46	1.6	398	2.3	562	2.8	689	3.3	795	3.6	889	4.0	974	4.3	1052	4.6	1125	4.9	1193	5.2	1257	5.4	1319
0.5	1.7	465	2.4	658	2.9	806	3.4	931	3.8	1041	4.1	1140	4.5	1231	4.8	1316	5.1	1396	5.4	1472	5.6	1543

The drainage channel is designed as 2 linear segments with different characteristics, as shown in Figure 35.

The first segment, 74 m of length parallel to the Concrete Pad, has a variable section to give the 0.5% necessary slope to the channel. The section is greater than the minimum design section in all the length, with a minimum section at the start of the channel of 670 mm wide at the bottom and 500 mm deep, and a maximum section at the end of the first linear segment with 300 mm wide at the bottom and 870 mm deep (Figure 36).

The second segment, 46.5m of length, has a constant section equal to the end of the previous segment, and the slope is given by the terrain. This second linear segment includes a local depression area for sampling. The depression consists of a 600 mm length zone with a 200 mm deeper zone for sampling, ensuring at least 200 mm depth in a laminar shallow flow on the channel. The transition from the regular section to the depression is linear over 200 mm giving a total length of the sampling area of 1 m.

The two linear segments are joined by a 73 degree turn of constant section, which allows the re-direction of the drainage channel from the side of the Concrete Pad to the end of the existing drainage system.

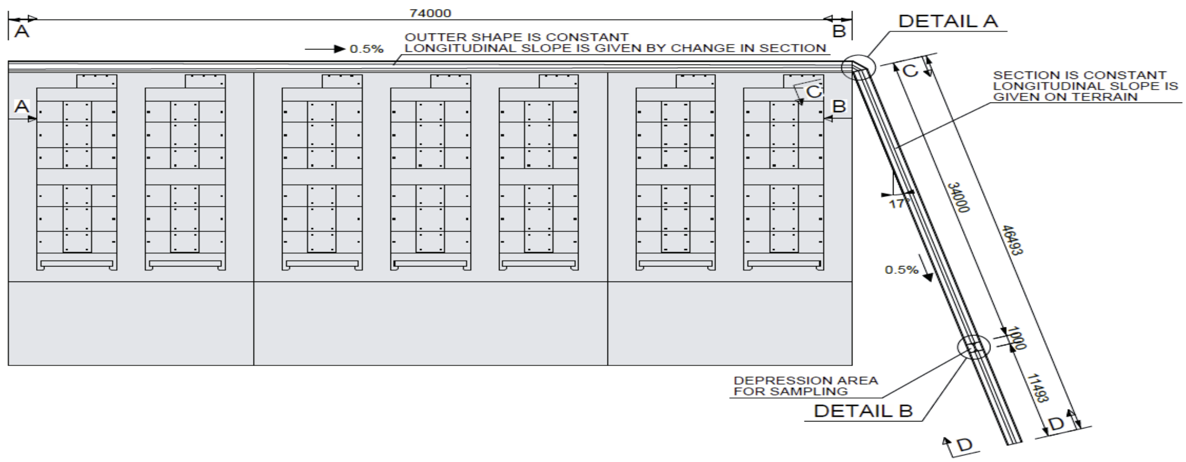

Figure 35: Stormwater Drainage Channel Layout

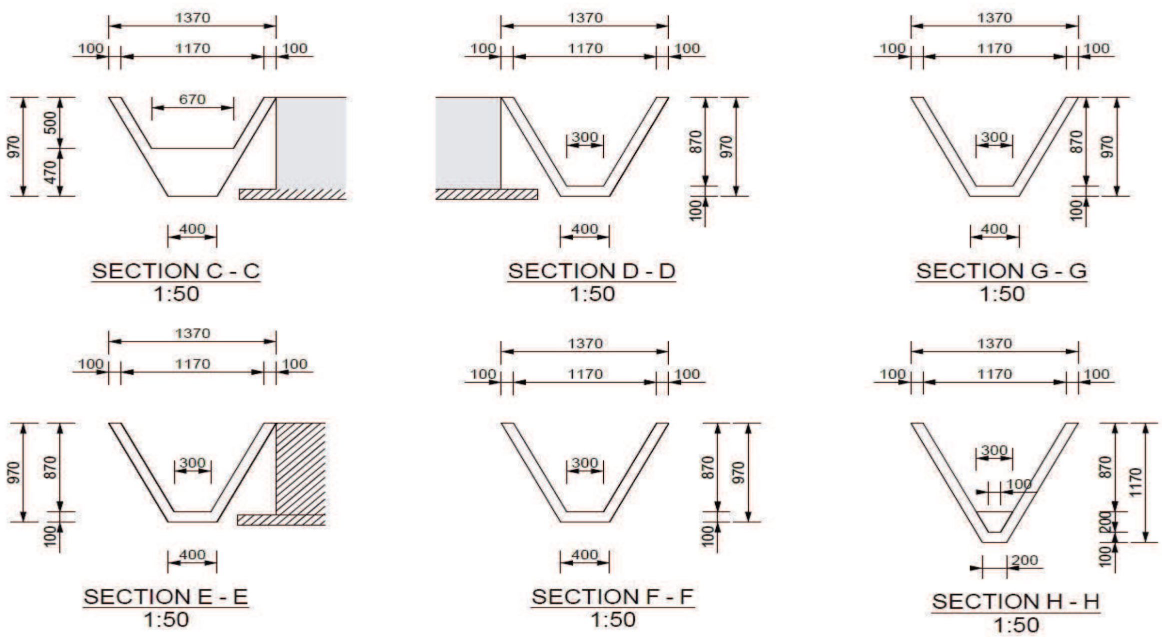

Figure 36: Stormwater Drainage Channel Cross-Sections

The drainage channel includes a local depression area for sampling, as shown in Figure 37. The depression consists of a 600 mm length zone with a 200 mm deeper zone for sampling, ensuring at least 200 mm depth in a laminar shallow flow on the channel. The transition from the regular section to the depression is linear over 200 mm giving a total length of the sampling area of 1 m.

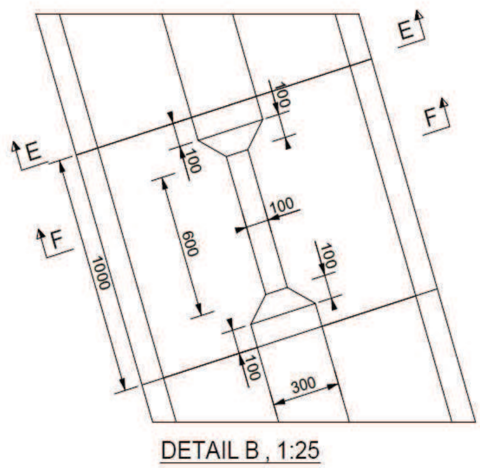

Figure 37: Sampling Trough

3.8.5 IAEA Safeguards

The following IAEA safeguard controls will be established:

- The IAEA will inspect the Koeberg SFPs before and following a cask loading campaign to ensure configuration control in the pools.
- The HI-STAR 100 overpack will be fitted with seals by the IAEA inspector in compliance with the South African Non-Proliferation Agreement Treaty on the Non- Proliferation of Nuclear Weapons and in accordance with the Eskom safeguards procedure.
- The current Design Information Questionnaire (DIQ) will be updated to reflect the progressive placement of HI-STAR 100 casks on the TISF.

The TISF area will be monitored via Security and IAEA cameras to prevent diversion of fissile material and sabotage.

3.8.6 Electrical Design

The complete TISF Electrical design is included in a separate design. Electrical design includes the specifications from RP and Maintenance Groups activities on the plant. The electrical design includes the specifications to comply with required ASMs and external lighting, the IAEA Safeguards design, and the thermal monitoring system. The following sections summarize the main aspects of the TISF Electrical design.

3.8.6.1 ASMs Lighting

Lighting will be designed limiting only to essential activities. The lighting necessary for inspection and maintenance will be installed inside the ASM. The ASM is not a building, so indoor lighting will be designed for outdoor environment with standard/generic lighting for ASM enclosures.

Internal lighting of the ASMs will be powered by an uninterrupted supply, 9 LNF (220 Vac).

3.8.6.2 Outdoor Lighting

External lighting will include 2 High Mast Flood Lights positioned at A and B in Figure 38.

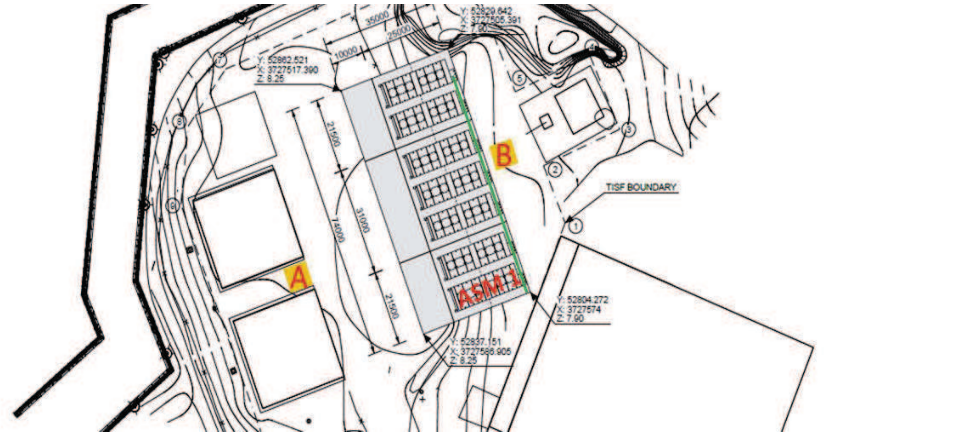

Figure 38: TISF Electrical Concept Design

The characteristics of these High Mast Flood Lights are:

- Standard tapered high mast poles (30 m)
- SPECTRALED 200 W MAGLIGHTS
- 10 lights per mast

3.8.6.3 Thermal Monitoring

Temperature monitoring will be powered by an uninterrupted supply, 9 LNF (220 Vac). Temperature monitoring equipment is formed by:

- Pt100 RTD (Air Probe) Length 150mm, Sheath 6mm with aluminium head. Supplier: Temperature Controls
- Digital Temperature Meter with 1 setpoint / alarm SPCO 220V AC DPM 4003-3004-M. Supplier: Instrotech

The ASM interior temperature will be indicated on a digital display module in the central control cabinet. A set point of 38ºC shall initiate an alarm on the local alarm panel, and in the unit control rooms (use potential free contacts).

The central control cabinet for all 7 x ASMs will be housed / located in ASM1 (ASM1 is indicated in Figure 38).

3.8.7 Fire Protection

According to Section 2.3.6 of the HI-STAR 100 FSAR [72], “there are no combustible or explosive materials associated with the HI-STAR 100 System. No such materials would be stored within an ISFSI”. The ASM is not conceived as a building, it is a shielding module, that could be accessed by personnel but limited to inspection and maintenance tasks. Therefore, fire detection system and extinguishing capabilities are not required as per applicable regulations. However, the TISF Fire Protection design includes defence-in-depth measures as per Eskom requirements.

3.8.8 Haul Route

The TISF Haul Route is the path to be followed by the HI-STAR 100 cask transport equipment from the Reactor Buildings to the TISF. The proposed route is shown in Figure 39, and it is divided into the following parts:

- Part A: From the Reactor Buildings to the CSB. This part of the TISF Haul Route has been previously qualified for the transport of the Castor and the HI-STAR 100 casks and for the transport of the Old Steam Generators.
- Part B: From the CSB to the TISF. This part of the TISF Haul Path has been previously qualified for the transport of the Old Steam Generators.
- Part C: OSGISF Turning Circle. This part of the TISF Haul Route has been previously qualified for the transport of the Old Steam Generators [75].
- Part D: TISF Approach Aprons and Storage Area. Approach Aprons and Storage Area are specifically designed as to withstand the loads from the HI-STAR 100 cask transport and handling equipment as summarized in 3.16.8.

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The figure has been removed as it identifies the TISF location and the haul path between the Fuel Buildings and the TISF.

Figure 39: TISF Haul Route

The Eskom HI-STAR 100 cask haul path qualification, qualifies the existing road between the Fuel Buildings and the Cask Storage Building (Part A) for use as the haul path during the cask transfer process. This report compares the loads imposed on the roadway by the new Cask Transporter, to those imposed by the previously used Cask Transporter and checked these loads against the same criteria. The maximum load per line for the Old Cask Transporter was 17.9 t (183 kN) and the maximum load per line for the New Cask Transporter was 17.1 t.

The Eskom Steam Generator haul path qualification [75] evaluates whether the Steam Generators (SGs) could be safely transported in and around KNPS. The scope of this document was to analyse the effect that the transport of the SGs would have on the roads inside the controlled security area, which begins at ACP2 of KNPS, as well as the sub-soil services beneath the roads that will be utilized (Parts A and B). The maximum load per line for the SGs transport was 29.39 t.

Moreover, the study OSGISF Civil Services Minor Modifications Report [66] evaluates whether the SGs could be safely transported inside the OSGISF (Part C). The scope of this document was, among others, to analyse the effect that the transport of the SGs using the KAMAZ 25 would have on the OSGISF Turning Circle. According to this document, the maximum load per line for the SGs transport using the KAMAZ 25 was 36.0 t. Moreover, the load per line of the KAMAZ 25 is equivalent to the load line of the Goldhofer because both have 8 215/75R 17.5 tires per axle with a separation between axles of 1500 mm. Therefore, the load per line of the KAMAZ 25 can be directly compared to the load per line of the Goldhofer.

The TISF Haul Route and any component crossed along this Haul Route shall be qualified to support the loads applied by the transport of the HI-STAR 100. The HI-STAR 100 will be transported by the

Goldhofer transporter in two different configurations. The Goldhofer dimensions and weight are detailed in Manufacturer's Certificate

- Goldhofer 6+4-axle configuration. This configuration is used from the Reactor Buildings to the Approach Aprons inside the TISF (Parts A, B, C and D):
    - Unloaded trailer mass: 45201 kg.
    - Loaded trailer mass: 177340 kg .
    - Maximum load per line: 17.73 t.
- Goldhofer 6-axle configuration. This configuration is used for the operation of loading the HI- STAR 100 inside the ASM (Parts C and D):
    - Unloaded trailer mass: 31351 kg .
    - Loaded trailer mass: 163490 kg.
    - Maximum load per line: 27.25 t.

Table 19 includes the TISF Haul Route Analysis which summarizes the possible TISF Transport Configurations and compares them with the previously qualified heavy transport configurations at Koeberg. All the TISF Transport Configurations are bounded by the previous qualifications.

Table 19: TISF Haul Route Analysis

	Previously Qualified Transport Configurations (Maximum Load per Line)	**TISF Transport Configurations** (Maximum Load per Line)	**Previously Qualified Transports Bounding for TISF Haul Route**
Part A	Old Cask Transporter (17.9 t) New Cask Transporter (17.1 t)	Goldhofer 6+4-axle configuration (17.73 t)	YES
Part B	OSG Kamag 25 Transporter (29.39 t)	Goldhofer 6+4-axle configuration (17.73 t)	YES
Part C	OSG Kamag 25 Transporter (36 t)	Goldhofer 6+4-axle configuration (17.73 t)	YES
		Goldhofer 4-axle configuration (27.25 t)	

3.8.9 Operations

3.8.9.1 Procedure for Loading the HI-STAR 100 System in the Spent Fuel Pool

As per section 8.1 of the HI-STAR 100 FSAR [72] or Eskom specific procedures prepared for previous loadings performed at Koeberg.

3.8.9.2 TISF Operations

The TISF operations will be conducted using the Goldhofer and the Gantry Crane. Two types of operations can be conducted on the TISF, i.e., placing and removing HI-STAR 100 casks from the storage pad.
The conceptual procedure is explained in this Section including conceptual 3D models and 2D drawings developed with the graphical information for the Goldhofer, Gantry Crane and HI-STAR 100 cask included in the drawings for the transport combination, layout and lifting plan prepared by Vanguard for the CSB.

The intention of these drawings is to define the equipment position during operations and geometry compatibility for the proposed procedures. However, specific and detailed procedures shall be prepared for these operations and included in the project Implementation safety case for approval by both Eskom and the NNR.

The loading procedure of the storage pad is designed as follows:

Step 1 - The Gantry Crane is installed in front of the ASM to be loaded. The rails shall be installed as to allow Step 2 to be developed with the Gantry Crane loading acting on the Approach Apron (Figure 40).

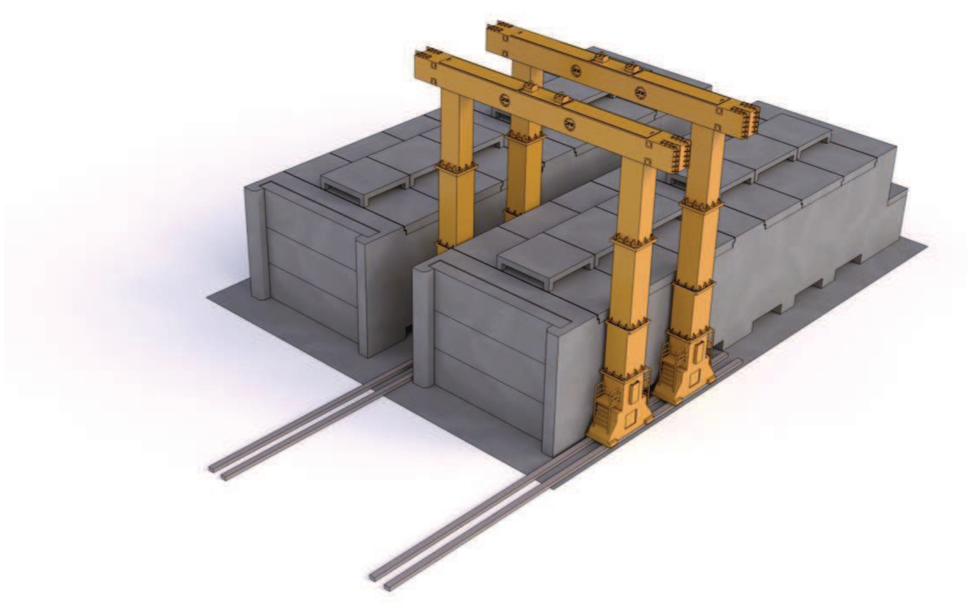

Figure 40: Loading Procedure at TISF – Step 1 (Conceptual 3D View)

Step 2 - The Goldhofer with 10-axle configuration (6 axle + 4 axle) enters the Approach Apron and it is located in front of the ASM with its longitudinal axis parallel to the longitudinal axis of the ASM (Figure 41 and Figure 42). The cask bottom enters always first in the ASM.

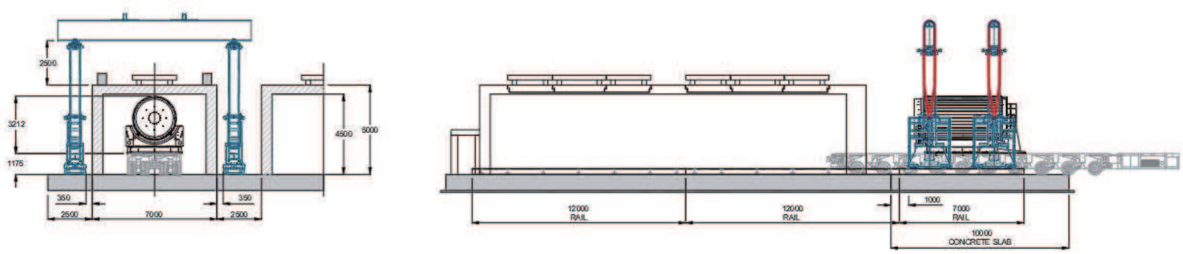

Figure 41: Loading Procedure at TISF – Step 2 (2D Drawing with Equipment)

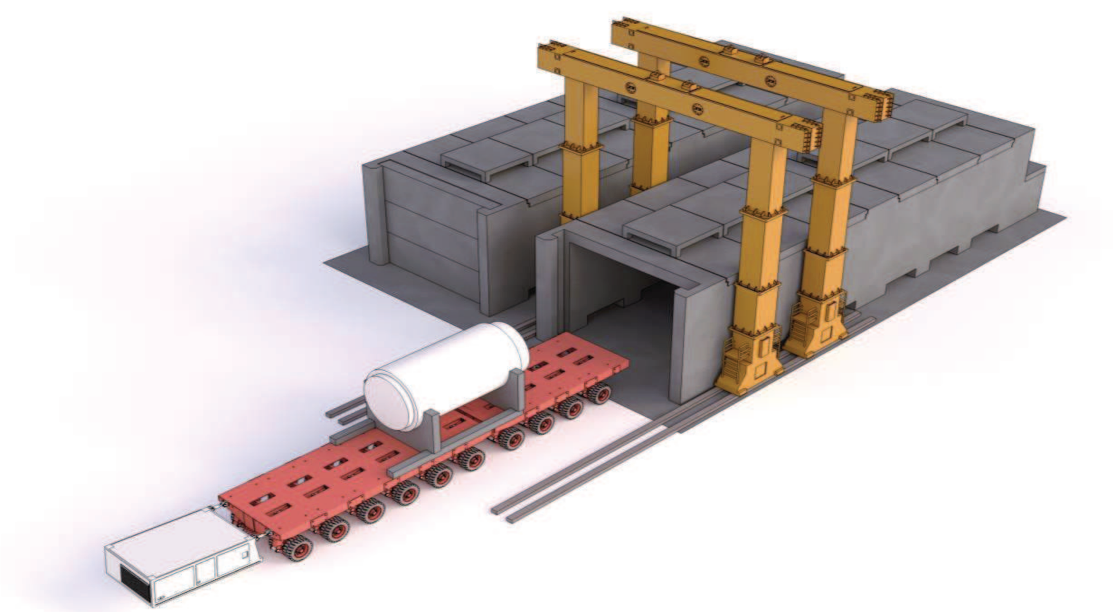

Figure 42: Loading Procedure at TISF – Step 2 (3D Conceptual Drawing)

Step 3 - In order to allow the entrance of the Goldhofer inside the ASM, it is necessary to transfer the HI-STAR 100 to the 6-axle Goldhofer configuration by detaching the 4-axle Goldhofer. For this purpose, the Gantry Crane will be used as to support the HI-STAR 100 in its position, while the Goldhofer is displaced below until the HI-STAR 100 cask is correctly positioned over the 6-axle Goldhofer. Then, the 4-axle Goldhofer can be retired (Figure 43 and Figure 44).

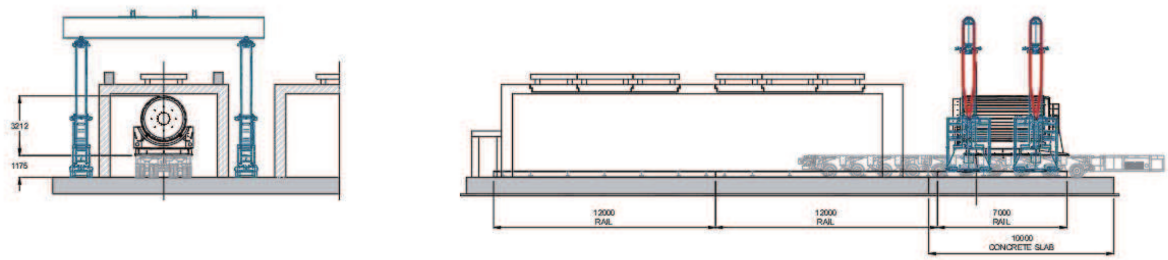

Figure 43: Loading Procedure at TISF – Step 3 (2D Drawing with Equipment)

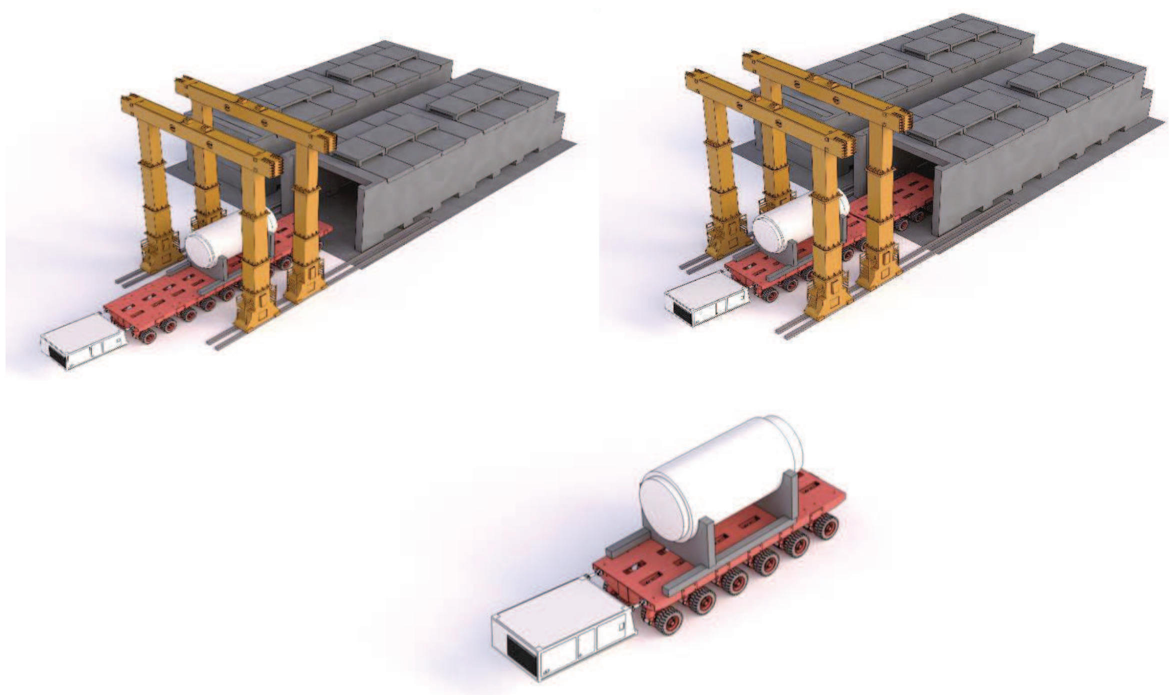

Figure 44: Loading Procedure at TISF – Step 3 (3D Conceptual Model)

Step 4 - The ASM entrance cover shall be removed with the Gantry Crane to an adequate transport or other auxiliary equipment and placed temporarily in available area in the turning circle. The top covers of the ASM shall be removed with the Gantry Crane and placed temporarily over the other top covers by using concrete blocks as supports. Figure 45 shows the position of the top covers placed temporarily over the other top covers (concrete blocks included in Figure 46). The lifting of the top covers is conducted using the Gantry Crane through the four lifting embedments installed in each of the top covers shown in Figure 54.

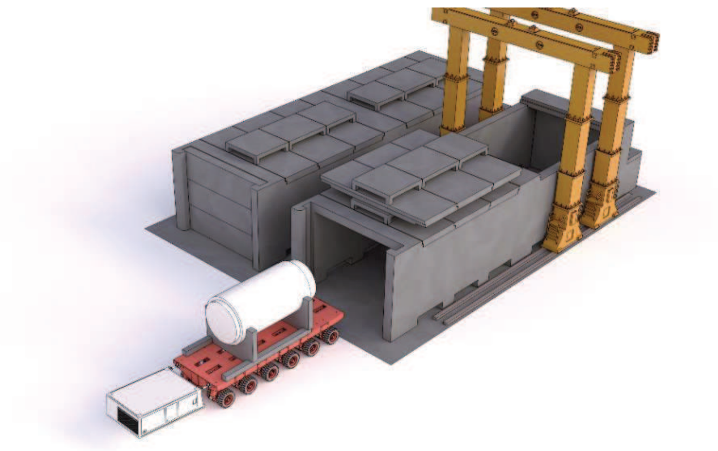

Figure 45: Loading Procedure at TISF – Step 4 (3D Conceptual Model)

Step 5 - The 6-axle Goldhofer loaded with the HI-STAR 100 will enter inside the ASM to its final position. The Gantry Crane will be used to support the HI-STAR 100 and then the Goldhofer will retire and the HI-STAR 100 will be lowered to its final position inside the ASM (Figure 46 and Figure 47).

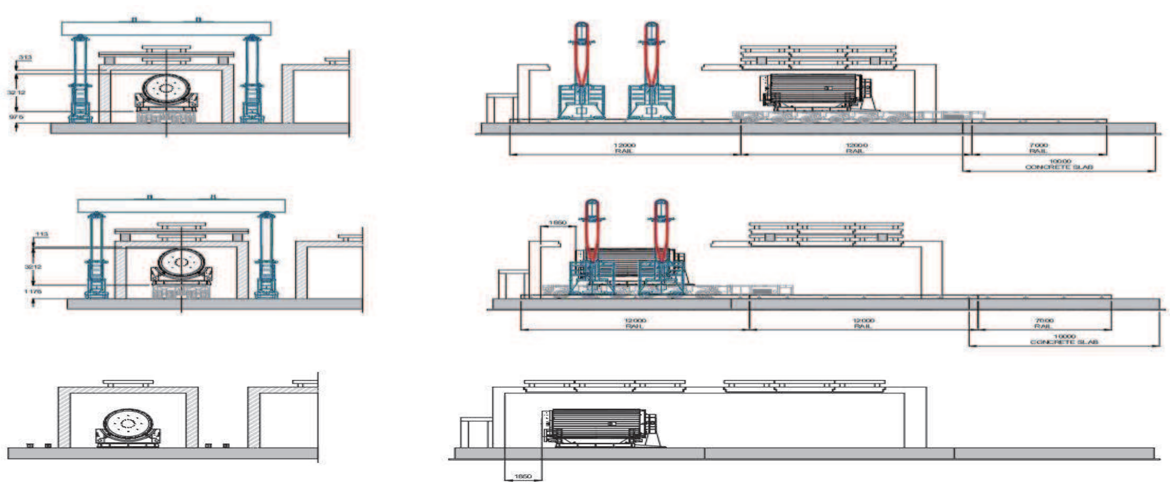

Figure 46: Loading Procedure at TISF – Step 5 (2D Drawing with Equipment)

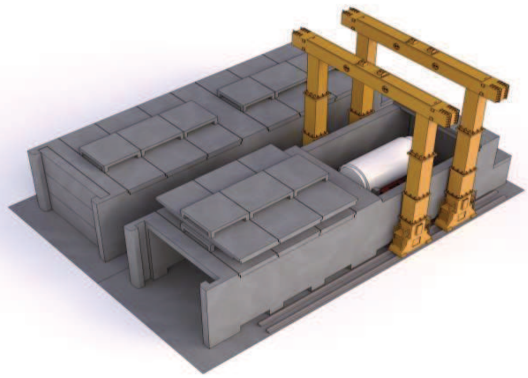

Figure 47: Loading Procedure at TISF – Step 5 (3D Conceptual Model)

Step 6 - The same procedure applies to the loading of the other HI-STAR 100 inside the ASM (Figure 48).

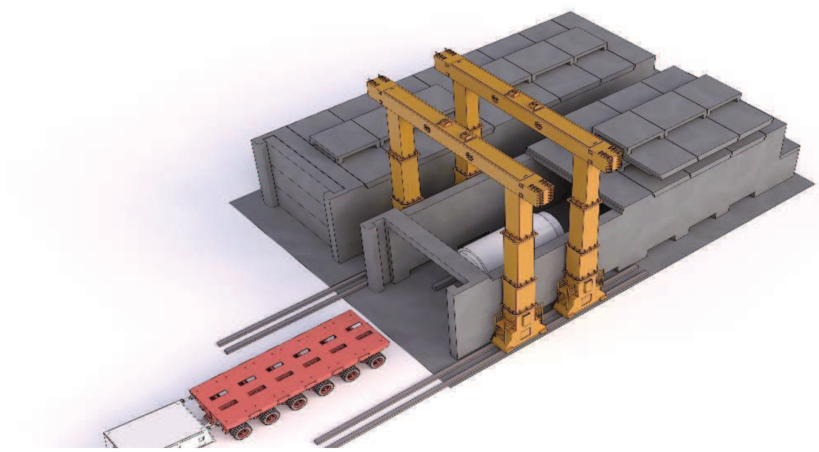

Figure 48: Loading Procedure at TISF – Step 6 (3D Conceptual Model)

3.8.9.3 Procedure for Unloading the HI-STAR 100 System in the Spent Fuel Pool

As per section 8.1 of the HI-STAR 100 FSAR [72] or Eskom specific procedures prepared for previous loadings performed at Koeberg.

3.8.9.4 Placement of the HI-STAR 100 System into Storage Directly from Transport

The HI-STAR 100 casks shall be transferred from the Fuel Building to the TISF on the Goldhofer to enter in the Approach Aprons.
The procedures for placing the HI-STAR 100 casks onto the storage pad directly from transporter are as stated in Section 3.8.9.2.

3.8.10 Waste Management

In accordance with the EIA [65] it is necessary to develop a waste management plan, laying out:

- Expected type and amount of waste.
- Measures to reduce waste.
- Type and expected volume of recyclable waste.
- Recycling facilities that will collect/receive waste.
- Type of storage for different waste types.
- Waste contractors that will collect waste.

It is not expected to generate waste during the operation of the TISF. The following Waste Management Plan (WMP) (see Table 20) is developed for all the waste expected during the decommissioning of the TISF.

Table 20: Waste Management Plan for Decommissioning

Waste Type	Expected amount of waste	Measure to reduce the amount of waste	Type of storage	Responsible Party
HI-STAR 100 casks (see §3.8.11)	14 casks x 114 t = 1596 t	The amount of waste cannot be reduced as recycling is not possible.	Disposal	Eskom and the depository
Concrete from storage pads, ASMs and Approach Aprons	3912 m^3	Recycling of the concrete will form part of the decommissioning strategy. Responsible disposal will only be considered as a last resort.	Recycling or responsible disposal	Decommissioning contractor
Reinforcement steel and steel anchors and embedments	954981 kg	Recycling of the steel will form part of the decommissioning strategy.	Recycling	Decommissioning contractor
Engineered fill	To be determined	The in-situ material will be used under the Concrete Pad and Approach Aprons. Only external material will be included in the design to replace the disturbed material from the OSGISF turning circle	Retire in-situ	Eskom

3.8.11 Decommissioning

Subsequent to the plant shutting down, spent fuel from the core will be left in the SFPs for a period sufficient for cooling, depending on the dry storage technology to be employed.
In line with the Koeberg decommissioning strategy, 240-123880544, Revision 2: Decommissioning Strategy for Koeberg Nuclear Power Station - Alternative Reference Number: EYB-643 [60], following the removal of spent fuel and casks from the Koeberg site, the TISF and the CSB, will be demolished accordingly. It can be expected that the buildings will not be contaminated and therefore will be demolished under Phase 6a for non-contaminated structures.

3.9 Operational Requirements and Changes

3.9.1 Loading and Unloading Procedures at TISF

Specific and detail procedures shall be prepared for the loading operations at the TISF including:

- Transferring the loaded cask to the transport vehicle.
- Transporting the cask to the TISF.
- Placing the cask in the TISF.

For retrieving spent fuel from a loaded cask in the TISF and returning it to the Spent Fuel Pool specific and detail procedures shall be prepared, including:

- Retrieving of the cask from the TISF.
- Transporting the cask from the TISF to the Reactor Building.

It will be necessary to replicate the actual evolution to accomplish the following overall goals:

- Demonstrate the functionality of all equipment.
- Test and refine the procedures used for loading and unloading activities.
- Train and rehearse licensee personnel before actual movement of spent fuel.

3.9.2 Air Vents Monitoring

The air vent blockage accident shall be mitigated to prevent overheating of the spent fuel casks. During normal operations regularly scheduled operator walkdowns could identify any air vent blockages. Additionally, a thermal monitoring program based on dual thermocouple locations will be used.

As operating experience, according to CoC 1029 Renewal Application for the Standarized Advanced NUHOMS System [106], thermal monitoring or visual inspections are used to provide indication of HSM performance or a blocked vent condition.

The HI-STAR 100 requires that the ambient temperature during storage be less than 38 °C [119], so the ambient temperature within the ASMs will be monitored to ensure that this requirement is satisfied.

3.10 Maintenance Requirements and Changes

3.10.1 Civil Inspections

The civil inspection programme (240-166149425 [61]) will be updated to incorporate the required inspections and monitoring of the TISF. Guidelines based on applicable regulations are included in §3.15.2

3.10.2 Radiological Maintenance and Monitoring

Direct radiation measurements shall be verified by the environmental program to verify compliance with the dose limits in 10 CFR 72.104 (the annual dose equivalent to any real individual who is located beyond the TISF controlled area must not exceed 0.25 mSv).

In addition, the radiological controls established in the controlled zone inside the TISF must be carried out to ensure compliance with RD-0022, which includes radiation workers being continuously monitored for dose exposure using electronic personnel dosimetry and thermo-luminescent dosimeters while working at the TISF.

3.11 Nuclear Safety

Nuclear Safety has been considered during the design process:

- Components/Structures Classification is defined in Section 3.11.1.
- Classification of Equipment is defined in Section 3.11.2.
- Outcome from the Safety Screening is summarised in Section 3.11.3.
- The outcome of the Safety Screening concluded that a Safety Evaluation was required, and the outcome of the Safety Evaluation is, therefore, summarised in Section 3.11.4.

The TISF will be constructed in a modular manner as described in Section 4.6.2. The construction activities include:

- Bulk Earthworks of the entire Cask Storage Area
- Construction of Concrete and Approach Apron Pads .
- Execution of off-site precast components of the ASMs.
- Construction of the ASMs within the Concrete Pads.

Loading of a minimum of four (4) HI-STAR 100 casks from Unit 2 before Outage 227.

Construction activities will be paused during the HI-STAR 100 cask loading campaign and the necessary measures will be established to ensure safe movement of the casks.

Nuclear Safety during construction has been considered as follows:

- The only SSCs that could be potentially affected by the construction activities are the OSGISF and CSB, because the location of the TISF is separate from that of the plant, but in the vicinity of the CSB and the OSGISF. The interfaces with the existing plant during construction are described in Section 4.4.

- The Risk Assessment during construction will be included in the Eskom Safety Case for NNR Approval prior to construction activities. The risk Assessment will consider the potential risks regarding fires, explosions, design basis hazard events and falling objects. This assessment must demonstrate that the potential risks do not prevent the performance of the functions of the HI-STAR 100 cask/s already loaded at the TISF or must specify the compensatory measures necessary to mitigate those risks.

- The use of ALARA principle will be considered to prevent unnecessary dose exposure during construction.

- Availability of a Turning Circle to allow manoeuvring of the HI-STAR 100 casks transport equipment. The availability of the OSGISF Turning Circle is the same as discussed in Section 4.4

- Evaluation of the Haul Path to ensure safe movement of the casks.

- The use of ALARA principle will be considered to prevent unnecessary dose exposure during construction of the remaining ASMs when the first four loaded HI-STAR 100 casks are placed inside the ASMs.

3.11.1 Components/Structures Classification

3.11.1.1 Storage Area Classification

The Storage Area includes the Concrete Pad and the ASMs. The Storage Area classification is detailed below.

Storage Area Safety Classification: LS

Since the Storage Area has a direct effect on a safety related system, i.e., the spent fuel casks, the Storage Area is classified as being linked to safety.

Storage Area Importance Classification: SR

The importance category of this modification is SR (safety related) according to KSA-010 [33] because the Storage Area is formed by the Concrete Pad and the ASM, which are non-fluid retaining SSCs required to store spent fuel.

Storage Area Seismic Classification: ND

The Storage Area is required to guarantee retrievability of the casks before, during and following a seismic event. Therefore, it is classified as Non-Destruct (ND).

Storage Area Quality Classification: Q2

Due to the Storage Area being SR and ND, the construction should include a detailed quality control plan in accordance with ISO 9001. Hence, the Storage Area is classified as Q2.

Storage Area Safety Level: L2

Since the Storage Area is classified as SR and Q2, it is therefore classified safety level L2 in accordance with RD-0034.

Storage Area Environmental Classification: 0

The Storage Area is not in or part of containment; neither any part of it be affected by primary coolant or steam. Therefore, it is classified 0.

Storage Area Design Extension Conditions:

The Storage Area is designed as to withstand the effects of DEC for seismic, flooding, tornadoes and winds guaranteeing retrievability of the spent fuel casks before, during and after these events.

3.11.1.2 Approach Aprons Classification

The Approach Aprons classification is detailed below:

Approach Aprons Safety Classification: NSF

Since the Approach Aprons are not pressure-retaining and they have no direct effect on a safety related system, the Approach Aprons are classified as being NSF.

Approach Aprons Seismic Classification: NC

The Approach Aprons are not required to guarantee retrievability of the casks before, during and following a seismic event. Therefore, it is classified as NC.

Approach Aprons Quality Classification: Q3

Due to the Approach Aprons being NSF and NC, the Approach Aprons are classified as Q3.

Approach Aprons Safety Level: L3

Since the Approach Aprons are classified as NSF and Q3, it is therefore classified safety level L3 in accordance with RD-0034.

Approach Aprons Environmental Classification: 0

The Approach Aprons are not in or part of containment; neither any part of it be affected by primary coolant or steam. Therefore, they are classified 0.

3.11.2 Classification of Equipment

3.11.2.1 Mechanical Equipment

There is no mechanical equipment.

3.11.2.2 Electrical Equipment

Electrical Equipment Safety Classification: NSF

The electrical equipment is classified as NSF because the electrical equipment included in the TISF does not perform a function that initiates an emergency reactor shutdown, and/or containment isolation, and/or essential to protect against adverse reactor core temperature conditions, and/or containment and reactor heat removal, and/or are essential in preventing significant release of radioactive material to the environment.

Electrical Equipment Quality Classification: Q3

The electrical equipment is classified as Q3; final inspection and test are sufficient.

Electrical Equipment Safety Level: L3

Since the electrical equipment is classified as NSF, the safety level is L3.

Environmental Classification: 0

The Electrical Equipment is not in or part of containment; neither any part of it be affected by primary coolant or steam. Therefore, it is classified 0.

3.11.3 Safety Screening

Based on the Safety Screening (No: S2023-0056) performed in accordance with KAA-709 [36], this modification requires a Safety Evaluation and NNR approval based on the following:

- Section 4.2 Does the proposed activity or condition involve a change to an SSC that affects the design as described in the SAR and DSE?

  Yes, the addition of the spent fuel cask storage pad with ASMs in the TISF must be described in the NIL-01 SAR. The ASMs will be constructed modularly in two phases.

- Section 4.3 Does the proposed activity or condition involve a change to a procedure that affects how design base (SAR and DSE described) SSC design functions are performed or controlled?

  Yes, the procedures to move the casks onto the TISF and placement in the ASMs have to be developed based on the approved analyses included in the TISF storage pad detailed design once the detailed design has been fully approved.

- Section 4.4 Does the proposed activity or condition involve revising or replacing an SAR described evaluation methodology that is used in establishing the design bases or used in the safety analysis?

  Yes, the computer code used for radiation shielding calculations (SCALE MAVRIC) is different from the code that was previously used (MCNP) for dose calculations for the HI-STAR 100 storage casks in the SAR. The computer code used for seismic analysis, P-CARES, is not in the SAR.

- Section 5.6 Will or could the activity or condition introduce a new common-cause failure?

  Yes, the design of the air openings in the ASM modules makes them vulnerable to blockage, for example from debris deposited by flooding or tsunami. This could potentially disrupt air cooling to all the casks that are stored in all the ASMs in the TISF.

- Section 7.2 Is the activity or condition a change to a document that needs NNR approval?

  Yes.

- Section 7.3 Is the activity or condition a modification that requires approval according to the requirements of LD-1012?

  Yes.

3.11.4 Safety Evaluation

The outcome of the Safety Evaluation (No: E2023-0001) is summarised as follows:

- No Safety Justification required.
- SAR change is required.
- No OTS, KCS or SRSM change required.
- No SAMG or EP change required.
- No EOP change required.
- Activity or condition needs NNR approval.

3.12 Conventional Safety

The design changes due to the modification does not introduce any new hazardous location (Hazloc) areas nor involve changes to existing Hazloc classified areas, therefore there is no Hazloc impact. The design changes further do not introduce new risks to personnel or plant integrity during Operating mode and Maintenance.

The construction activities to be developed are those established for typical reinforced concrete civil works (earthworks, formwork activities, steel fixing, using of power tools, scaffolding erection & dismantling, placing concrete, crane lifting activities, laboratory activities), and the Risk Assessments for each task to be performed will be prepared and submitted by WBHO including the identification of the hazards linked to each task of the Construction Process.

3.13 Selection of Equipment

3.13.1 Reinforced Concrete

Characteristics of the TISF pad are specified in Table 2.2.9 of the HI-STAR 100 FSAR [72] shown in Figure 49. It provides two examples of acceptable ISFSI pad design parameters: Parameter Set A for ISFSI pads up to 0.9 m thick and Parameter Set B for ISFSI pads up to 0.7 m thick.

PARAMETER	PARAMETER SET 'A'[†]	PARAMETER SET 'B'
Concrete thickness, t_p	≤ 36 inches (90 cm)	≤ 28 inches (70 cm)
Concrete Compressive Strength (at 28 days), f_c'	≤ 4,200 psi (29 MPa)	≤ 6,000 psi (40 MPa)
Reinforcement Top and Bottom (both directions)	Reinforcing bar shall be 60 ksi (410 MPa) yield strength ASTM material	Reinforcing bar shall be 60 ksi (410 MPa) yield strength ASTM material
Subgrade Effective Modulus of Elasticity[††] (measured prior to ISFSI pad installation), E	≤ 28,000 psi (190 MPa)	≤ 16,000 psi (110 MPa)

Figure 49: Examples of Acceptable ISFSI Pad Design Parameters

According to Section 2.2.3.2 of the HI-STAR 100 FSAR users may design their ISFSI pads in compliance with either parameter Set A or Set B. Alternatively, users may design their site-specific ISFSI pad and subgrade using any combination of design parameters that result in a structurally competent pad that meets the provisions of ACI 318 and also limits the deceleration of the cask to less than or equal to 60 g's for the design basis drop and tipover events. The structural analysis for site- specific ISFSI pad design shall be performed using methodologies consistent with those described in the HI-STAR 100 FSAR.

The acceptance criteria for the tipover and side drops is to achieve a deceleration less than 60g's.

It is shown in Appendix 3.A that the peak deceleration is less than 60g's for tip-over. Table 3.A.3 shows that the maximum deceleration level at the top of the cask is 66.0 g's, while the corresponding deceleration level at the top of the fuel basket is 59.8 g's. For the case of a vertical drop from a height of 21" (533 mm), the bounding longitudinal deceleration is 52.3 g's. Finally, for a side drop from a height of 72" (1,829 mm), the maximum deceleration is 49.7 g's. Based on the above results, it is concluded that the design basis deceleration limit of 60g's (Table 3.1.2) provides a conservative input for Level D stress calculations to demonstrate retrievability of stored fuel.

As per the previous paragraph extracted from the HI-STAR 100 FSAR, the limiting assessment for the generic FSAR is the tipover analysis. However, according to section 2.2.3.2 of the HI-STAR 100 FSAR, a tip-over analysis of a loaded HI-STAR 100 overpack stored on an ISFSI (or TISF in this case) pad in the horizontal orientation is not required because the side drop evaluation bounds this accident. A vertical tip-over accident is not credible for horizontally storage casks.

The side drop evaluation, which is the limiting condition for the horizontally stored HI-STAR 100, results in a maximum deceleration of 49.7 g's. Therefore, a margin of 10.3g's is available to determine the site-specific parameters for Koeberg.

Appendix A2.5 – SIDE DROP ANALYSIS includes the site-specific evaluation for the side drop to determine the upper bound for the concrete compressive strength (see Table 21).

Table 21: Concrete Pad Concrete Compressive Strength Upper Limit

	FSAR HI-STAR 100 (60g's for VERTICAL TIPOVER with 193 MPa for subgrade conditions)	**APPENDIX A2.5 SIDE DROP ANALYSIS** (60g's for 72" (1,829 mm) SIDE DROP with 193 MPa for subgrade conditions)	**CSB UPPER LIMIT**
Limit for Cylinder Concrete Compressive Strength	29 MPa	47 MPa	-
Limit for Cube Concrete Compressive Strength	34.8 MPa	56.4 MPa	51.7 MPa

Cylinder Concrete Compressive Strengths are included for keep traceability with the values included in the HI-STAR 100 FSAR.

According to the results obtained, the concrete mix for the storage pad will be designed as to comply with the upper limit based on the operational experience from the CSB, i.e., 51.7 MPa in cubic compressive strength at 28 days.

The concrete mix for the storage pad will be designed as to comply with the lower limit based on the structural calculations included in Appendix A2.3 – STRUCTURAL CALCULATIONS, which is 30 MPa in cubic compressive strength at 28 days.

The shielding analysis is conducted based on a concrete density of 2.2994 t/m^3. This density can typically be achieved with standard concrete mixtures without the need for special measures. Nevertheless, it is imperative to validate that the concrete mix design meets this requirement and to ensure, during construction, that the actual concrete density adheres to this minimum value to maintain the validity of the shielding analyses. Therefore, a density test, in accordance with SANS 6251:2006 Concrete tests - Density of hardened concrete, is necessary to confirm the suitability of the concrete mix design prior to construction, ensuring compliance with the shielding requirements. Additional density tests will also be included in the respective Quality Control Plans (QCP/ITP) to verify that the actual concrete density meets this minimum value during construction.

The structural analysis, on the other hand, is based on a concrete density of 2.5 t/m^3, which is a standard practice in structural calculations for determining the self-weight of reinforced concrete structures. The load factors utilized for self-weight in various load combinations account for potential variations in density values, hence it is not customary to require verification during construction. Nevertheless, it can be readily confirmed that the concrete density obtained from the aforementioned tests remains below 2.5 t/m^3.

Additionally, other concrete specifications for the specific marine environment at Koeberg are defined based on Eurocode 2 requirements. First of all, it is necessary to define the environment exposure classes shown in Figure 50:

- The environment exposure class for durability is XC4 (Carbonation – Cyclic wet & dry, concrete subject to water contact).
- The environment exposure class for attack is XS1 (Sea water – Airborne salts not in direct contact with sea water (structures near to or on the coast).

2 Corrosion induced by carbonation		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2

4 Corrosion induced by chlorides from sea water		
XS1	Exposed to airborne salt but not in direct contact with sea water	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spray zones	Parts of marine structures

Figure 50: Exposure Classes Related to Environmental Conditions in Accordance with EN 206- 1, Applied for Koeberg Marine Environment

According to EN 206-1, requirements for the concrete to withstand the environmental actions are given either in terms of limiting values for concrete composition and established concrete properties, or the requirements may be derived from performance-related design methods.

For exposure class XC4+XS1, the following requirements are applicable for durability:

- Minimum concrete compressive strength (see Figure 51). C30/37 -> 37 MPa in cubic compressive strength at 28 days.
- Minimum cover: 45 mm.
- Maximum w/c ratio (Figure 52): 0.5.
- Minimum content of cement (kg/m^3) (see Figure 52): 300.
- Maximum water penetration depth (UNE-EN 12390-8): 50 mm.
- Average water penetration depth (UNE-EN 12390-8): 30 mm.
- CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash.

Table 43.2.1.b Minimum desired characteristic strength of the concrete(*)

Dosing parameter	Concrete type	Exposure class																				
		XC0	XC1	XC2	XC3	XC4	XS1	XS2	XS3	XD1	XD2	XD3	XF1	XF2	XF3	XF4	XA1	XA2	XA3	XM1	XM2	XM3
Characteristic strength (N/mm^2)	Mass	20	-	-	-	-	-	-	-	-	-	-	30	30	30	30	30	30	35	30	30	30
	Reinforced	25	25	25	30	30	30	30	35	30	30	30	30	30	30	30	30	30	35	30	30	30
	Prestressed	25	25	25	30	30	30	35	35	35	35	35	30	30	30	30	30	35	35	30	30	30

Figure 51: Minimum Desired Characteristic Strength of the Concrete in Accordance with EN 206-1

Table 43.2.1a Minimum cement content and maximum water/cement ratio

Dosing parameter	Concrete type	Exposure class																				
		X0	XC1	XC2	XC3	XC4	XS1	XS2	XS3	XD1	XD2	XD3	XF1	XF2	XF3	XF4	XA1	XA2	XA3	XM1	XM2	XM3
Maximum water/cement ratio	Mass	0.65	-	-	-	-	-	-	-	-	-	-	0.55	0.50	0.55	0.50	0.50	0.50	0.45	0.50	0.50	0.50
	Reinforced	0.65	0.60	0.60	0.55	0.55	0.50	0.50	0.45	0.50	0.50	0.50	0.55	0.50	0.55	0.50	0.50	0.50	0.45	0.50	0.50	0.50
	Prestressed	0.60	0.60	0.60	0.55	0.55	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.50	0.45	0.50	0.50	0.45	0.45	0.50	0.50	0.50
Minimum cement content (kg/m^3)	Mass	200	-	-	-	-	-	-	-	-	-	-	275	300	275	300	275	300	325	300	300	300
	Reinforced	250	275	275	300	300	300	325	350	325	325	325	300	325	300	325	325	350	350	325	325	325
	Prestressed	275	300	300	300	300	300	325	350	325	325	325	300	325	300	325	325	350	350	325	325	325

Figure 52: Minimum Cement Content and Maximum Water/Cement Ratio in Accordance with EN 206-1

Since in this case there is an upper bound for concrete compressive strength, it is considered that it is more important to comply with the upper bound limit than requiring the concrete compressive strength as per durability Eurocode 2 requirements, since final concrete compressive strength is usually over the required limits. Concrete mix suppliers are used to design concrete mixes as to comply with a lower limit, but it is not that usual to require to comply with an upper bound limit. So it is decided to increase the required minimum cover to 60 mm, as per the worst environment in SANS 10100-1 [51].

3.13.2 Engineering Fill

The engineered fill (see Figure 53) shall comply with the maximum Young Modulus of 193 MPa.

According to the Geotechnical Investigation for the proposed Koeberg 400 kV Gas Insulated Substation, the sands have a low to moderate maximum dry density and high to very high optimum moisture content value. The CBR swell value is very low. The material is classified as G8 or G9 according to the TRH 14 guidelines (National Institute for Transport and Road Research, 1987) and considered to be suitable for the construction of selected or subgrade layer material and moderate to low stiffness engineered fills.

According to JN745-NSE-ESKB-L-7531 Rev 1 – EXCAVATION OF MATERIAL BELOW EXISTING CSB FLOOR , "The existing floor slab is underlain by subgrade material which comprises a fine-grained sand which has similar grading characteristics to the materials tested outside the building. This implies that the subgrade material is either compacted in situ sand or may be selected fill material imported into the CSB Cask area from outside the building".

"The general subgrade beneath the site is of fair quality, being in the estimated range G8 to G9. Therefore, as a general indication, the recommended treatment of the subgrade is to carry out a nominal rip, wet, and recompact procedure. A minimum compaction of 95% MDD is recommended. Backfilled layers should not be thicker than 150mm before compaction. Provided this is carried out a CBR of the order of 12 can be expected".

Both studies are consistent with the Geotechnical Report for the TISF area [74]. Using the in-situ material gives confidence on complying the Young Modulus upper limit, since the existing soil does not exceed 193 MPa even in very dense layers (E = 35-55 MPa). Additionally, according to Table 13 of NUREG/CR-6608, Young Modulus for sand soils can vary between 6.9 and 83 MPa, so compliance with the upper limit is also guaranteed based on this reference.

According to the bearing pressure results included in Appendix A2.3 – STRUCTURAL CALCULATIONS, the maximum pressure is 60.8 kPa. The N_{SPT} values obtained for the TISF area [74] ranges between 20 and 50, approximately. Using the Meyerhof equation that correlates N_{SPT} results with admissible service pressure, the existent soils have an admissible service pressure between 80 kPa and 200 kPa. Since the service pressure is 60.8 kPa, the existent in-situ soil is considered as appropriate. The engineered fill will be recompacted following the same recommendations as in the CSB:

- A minimum compaction of 95% MDD.
- Backfilled layers should not be thicker than 150mm before compaction.

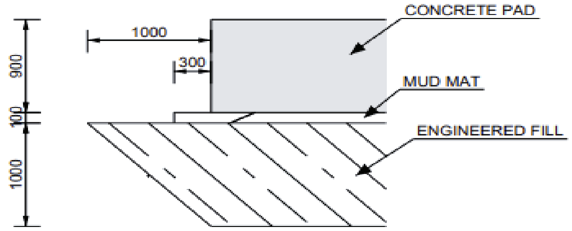

Figure 53: Concrete Pad, Mud Mat and Engineered Fill Thickness

3.13.3 Anchors

The ASM to be constructed in the TISF is a reinforced concrete structure with a removable roof to install the HI-STAR 100 inside. This removable roof consists of precast reinforced concrete structures anchored to the structure of the ASM which is constructed in-situ and connected to the storage pad. Due to the design requirements of the roof, a group of structural embedments and fasteners and lifting embedments are designed (see Figure 54).

The structural embedments and fasteners consist of HALFEN Bolt Anchors 1988 [70] DIN 976 stud bolts, DIN 934 nuts, DIN 125-A washers and bearing plates. Two sizes (M20 and M30) are designed due to the different weights of the parts to be anchored. The lifting embedments consist of HALFEN HD Socket 6360-7.5-400 [71]. The design demands for the structural embedments and fasteners and lifting embedments are calculated following NUREG-2215 [23] load combinations and they are below their capacities calculated according to ACI 349-13 [2] and SANS 10162-1 [54]. The steel to be used is A4-80 stainless steel with high corrosion resistance due to the highly corrosive marine environment at Koeberg TISF.

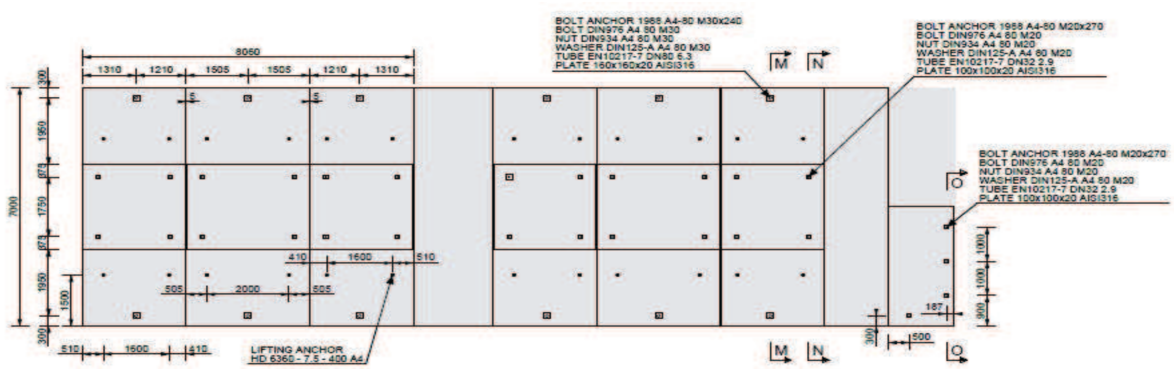

Figure 54: Roof Cover Embedments and Fasteners

3.13.4 Grout for Openings during Concrete Casting

The ASM is a reinforced concrete structure connected to the storage pad. During the construction of the ASM walls, temporary wall ties through the wall when joining the inner and outer shutter are expected to be used. After the formwork removal, the openings produced by ties will be closed using high strength cementitious grout with a minimum density of 2300 kg/m^3. Two possible options are defined to be used: Sika SikaGrout-212 [81] or Saint-Gobain duragrout [80].

The summary of requirements for selection of the equipment is shown in Table 22.

Table 22: Selection of Equipment – Summary of Requirements

Concrete Pad	Minimum cube concrete compressive strength: 30 MPa Maximum cube concrete compressive strength: 51.7 MPa Minimum cover: 60 mm Maximum w/c ratio: 0.5 Minimum content of cement (kg/m3): 300 Maximum water penetration depth (UNE-EN 12390-8): 50 mm Average water penetration depth (UNE-EN 12390-8): 30 mm CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash. Consistency: 100-150 mm in Slump Test (SANS 5862-1)
Engineered Fill	Existent soil compacted to 95%MDD in layers of no more than 150 mm.
Concrete ASM	Minimum cube concrete compressive strength: 30 MPa Minimum density: 2.2994 t/m^3 Maximum density: 2.5 t/m^3 Minimum cover: 60 mm Maximum w/c ratio: 0.5 Minimum content of cement (kg/m^3): 300 Maximum water penetration depth (UNE-EN 12390-8): 50 mm Average water penetration depth (UNE-EN 12390-8): 30 mm CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash. Consistency: 100-150 mm in Slump Test (SANS 5862-1)

Concrete Approach Aprons	Minimum cube concrete compressive strength: 30 MPa Minimum cover: 60 mm Maximum w/c ratio: 0.5 Minimum content of cement (kg/m^3): 300 Maximum water penetration depth (UNE-EN 12390-8): 50 mm Average water penetration depth (UNE-EN 12390-8): 30 mm CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash. Consistency: 100-150 mm in Slump Test (SANS 5862-1)
Fasteners	As per requirements in §3.13.3.

3.14 Technological Obsolescence

Concrete structure is designed for the Design Life. There is no equipment subjected to Technological Obsolescence.

3.15 Ageing Management

The implementation of Ageing Management requirements for spent fuel storage must be done for the application for renewals of specific licenses for independent spent fuel storage installations (ISFSIs) and certificates of compliance (CoCs) for spent fuel storage designs, and for implementation of ageing management programs (AMPs) for holders of CoCs and specific and general ISFSI licensees subject to renewal requirements.

According to RG 3.76 [14], in the context of an initial application and not a renewed term, it is necessary to address the design and performance, including material performance, of SSCs during the requested license term. To address issues associated with materials ageing degradation and to demonstrate adequate materials performance in the requested initial license term, the applicant shall describe maintenance programs (e.g. monitoring, inspections) to address materials ageing degradation, consistent with the guidance in Section 8.5.14 of NUREG-2215 [23].

For the future renewal applications, the following regulations and guidance shall be followed:

- 10 CFR 72.42 [1] includes requirements for the renewal of ISFSI specific licenses and for license renewal applications, including requirements for time-limited ageing analyses (TLAAs) and AMPs.
- 10 CFR 72.240 [1] provides requirements for the renewal of spent fuel storage cask designs and for CoC renewal applications, including requirements for TLAAs and AMPs.
- NUREG-1927, Revision 1, "Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel," issued June 2016 [19], provides guidance for the NRC's safety review of renewal applications for ISFSI specific licenses and CoCs for spent fuel storage cask designs.
- NUREG-2214, "Managing Aging Processes In Storage (MAPS) Report," issued July 2019 [22], provides a generic technical basis for renewal of ISFSI specific licenses and CoCs for

spent fuel storage cask designs.

- NEI 14-03 Revision 2 “Format, Content and Implementation Guidance for Dry Cask Storage Operations-Based Aging Management” [78] provides an operations-based, learning approach to ageing management for the storage of spent fuel, which builds on the lessons learned from industry’s experience with ageing management for reactors.

3.15.1 HI-STAR 100 Design Life

According to HI-STAR 100 FSAR Section 1.2.1.5 [72] the design life of the HI-STAR 100 System in long term storage is given in Table 2.0.1. The design life is the length of time for which the storage system has been engineered to conservatively render all of its intended design functions. This is accomplished by using materials of construction with a long proven history in the nuclear industry and specifying materials known to withstand their operating environments with little to no degradation. A maintenance program is also implemented to ensure the HI-STAR 100 System will exceed its design life.

Because there are no identifiable failure modes that may limit the active useable life of the HI-STAR 100 cask (also referred to as the "service life"), the expected service life has been set as 100 years.

According to Section 9.2, maintenance program for the HI-STAR 100 System is incorporated in its Operations Manual. This document shall delineate the detailed inspections, testing, and parts replacement necessary to ensure continued structural, thermal and confinement performance; radiological safety, and proper handling of the system in accordance with 10CFR72 [1] regulations, the conditions specified in the Certificate of Compliance, and the design requirements and criteria contained in the FSAR.

The inspection and maintenance programs, including the required spare parts for the Koeberg HI-STAR 100 casks are documented in the NNR approved Eskom Safety Case for loading, transfer, placement, and storage of HI-STAR 100 casks at Koeberg.

The AMP for operations beyond the initial 20 years of storage will be compiled and submitted by Eskom separately for NNR approval.

3.15.2 Initial Storage Term

According to NUREG 2215 [23], In some cases, materials degradation may challenge the ability of a component to fulfil its intended function for the duration of the storage term. If an applicant cannot demonstrate adequate materials performance, then the SAR should describe maintenance programs (e.g., monitoring, inspections) to address issues associated with materials ageing degradation.

Some examples of such maintenance activities from previous reviews include the following:

- Transfer cask maintenance programs that inspect for corrosion, wear, and loose or damaged fasteners.
- Coatings inspections, in cases where coatings are credited for preventing corrosion, enhancing heat transfer, or where coating debris could interfere with ventilation pathways.
- Concrete inspections to identify deterioration and basemat settling.
- Radiation surveys to monitor neutron shield effectiveness.

The maintenance activities shall provide for timely identification of materials degradation such that corrective actions can be implemented before a loss of component intended functions. Monitoring and inspection activities should take the following measures:

- Use the methods that are demonstrated to be capable of evaluating the degradation mechanism.
- Be performed at a frequency that is sufficient to identify degradation before a loss of component function.
- Include clear, actionable acceptance criteria.

The materials selected and used in this design are considered to demonstrate adequate performance at least for 50 years, which is the usual design life for concrete structures. According to ACI 349.3R [3] the techniques proven to be useful in the evaluation of a concrete structure can be categorized as follows:

- Visual inspection.
- Non-destructive testing.
- Invasive testing.
- Analytical methods.

Visual inspection can provide significant quantitative and qualitative data regarding structural performance and the extent of any degradation. Visual inspection includes direct and indirect inspection of exposed surfaces, crack and discontinuity mapping, physical dimensioning, collection of data pertinent to the environment that the structure is exposed, and protective coatings review. This technique can be used to define the current condition of an accessible concrete structure in terms of the extent and cause of degradation, material deficiencies, performance of coatings, condition of cover concrete, damage from past service loads, and current response to applied loads, as evidenced by vibration, deflection, settlement, cracking, and spalling.

The frequency at which periodic evaluations are conducted within the evaluation procedure should be defined by Eskom based on the civil structures' inspection and maintenance procedures, including the TISF in the maintenance procedures for civil structures in Koeberg as indicated in §3.10.1. The scheduling of ASM inspections should consider the maintenance inspections required for the design life of the HI-STAR 100 (e.g., corrosion inspections and coating repairs).

Evaluation frequency should be based on the aggressiveness of environmental conditions and physical conditions of the plant structures. The established frequencies should also ensure that any age-related degradation is detected at an early stage of degradation and that appropriate mitigative actions can be implemented.

Structure category	Frequency of visual inspection
Below-grade structures	10 years (each ISI interval)
Structures exposed to natural environment (direct and indirect)	5 years (two per ISI interval)
Structures inside primary containment	5 years (two per ISI containment interval)
Continuous fluid-exposed structures	5 years (two per ISI structures interval)
Structures retaining fluid and pressure	5 years (two per ISI pressure interval)
Controlled interior environment	10 years (each ISI interval)

Figure 55: Frequency of Inspection, Table 6.1 of ACI 349.3R

All safety related structures should be visually inspected at intervals not to exceed 10 years. Additionally, the frequency of inspection for other components should follow those in Table 6.1 of ACI 349.3R [3] (see Figure 55). For consistency with ASME (B&PVC), Section XI in-service inspection (ISI) requirements, the frequencies in Table 6.1 are alternately expressed in terms of years and in-service inspection interval.

The Concrete Pad, ASM and Approach Apron are structures exposed to natural environment and it is recommended that an inspection is executed once each 5 years.

The Koeberg surveillance procedure for civil structures, 240-166149425, Revision 1 [61], defines the basis and scope of non- license binding surveillances undertaken as part of the Civil Preventative Maintenance Programme at Koeberg Nuclear Power Station and will be updated accordingly, to include civil inspection requirements for the TISF Storage Area.

A Pad level survey will be conducted for each sub-pad on completion of each construction phase.

3.16 Design Calculations and Analyses

3.16.1 List of Design Documents

Appendix A2.1 – SHIELDING CALCULATIONS (00857IT013)

Appendix A2.2 – SEISMIC CALCULATIONS (00857IT011)

Appendix A2.3 – STRUCTURAL CALCULATIONS (00857IT012)

Appendix A2.4 – THERMAL CALCULATIONS (00857IT009)

Appendix A2.5 – SIDE DROP ANALYSIS (00857IT014)

Appendix A2.6 – THERMAL ANALYSIS FOR STRUCTURAL (00857IT010)

Appendix A2.17 – APPROACH APRON DESIGN CALCULATIONS (00857IT015)

3.16.2 List of Review Reports for Codes

The following reports were compiled to demonstrate RG-0016 compliance of all the codes utilised in compiling the design documents in Section 3.16.1:

Appendix A2.7 – REVIEW REPORT FOR CODE MAVRIC SCALE 6.2.4 (00857IV001)

Appendix A2.8 – REVIEW REPORT FOR CODE ANSYS (00857IV002)

Appendix A2.9 – REVIEW REPORT FOR CODE P-CARES (00857IV003)

3.16.3 List of Review Reports for Methods

The following reports were compiled to demonstrate RG-0016 compliance of all the methods utilised in compiling the design documents in Section 3.16.1:

Appendix A2.10 – REVIEW REPORT FOR METHOD FOR SHIELDING (00857IV004)

Appendix A2.11 – REVIEW REPORT FOR METHOD FOR SEISMIC RESPONS (00857IV005)

Appendix A2.12 – REVIEW REPORT FOR METHOD FOR LIQUEFACTION (00857IV006)

Appendix A2.13 – REVIEW REPORT FOR METHOD FOR STRUCTURAL (00857IV007)

Appendix A2.14 – REVIEW REPORT FOR METHOD FOR THERMAL (00857IV008)

Appendix A2.15 – REVIEW REPORT FOR METHOD FOR SIDE DROP (00857IV009)

The detailed design calculations, including results, software models and applied calculation methodologies for the TISF design analyses are redacted / not included as they are KCC intellectual property. See Appendix A2.

3.16.4 Detailed Design Drawings

The drawings in support of the proposed detailed design are illustrated in Appendix A2.16: Appendix A2.16 – TISF KOEBERG DETAILED DESIGN DRAWINGS

- 00857PL004 – NOTES
- 00857PL005 – TISF LAYOUT
- 00857PL006 – SHAPE DRAWINGS GENERAL VIEW
- 00857PL007 – SHAPE DRAWINGS AUXILIARY SHIELDING MODULE
- 00857PL008 – REBAR DETAIL 1
- 00857PL009 – REBAR DETAIL 2
- 00857PL010 – OPERATIONS

3.16.5 Accident Analysis

Chapter 11 of the HI-STAR 100 FSAR [72] presents the evaluation of the HI-STAR 100 System for the effects of off-normal and postulated accident conditions.

This section includes for each postulated event, the event cause, means of detection, consequences, and corrective action. Those events that are completely covered by the HI-STAR 100 FSAR are just identified and referenced to the applicable part of the FSAR.

Specific detail is included to assess those events that are modified by the TISF site-specific conditions and the design proposed.

3.16.5.1 Off-Normal Events

The results of the evaluations performed herein demonstrate that the HI-STAR 100 System can withstand the effects of off-normal events without affecting the design function and are in compliance with the applicable acceptance criteria. The section demonstrates that no instruments or controls are required to remain operational under all credible off-normal conditions. The following sections present the evaluation of the HI-STAR 100 System for the design basis off-normal conditions which demonstrate that the requirements of 10CFR72.122 are satisfied, and that the corresponding radiation doses satisfy the requirements of 10CFR72.106(b) and 10CFR20.

The influence of the ASM and the site-specific conditions at Koeberg is evaluated for each off-normal event postulated in the HI-STAR 100 FSAR . None of the postulated environmental phenomenon or accident conditions identified would cause failure of the confinement boundary. The MPC seal or boundary leakage is therefore not considered a credible event. Koeberg employs a vacuum drying system to evacuate moisture during loading of MPC. This renders the malfunction of Forced Helium Dehydrator (FHD) event not credible for the facility.

a) Off-Normal Pressure

There are three pressure regions in the HI-STAR 100 System and they are the MPC internal (where off-normal pressure affects the MPC internal cavity), the MPC external/overpack internal (where off- normal pressure affects the MPC exterior), and the overpack external (where off-normal pressure affects the exterior of the overpack) pressure regions.

There is no cause or postulated cause for an off-normal MPC external/overpack internal pressure or an off-normal overpack external pressure. Therefore, no off-normal overpack external pressure or off- normal MPC external/overpack internal pressure is evaluated.
The off-normal pressure for the MPC internal cavity is a function of the initial helium fill pressure and the temperature obtained with maximum decay heat load design basis fuel. The maximum off-normal pressure is calculated in FSAR as equal to the normal condition design pressure. Therefore, no additional analysis is required.

b) Off-Normal Environmental Temperatures

The off-normal temperatures defined in the HI-STAR 100 FSAR bound the TISF Koeberg design-basis off-normal temperatures, as indicated in §3.7. As demonstrated in §3.16.9, the ASM, required for dose limit compliance, is designed to prevent a negative impact on the acceptable margins to the allowable limits of the HI-STAR 100. The openings in the ASM concrete structure enables the natural ventilation of the HI-STAR 100 while the concrete structure protects the cask against solar isolation and radiation form nearby casks. Thus, the FSAR thermal evaluation of the HI-STAR 100 remains valid for all normal, off-normal and accident conditions.

The postulated cause, detection, analysis of effects and consequences, corrective action and radiological impact of off-normal environmental temperatures are described in Section 11.1.2 of the HI- STAR 100 FSAR and remains valid for the TISF design at Koeberg due to the mentioned justification.

c) Leakage of One MPC Seal Weld

The HI-STAR 100 System has multiple boundaries to contain radioactive fission products within the confinement boundary and the helium atmosphere within the helium retention boundary (overpack internal cavity). The radioactive material confinement boundary is defined by the MPC shell, baseplate, MPC lid, and vent and drain cover plates. The closure ring provides a redundant welded closure to prevent the release of radioactive material from the MPC cavity.

The MPC design, welding, testing and inspection meet the requirements such that leakage from the helium retention boundary is considered non-credible.

d) Off-Normal Load Combinations

The Storage Area will be designed as to withstand the off-normal load combinations defined in Appendix A2.3 – STRUCTURAL CALCULATIONS, without affecting the behaviour of the cask described in the HI-STAR 100 FSAR .

e) Malfunction of FHD

The FHD system is a forced helium circulation device used to effectuate moisture removal from loaded MPCs. For circulating helium, the FHD system is equipped with active components requiring external power for normal operation.

The HI-STAR 100 System is designed to withstand the FHD malfunction without an adverse effect on its safety functions. Consequently, no corrective action is required.

3.16.5.2 Accidents

The results of the evaluations performed herein demonstrate that the HI-STAR 100 System can withstand the effects of all credible accident conditions and natural phenomena without affecting safety function and are in compliance with the acceptable criteria. The section demonstrates that no instruments or controls are required to remain operational under all credible accident conditions. The following sections present the evaluation of the design basis postulated accident conditions and natural phenomena which demonstrate that the requirements of 10CFR72.122 are satisfied, and that the corresponding radiation doses satisfy the requirements of 10CFR72.106(b) and 10CFR20.

The influence of the ASM and the site-specific conditions at Koeberg is evaluated for accident postulated in the HI-STAR 100 FSAR . Two additional accidents are included as credible accidents due to the presence of the ASM.

a) Handling Accident

The HI-STAR 100 is transferred to the TISF in horizontal position on transporter. According to the HI- STAR 100 FSAR [119] a horizontal drop of the loaded HI-STAR 100 cask is not a credible accident as the loaded HI-STAR 100 cask shall be lifted and handled by devices designed in accordance with the criteria specified in with NUREG-0612 [25] and ANSI N14.6 [4] to prevent uncontrolled lowering.

The Koeberg Gantry Crane single failure proof in compliance with NUREG-0612 [17] and ANSI N14.6 [4].

In addition, to protect against fuel and cask damage, in case of an unlikely drop of a cask, the TISF storage pad is constructed in accordance with the FSAR specifications to ensure that impact loads from cask drop accidents remain with the HI-STAR 100 deceleration limit of 60g.

Furthermore, the HI-STAR 100 casks are lifted to respect their designed drop height limit for horizontal lifts of 1,83 m to prevent fuel damage in the unlikelihood of cask drop accident during handling of casks at the TISF.

b) Tip-Over

According to section 2.2.3.2 of the HI-STAR 100 FSAR, a tip-over analysis of a loaded HI-STAR 100 overpack stored on an ISFSI (or TISF in this case) pad in the horizontal orientation is not required because the side drop evaluation bounds this accident.

c) Fire

The design basis fire exposes the HI-STAR 100 overpack to a temperature of 800°C, and the fuel source spreads to 1 metre for 5 minutes.

The worst-case shielding consequence of a design basis fire assumes that because of the fire, the neutron shield is completely destroyed and replaced by a void.

The fire emergency plan actions are documented in KEP-088 [37]and requires in the main that if damage to the neutron shield is limited to a localized area, local repairs be performed to replace the damaged neutron shield material. If damage to the neutron shield is widespread and / or radiological conditions dictate, the overpack shall be unloaded in accordance with the unloading procedure as referenced in the NNR approved site operations safety justification before the repair of the neutron shield.

The ASM could be damaged after a fire event, but it will keep partially the shielding function, reducing the radiation dose that could result after this event in respect to the consequences of this accident without ASM.

d) Partial Blockage of MPC Basket Holes

The HI-STAR 100 system is designed to withstand reduction of flow area due to partial blockage of the MPC basket vent holes. As the MPC basket vent holes are internal to the confinement barrier, the only events that could partially block the vents are fuel cladding failure and debris associated with this failure, or the collection of crud at the base of the stored spent fuel assembly.

However, the HI-STAR 100 system maintains the spent fuel in an inert environment with fuel rod cladding temperatures below accepted design and Regulatory limits. Koeberg spent fuel assemblies are also visually inspected for debris and sip tested to verify leak-tightness before loading into dry storage casks.

Therefore, there is no credible mechanism for partial blockage during storage in the HI-STAR 100 cask.

e) Tornado

A design basis tornado wind missile may cause localized reduction in the neutron shielding to a HI-STAR 100 cask stored on an open pad. Damage sustained by the neutron shield shall be repaired in accordance with the procedure steps following a fire accident as documented in KEP-088.

However, the ASMs on the Koeberg TISF will be designed to withstand the design-basis high winds and tornado forces thereby acting as a missile shield. Localised damage could appear on the concrete surfaces, but the ASM will be designed as to assure the retrievability of the HI-STAR 100 cask following such an event.

f) Flood

The HI-STAR 100 overpack does not tip-over due to design basis flood. The results for these analyses are based on USNRC postulated parameters. The design basis flood for the HI-STAR 100 cask is of a velocity of 4 m/s, with a depth of 200 m. However, the Koeberg design basis flood velocity is higher at 7 m/s.

On the TISF, the ASM will act as a barrier decreasing flood velocities acting on the HI-STAR 100 casks. Localized damage could appear on the concrete surfaces, but the ASM will be designed as to assure the retrievability of the HI-STAR 100 cask after this event. At the completion of the flood, the exterior of the overpack and the ASM should be inspected. The ventilation openings shall be cleaned as to guarantee the correct ventilation of the HI-STAR 100 cask. Any silting deposition should be eliminated as per specific procedures establishing the maximum time for mitigation. The station emergency procedure KEP-088 [37] will therefore be updated to include the post-event inspection corrective actions.

In addition, the Koeberg Safety Analysis Report (SAR) [41] states:

The maximum predicted high water level for a one-million-year return period is +6.97 m mean sea level (MSL) and makes allowance for the combination of the highest tides and other natural phenomena.

The plant and CSB terrace level (level 0.00 m) is at the +8.00 m MSL which allows for adequately drained during a Koeberg design basis flood external event.

The TISF terrace level (level 0.00 m) will be constructed at 8.14 MSL with a slope of 1% thereby allowing adequate drainage during a Koeberg design basis flood external event.

g) Earthquake

According to the HI-STAR 100 FSAR , if the earthquake required cannot be satisfied for a particular site, then a 3-D time history analysis may be performed to demonstrate the stability of the HI-STAR 100 overpack in its horizontal storage configuration.

Seismic Calculations are described in §3.16.7 and included in Appendix A2.2 – SEISMIC CALCULATIONS, verifying that the cask remains stable, and it does not impact with the ASM walls. The ASM is designed to withstand the seismic loads in the structural analysis, which is described in §3.16.8 and included Appendix A2.3 – STRUCTURAL CALCULATIONS.

Therefore, there is no effect on thermal, shielding, criticality and confinement functions of the HI-STAR 100. The earthquake does not affect the safe operation of the HI-STAR 100 System. Since the loaded overpack does not tip-over, there is no increase in radiation dose rates or release of radioactivity.

Following the earthquake accident, the TISF operator shall perform a visual and radiological inspection of the overpacks in storage to determine if any of the overpacks have tipped-over due to the earthquake. The re-positioning of the HI-STAR 100 casks may be necessary if they have experienced sliding.
The liquefaction analysis is conducted and included in Appendix A2.2 – SEISMIC CALCULATIONS to define the demands in the storage pad and the ASM due to the layers where soil liquefaction should be considered to have been triggered. Localized damage could appear on the concrete surfaces, but the Storage Area is designed as to assure the retrievability of the HI-STAR 100 cask after this event. The station emergency procedure KEP-088 will therefore be updated to include the post-event inspection corrective actions.

h) 100% Rod Rupture

The maximum gas pressure in the MPC is considered for a postulated accidental release of fission product gases caused by 100% fuel rods rupture. The HI-STAR 100 thermal analysis demonstrates that the system's design pressure is not exceeded with 100% of the fuel rods ruptured.

i) Confinement Boundary Leakage

None of the postulated environmental phenomenon or accident conditions identified would cause failure of the confinement boundary. The MPC seal or boundary leakage is therefore not considered a credible event.

j) Explosion

There is no internal mechanism of causing an explosion within a sealed HI-STAR 100 cask. There are no explosive materials stored inside or in proximity of the CSB and TISF. Therefore, the explosive event within the CSB and the TISF is considered not credible.

k) Lightning

The HI-STAR 100 overpack contains many thousands of kilograms of highly conductive carbon steel over the external surface area. Such a large surface area and metal mass is adequate to dissipate any lightning which may strike the HI-STAR 100 system.

There are no combustible materials on the overpack surface. Therefore, lightning will not impair the structural performance of components of the HI-STAR 100 system that are important to safety.

The ASM provides defence in depth by protecting the overpack from direct interaction with the lightning.

l) Burial Under Debris

The HI-STAR 100 cask evaluation concludes that in the event of the CSB collapsing, the casks must be retrieved within a maximum of 4.5 days to preclude loss of integrity of the casks thereby allowing for fuel retrievability.

Damage sustained by the neutron shield shall be repaired in accordance with the procedure steps following a fire accident.
The burial under debris recovery plan is included in KEP-088 [37].

Note that Koeberg TISF Storage Area will be designed to withstand SSE and DEC seismic events thereby rendering the burial under debris accident not credible.

In the unlikely event the Storage Area is buried under debris, to prevent failure of fuel cladding temperature limits, the Koeberg Operator shall remove debris from the ASM vents within 60 hours of detecting the burial event. KEP-088 [37] will therefore be updated to include the post-event inspection corrective actions.

m) Extreme Environmental Temperature

The Koeberg design base ambient temperatures are:

- Minimum: 1.8ºC
- Maximum: + 40.2ºC

For horizontally orientated systems the normal environmental temperature is up to 38°C and the extreme environmental temperature is 50°C. Results of the extreme environmental temperature analyses demonstrate that the HI-STAR 100 system will continue to operate safely under these conditions. There is a possible consequence of a slight loss of the neutron shield effectiveness.
The emergency plan actions are the same as the fire emergency actions documented in KEP-088 [37]. As demonstrated in Appendix A2.4 – THERMAL CALCULATIONS, the ASM, required for dose limit compliance, is designed to prevent a negative impact on the acceptable margins to the allowable limits of the HI-STAR 100. The openings in the ASM concrete structure enables the natural ventilation of the HI-STAR 100 while the concrete structure protects the cask against solar isolation and radiation form nearby casks. Thus, the FSAR thermal evaluation of the HI-STAR 100 remains valid for all normal, off-normal and accident conditions.

n) Air Flow Blockage

The design of the TISF ASM introduces the risk that blockage of the air vent openings can lead to a loss of natural air circulation and decay heat removal from the casks. This accident is bounded by the analysis of the debris burial accident in the FSAR of the HI-STAR 100 casks which showed that, for this accident, overheating of the casks only occurs after more than 60 hours. Sufficient time is therefore available for operator intervention to unblock the air vents and restore natural air circulation, thereby preventing the overheating of the casks. During normal operations regularly scheduled operator walkdowns can identify any air vent blockages. The applicable inspection and maintenance and emergency procedure KEP-088 [37] will be updated accordingly, to ensure the ASM air vents remain free of debris under both normal and accident operating conditions.

o) ASM Top Cover Drop

The installation of the ASM results is the possibility of an additional accident, i.e., top cover drop over the cask while installing this item on the ASM. This risk is addressed in the design of the lifting embedments of the top covers and the fasteners used to fix the top covers to the ASM structure, in Appendix A2.3 – STRUCTURAL CALCULATIONS. During lifting operations, the top cover will remain suspended even if one of the lifting embedments fails. The fastening bolts that fix the top covers to the ASM structure are designed for design extension conditions including 0,5 g earthquakes. The structural design of the ASM therefore eliminates the risk of top cover drop for design basis conditions.

3.16.6 Shielding Calculations

3.16.6.1 Shielding Calculations – Purpose

The purpose of the shielding analysis is to determine the dose rates in the controlled zone (the restricted, discrete areas containing radiological hazards where the integrated dose equivalent to a person may exceed 1000 μSv per annum) and in the controlled area around the TISF (area immediately surrounding the TISF, for which the licensee exercises authority regarding its use and within which TISF operations are performed).

An analysis of the doses around the cask and the ASM is also performed to calculate the operational doses during inspection and maintenance tasks as well as during cask loading activities.

Shielding Calculations are included in Appendix A2.1 – SHIELDING CALCULATIONS, including the detail description about scope, method of analysis, input data, assumptions, analysis, results, conclusions, listing of computer files and references. In order to facilitate the revision of the detailed design, only a brief description about the calculations developed in the mentioned Appendix is included below.

The dose rate evaluations are performed with MAVRIC (Monaco with Automated Variance Reduction using Importance Calculations), a program included in the calculation system SCALE 6.2.4 and different models are developed. The MAVRIC models are shown in Figure 56, Figure 57 and Figure 58.

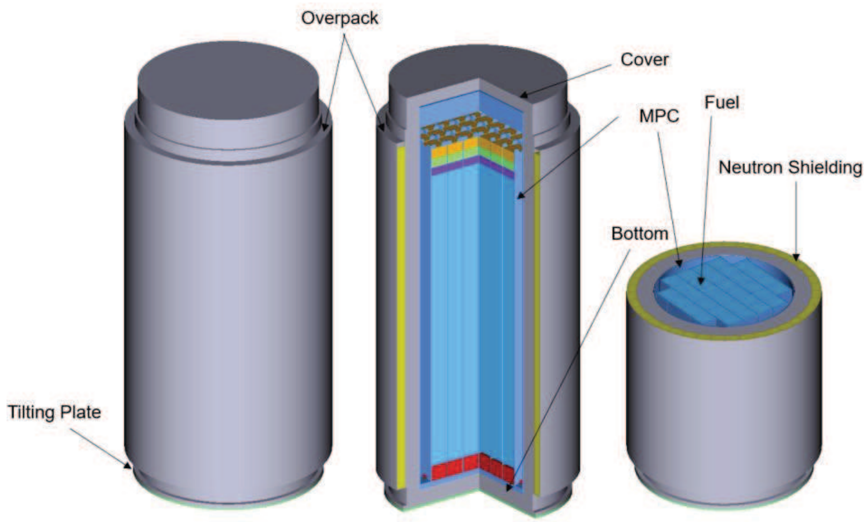

Figure 56: MAVRIC Loaded HI-STAR 100 Cask Model with the Tilting Plate

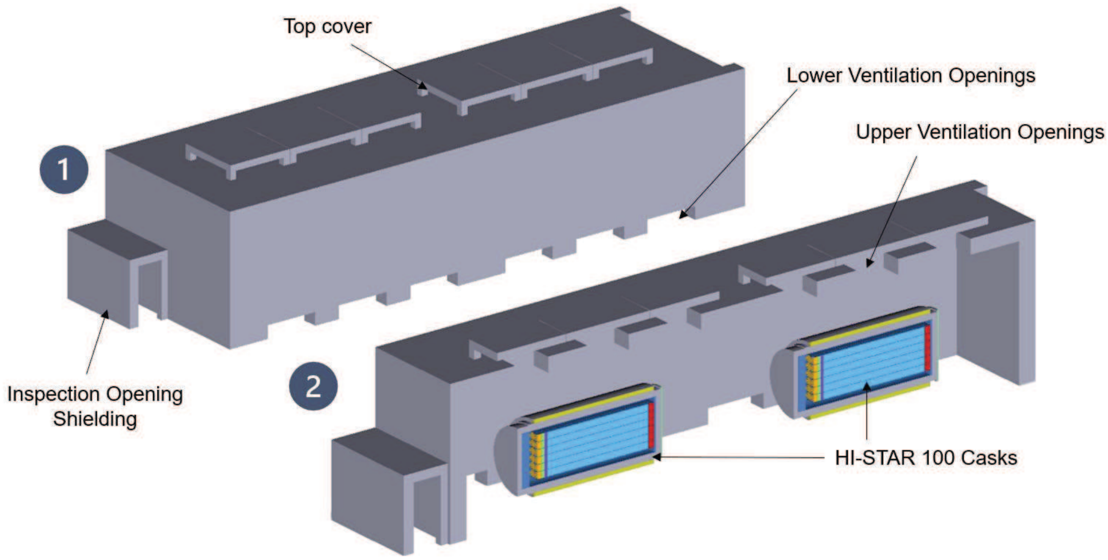

Figure 57: MAVRIC Model of the ASM (1) and Side Section of the MAVRIC Model of the ASM (2)

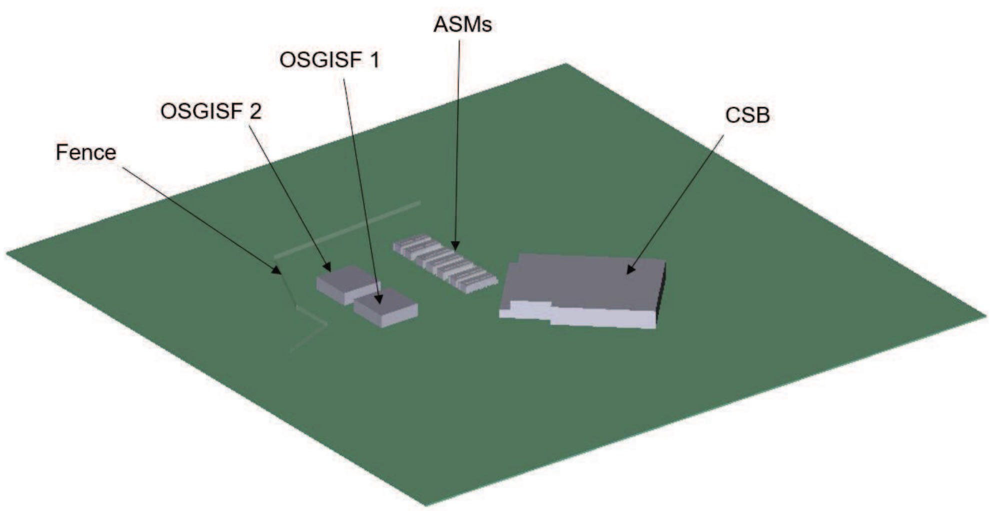

Figure 58: 3D MAVRIC Model of the Configuration Evaluated in the Site

3.16.6.2 Shielding Calculations – Standards

Shielding calculations has been performed to verify compliance with the following requirements:

- 10 CFR 72.104 Criteria for Radioactive Materials in Effluents and Direct Radiation from an ISFSI [1].
- 10 CFR 72.106 Controlled Area of an ISFSI [1].
- KAA-637 Access control to radiological controlled zones [35]
- 238-36 Operational Radiation Protection Requirements [26]
- RD-0022 Radiation Dose Limitation at Koeberg Nuclear Power Station [46].

3.16.6.3 Shielding Calculations – Acceptance Criteria

- The acceptance criteria for the shielding calculations during normal operations and anticipated occurrences are the following:

- The annual dose equivalent due to the direct radiation to any real individual who is located beyond the controlled area must not exceed 0.25 mSv (25 mrem) to the whole body, 0.75 mSv (75 mrem) to the thyroid and 0.25 mSv (25 mrem) to any other critical organ. The minimum distance from the spent fuel and storage facilities to the nearest boundary of the controlled area must be at least 100 m. The KBG TISF is located on the plant with the Site Boundary located at about 1.5 km from the facility. The Koeberg site boundary is also subjected to the < 0.25 mSv/a limit as required by the NNR. This includes contribution of all sources in NIL-01.
- The on-site controlled zone boundary dose rate must not exceed 0.5 μSv/h (1 mSv annual effective dose limit for an exposure of 2000 hours, a 40-hour week for 50 weeks in one year).

Additionally, in a design basis accident, the acceptance criteria is:

- The total effective dose equivalent for any individual located on or beyond the nearest boundary of the controlled area must not exceed 0.05 Sv (5 rem), or the sum of the deep-dose equivalent and the committed dose equivalent to any individual organ or tissue (other than the lens of the eye) of 0.5 Sv (50 rem). The lens dose equivalent may not exceed 0.15 Sv (15 rem) and the shallow dose equivalent to skin or any extremity may not exceed 0.5 Sv (50 rem).

3.16.6.4 Shielding Calculations – Results

- Controlled zone boundary:
  - The 0.5 μSv/h limit is reached at ~46 m in the Y direction and ~12 m in the X direction from the center of the ASMs array.
  - When considering the contribution from the OSGISF and CSB, it is shown that the dose rate limit of 0.5 μSv/h is reached in the Chemical Storage room area and in the entrance area to the CSB. Although the contribution to the dose coming from the ASMs is very small compared to the contribution from the sources stored in the CSB (9% in the Chemical Storage room area and 0.1-5% in the rest of the areas surrounding the CSB). Dose rate values from the OSGISF and CSB facilities at different locations can be found in Table 1 of Appendix A2.1. More detail on how these contributions have been considered is included in Section 5.1.2 of Appendix A2.1.

- Controlled area boundary (normal operation conditions):

  The 0.25 mSv annual dose limit is reached at ~89 m in the Y direction and 62 m in the X direction from the center of the ASMs array, which is well within the KBG Site Boundary and closer to the TISF itself. This means that the impact of the TISF of the Koeberg Site Boundary dose rate limit is significantly low. Therefore, even with consideration of the site effluent contribution the Koeberg Site Boundary < 0.25 mSv/a limit is well respected.

- Controlled area boundary (accident conditions):

  The maximum cumulative dose value obtained at 100 m from the ASMs after 30 days is 0.17 mSv.

- Installation operational doses (see Figure 59 and Figure 60):

  Total dose rate map (μSv/h) has been obtained around a HI-STAR 100 cask and around an ASM during cask introduction operations with one HI-STAR 100 cask inside the ASM. Dose rate values presented in each cell can be used to calculate the operational dose taking into account the operations to be carried out, the number of workers for each task and the times to carry out each task by the following expression:

$$Total\ dose\ (\mu Sv) = \sum_{i=1}^{n} DR_i\ (\mu Sv/h) \cdot t_i(h) \cdot N$$

Where n is the number of tasks to be performed, DRi is the dose rate value in the location where task i take place, ti is the time that task i lasts, and N is the number of workers involved in the task.

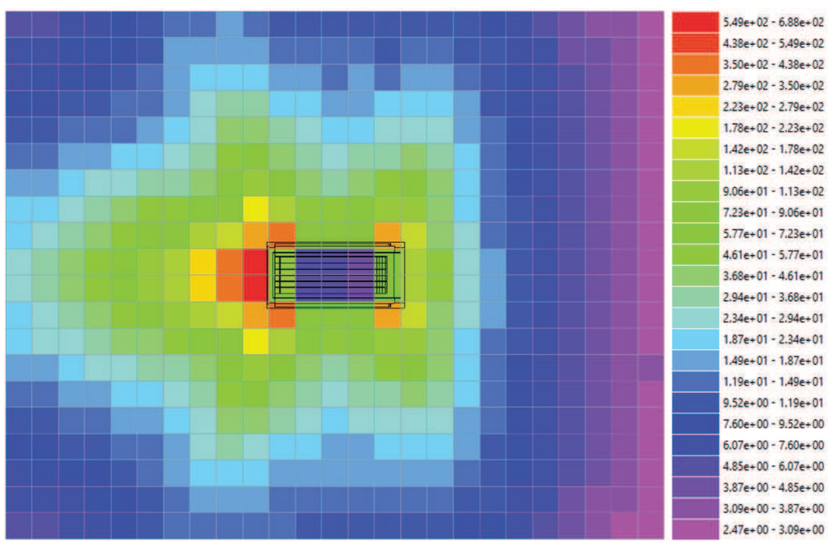

Figure 59: Dose rate map (μSv/h) around a loaded HI-STAR 100 cask

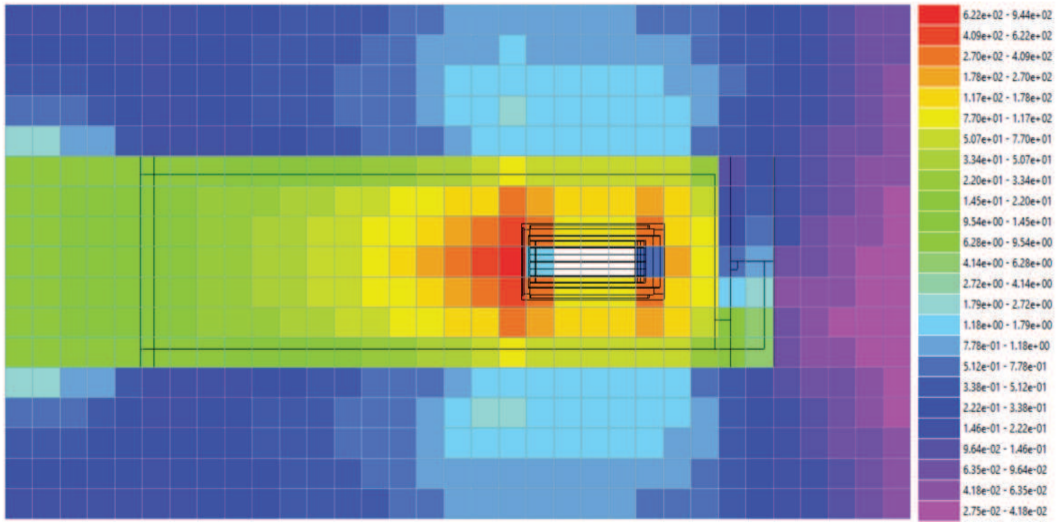

Figure 60: Dose rate map (µSv/h) inside and around an ASM during cask loading operations

- Inspection and maintenance operational doses (see Figure 61):

  Total dose rate map (µSv/h) has been obtained around the ASM with two HI-STAR 100 cask inside. Dose rate values presented in each cell can be used to calculate the inspection and maintenance operational doses dose taking into account the operations to be carried out, the number of workers for each task and the times to carry out each task by the following expression:

$$Total\ dose\ (\mu Sv) = \sum_{i=1}^{n} DR_i\ (\mu Sv/h) \cdot t_i(h) \cdot N$$

  Where n is the number of tasks to be performed, DRi is the dose rate value in the location where task i take place, ti is the time that task i lasts, and N is the number of workers involved in the task.

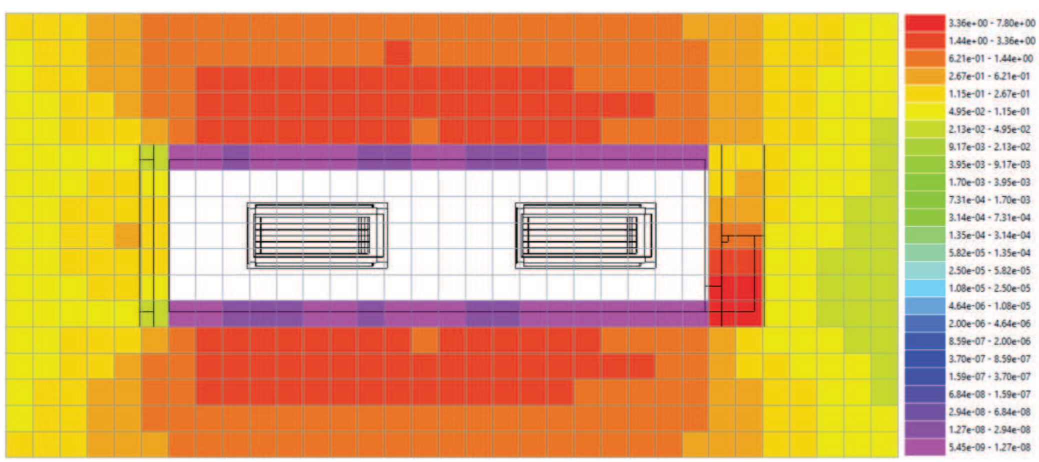

Figure 61: Dose rate map (µSv/h) around an ASM loaded with two HI-STAR 100 casks

3.16.6.5 Shielding Calculations – Conclusions and Recommendations

The main conclusions of the analysis are summarized below:

- Controlled zone boundary:
    - With the use of the ASM, it is possible not to exceed the dose limit of 0.5 µSv/h outside the TISF area, complying with the requirement established in KAA-637 and 238-36.
- Controlled area boundary (normal operation conditions):
    - The Owner Controlled Area boundary is located about 1.5 km away, so the limit established in 10 CFR 72.104 [1] is therefore complied.
    - The controlled area for the TISF area is within Eskom landholdings, and inside the area comprised with Access Control Point 1, so the TISF area is adequately restricted to protect members of the public and consistent with the requirements in 10 CFR Part 72.104.
- Controlled area boundary (accident conditions):
    - The cumulative dose value obtained at 100 m from the ASMs after 30 days, is below the 50 mSv (0.05 Sv) limit, complying with the requirement established in 10 CFR 72.106.
- Installation operational doses:
    - The dose rate obtained will be used to calculate the operational doses considering the operations to be carried out, the number of workers for each task and the times to carry out each task.
- Inspection and maintenance operational doses:
    - The dose rate obtained will be used to calculate the operational doses considering the operations to be carried out, the number of workers for each task and the times to carry out each task.

Compliance of codes and methods according to RG-0016 [50] is justified in the following Review Reports prepared following the guidelines of Section 5.6.1 and 5.6.3 of KGF-001 [40]:

- Review Report for the code MAVRIC SCALE 6.2.4 used in Shielding Calculations is included in Appendix A2.7 – REVIEW REPORT FOR CODE MAVRIC SCALE 6.2.4.
- Review Report for the method for Shielding Analysis is included in Appendix A2.10 – REVIEW REPORT FOR METHOD FOR SHIELDING.

3.16.7 Seismic Calculations

Seismic Calculations are included in Appendix A2.2 – SEISMIC CALCULATIONS, including the detail description about scope, method of analysis, input data, assumptions, analysis, results, conclusions, listing of computer files and references. In order to facilitate the revision of the detailed design, a description about the calculations developed in the mentioned Appendix is included below.

3.16.7.1 Seismic Calculations – Purpose

The purpose of the seismic calculations of the TISF of Koeberg NPP consists of two parts:

- The seismic response is studied to verify that the HI-STAR 100 horizontally stored in a cradle is seismically stable (i.e., do not overturn) and cask to cask and cask to ASM impacts do not occur. Moreover, the cradle to pad interface force and the soil-structure interaction effect on the free- field motion seismic response spectra are calculated to conduct the structural analysis and design of the storage pad and the ASMs in Appendix A2.3 – STRUCTURAL CALCULATIONS.

- The liquefaction susceptibility of the soil analysis is conducted to define the factor of safety against the occurrence of liquefaction and the settlements consequent to liquefaction. These settlements are calculated to be considered in the structural analysis in Appendix A2.3 – STRUCTURAL CALCULATIONS.

The seismic response analysis is performed using a 3D finite element analysis with LS-DYNA computer code [77] using the strain compatible soil properties and seismic input developed through P-CARES [83]. Figure 62 shows the finite element model used for seismic analysis including the foundation soil, the storage pad, the ASMs and the HI-STAR 100. Figure 63 and Figure 64 shows the storage pad, ASMs, HI-STAR 100 and cradle finite element models in detail. The storage pad is constructed as three individual pads that are not structurally connected and separately seismically qualified. The storage pad model is divided in three independent pads separated by expansion joints.

The analysis of the liquefaction susceptibility of the soil and the settlements consequent to liquefaction are conducted through NUREG/CR-5741 [15] empirical procedures.

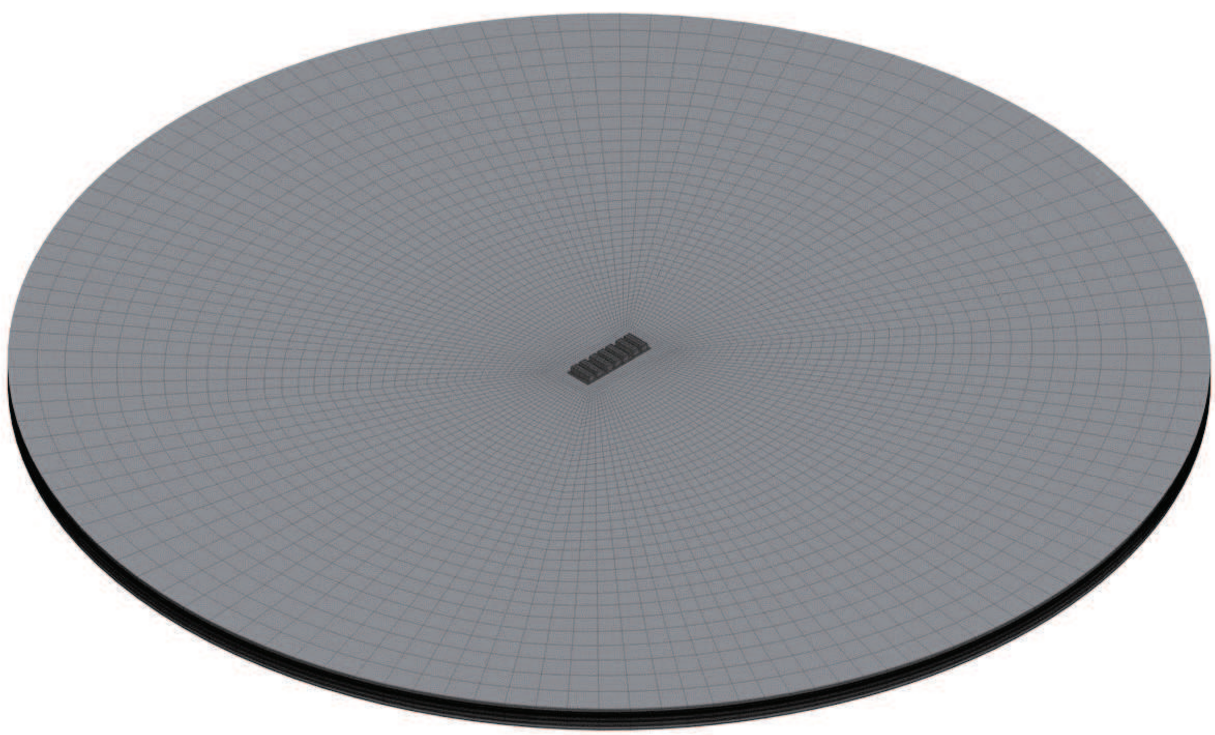

Figure 62: Finite Element Model for Seismic Analysis

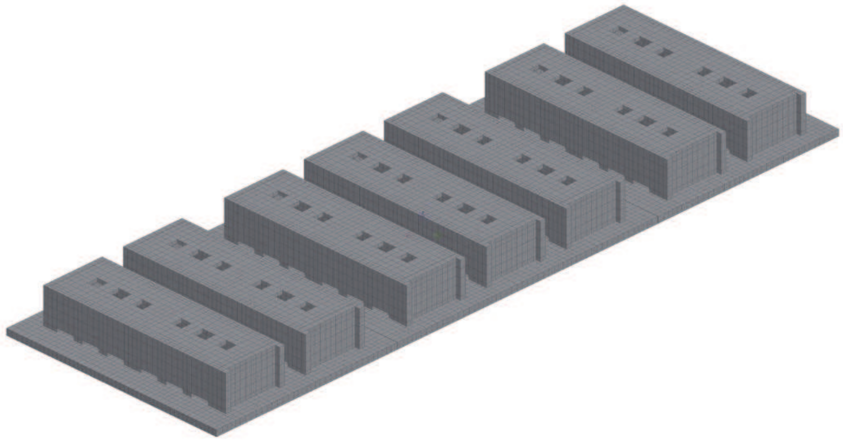

Figure 63: ASMs, Storage Pad, HI-STAR 100 and Cradle Finite Element Model for Seismic Analysis

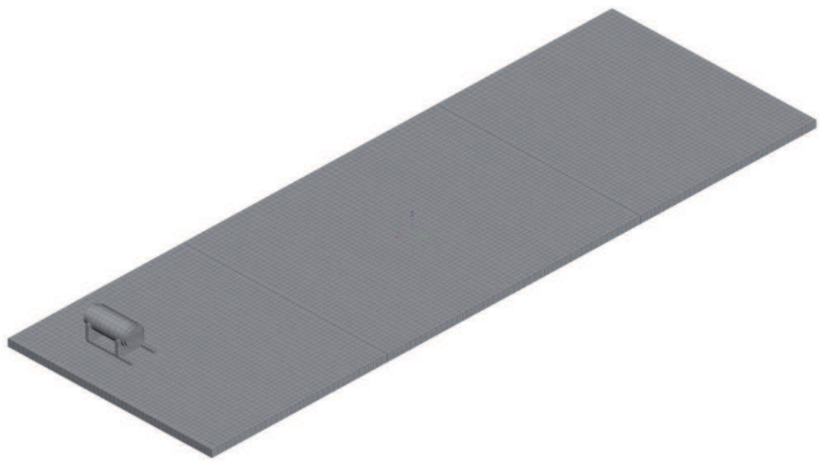

Figure 64: Storage Pad, HI-STAR 100 and Cradle Finite Element Model for Seismic Analysis (ASM is Hidden in this View)

3.16.7.2 Seismic Calculations – Standards

The seismic response analysis is conducted according to the following regulations:

- ASCE 4-16 Seismic Analysis of Safety-Related Nuclear Structures [6].
- NUREG/CR-6865 Parametric Evaluation of Seismic Behavior of Freestanding Spent Fuel Dry Cask Storage Systems [16].
- NUREG-0800 Section 3.7.1 Seismic Design Parameters [18].
- Regulatory Guide 1.92 Combining Modal Responses and Spatial Components in Seismic Response Analysis [13].
- Regulatory Guide 1.61 Damping Values for Seismic Design of Nuclear Power Plants [11].

The liquefaction analysis is conducted according to Regulatory Guide 1.198 [10] and NUREG/CR-5741 [15].

3.16.7.3 Seismic Calculations – Acceptance Criteria

The acceptance criteria for the seismic calculations is that the HI-STAR 100 horizontally stored in a cradle is seismically stable (i.e., do not overturn) and cask to cask and cask to ASM impacts do not occur.

3.16.7.4 Seismic Calculations – Results, Conclusions and Recommendations

The seismic calculations results show that the HI-STAR 100 horizontally stored in a cradle is seismically stable and there is no cask to cask or cask to ASM interactions. The minimum safety factor against tip-over is 862 and the minimum safety factor against cask to cask or cask to ASM impact is 5.2. Therefore, the casks are seismically stable (i.e., do not overturn) and cask to cask or cask to ASM impact do not occur under seismic conditions.

The maximum cradle to pad interface force is 3478 kN and it occurs in Case 14 with UB soil properties. According to this result, a conservative cradle to pad interface force of 4000 kN is defined to be considered in the structural analysis in Appendix A2.2 – SEISMIC CALCULATIONS.

The free-field motion seismic response spectra are not amplified in x and y horizontal directions but there is an amplification in the vertical direction up to 1.09. According to this result, conservative modification factors are defined considering a factor of 1 for the horizontal directions and a factor of 1.15 for the vertical directions. These modification factors shall be applied to the Dames and Moore (1981) spectra linearly scaled to 0.65 g and 0.6 g in horizontal and vertical directions, respectively, to define the in-structure seismic response spectra for the structural analysis in Appendix A2.2 – SEISMIC CALCULATIONS.

Several layers of the six boreholes studied would achieve conditions wherein soil liquefaction should be considered to have been triggered. The settlements consequent to liquefaction are expected to be between 15 mm and 120 mm. According to this result, a conservative liquefaction settlement of 120 mm is defined to be considered in the structural analysis in Appendix A2.2 – SEISMIC CALCULATIONS.

Compliance of codes and methods according to RG-0016 [50] is justified in the following Review Reports prepared following the guidelines of Section 5.6.1 and 5.6.3 of KGF-001 [40]:

- Review Report for the code ANSYS LS-DYNA used in Seismic Calculations is included in Appendix A2.8 – REVIEW REPORT FOR CODE ANSYS.
- Review Report for the code P-CARES used in Seismic Calculations is included in Appendix A2.9 – REVIEW REPORT FOR CODE P-CARES.
- Review Report for the method for Seismic Response Analysis is included in Appendix A2.11 – REVIEW REPORT FOR METHOD FOR SEISMIC RESPONSE.
- Review Report for the method for Liquefaction Analysis is included in Appendix A2.12 – REVIEW REPORT FOR METHOD FOR LIQUEFACTION.

3.16.8 Structural Calculations

Structural Calculations are included in Appendix A2.3 – STRUCTURAL CALCULATIONS for the storage pads and ASMs and in Appendix A2.17 – APPROACH APRON DESIGN CALCULATIONS for the approach aprons, including the detail description about scope, method of analysis, input data, assumptions, analysis, results, conclusions, listing of computer files and references. In order to facilitate the revision of the detailed design, a description about the calculations developed in the mentioned Appendixes is included below.

3.16.8.1 Structural Calculations – Purpose

The purpose of the structural calculations is the design of the reinforced concrete storage pads, ASMs and approach aprons to be built at the TISF of Koeberg NPP.

The structural analysis of the storage pad, the ASMs and the approach aprons is performed using 3D finite element analyses with ANSYS Mechanical computer code [62]. Figure 65 shows the finite element model of the storage pad and the ASM for structural analysis. Figure 66 shows the models for the structural analysis of the top cover and inspection opening shielding parts. Figure 67 shows the finite element model of the approach apron for structural analysis.

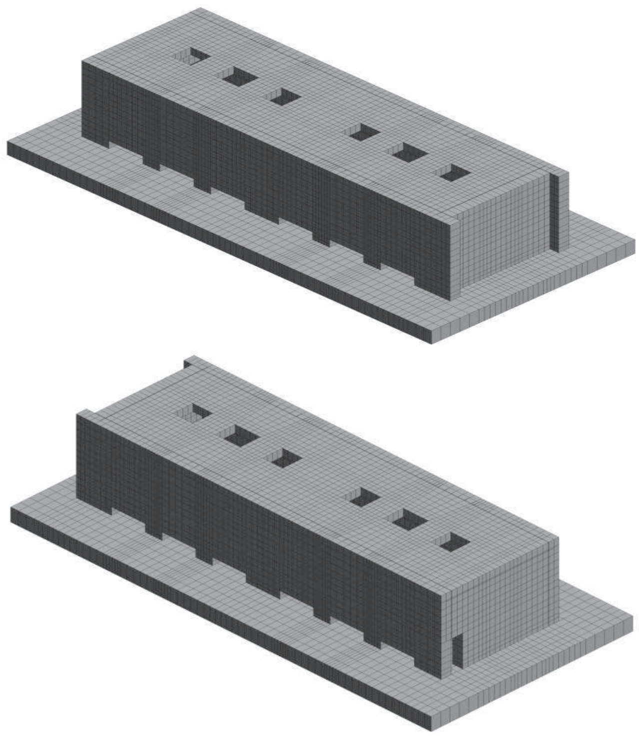

Figure 65: ASM and Storage Pad Finite Element Model for Structural Analysis (Front and Rear View)

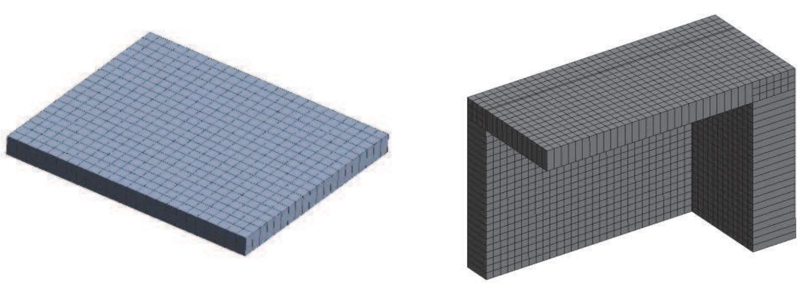

Figure 66: Top Cover and Inspection Opening Shielding Finite Element Models for Structural Analysis

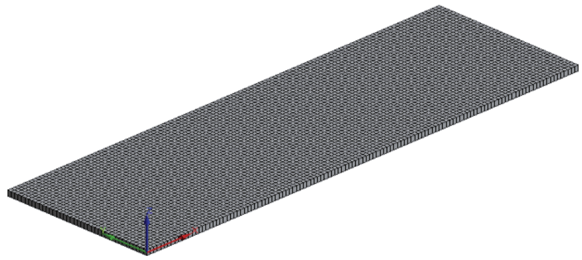

Figure 67: Approach Apron Model for Structural Analysis

3.16.8.2 Structural Calculations – Standards

The load cases and load combinations are defined according to the following international standard:

- NUREG-2215 Standard Review Plan for Spent Fuel Dry Storage Systems and Facilities[23]. The structural design of the concrete is conducted according to the following South African codes:
- SANS 10100-1 The structural use of concrete Part 1: Design [51].
- SANS 10100-2 The structural use of concrete Part 2: Materials and execution of work [52].
- SANS 10114 Detailing of steel reinforcement for concrete [53].

Additionally, concrete design is verified according to the following international code:

- ACI 349-13 Code Requirements for Nuclear Safety-Related Concrete Structures [2].

The structural design of steel parts is conducted according to the following South African codes:

- SANS 10162-1 The structural use of steel Part 1: Limit-states design of hot-rolled steelwork [54].

3.16.8.3 Structural Calculations – Acceptance Criteria

SANS 10100-2 defines the minimum cover to reinforcement for various conditions of exposure according to Table 23.

Table 23: Minimum Cover for Various Conditions of Exposure

1	2	3	4	5	6
Concrete	**Minimum cover** mm				
	Conditions of exposure				
	Mild	**Moderate**	**Severe**	**Very severe**	**Extreme**
Normal-density concrete	20	30	40	50	60
Low-density concrete	20	40	50	60	70
NOTE - This table should be used in conjunction with table A.8 of annex A.					

The minimum reinforcement area is calculated according to sections 4.11.4 of SANS 10100-1 [51] and of ACI 349-13. The maximum reinforcement ratio is defined according to 4.11.5 of SANS 10100-1.

The ultimate capacity of the concrete cross-sections is calculated as follows:

- Flexure and axial loads:
  - Section 4.4.2 of SANS 10100-1.
  - Chapter 10 of ACI 349-13.

Shear:

- Section 4.4.5 of SANS 10100-1.
- Chapter 11 of ACI 349-13.

The compliance with the serviceability limit state of concrete cracking is conducted according to Section 4.4.7 of SANS 10100-1 following the reinforcement spacing rules defined in 4.11.8.2.2.

The capacity of structural embedments is calculated according to Appendix D of ACI 349-13. The capacity of the structural fasteners is calculated according to section 13.12 of SANS 10162-1 [54].

The capacity of structural embedments is calculated according to Appendix D of ACI 349-13.

Geotechnical design is conducted for a maximum bearing capacity of 200 kPa [67].

3.16.8.4 Structural Calculations – Results, Conclusions and Recommendations

The results demonstrate that the provided reinforcement for each structural component in Table 24 are adequate and show capacities according to ACI 349-13 and SANS 10100-1 to withstand the demands for load combinations defined according to NUREG-2215 [23]. The structural embedments and fasteners and lifting embedments design demands following NUREG-2215 [31] load combinations are below their capacities calculated according to ACI 349-13 and SANS 10162-1. Moreover, the bearing pressure of the storage pads and the approach aprons are below the allowable bearing capacity of the soil of 200 kPa for all load combinations. Therefore, the storage pads, ASMs and approach aprons comply with the acceptance criteria listed in section 3.16.8.3.

Table 24: Reinforcement and Clear Cover for Structural Components

COMPONENT	X-AXIS	Y-AXIS	Z-AXIS	CLEAR COVER (mm)
C1(**) - Storage Pad	Ø32@150	Ø32@150 (*)	-	60
C2 - East and West Walls	4Ø16@200	Ø25@150 (*)	Ø32@100	60
C3 - East and West Walls Above Openings	4Ø16@400	Ø25@150 (*)	Ø32@150	60
C4 - Front Shielding Door	Ø32@150	4Ø16@250	Ø16@150 (*)	60
C5 - Rear Wall	Ø25@150 (*)	4Ø16@300	Ø25@150	60
C6 - Roof (Walls)	Ø32@100	Ø16@150 (*)	2Ø16@200	60
C7 - RoofShielding	Ø32@100	Ø20@125 (*)	4Ø16@250	60
C8 - Top Cover	Ø16@150	Ø16@150	-	60
C9 - Inspection Opening Shielding Roof	Ø16@150	Ø16@150	-	60
C10 - Inspection Opening Shielding Wall 1	Ø16@150	Ø16@150	-	60
C11 - Inspection Opening Shielding Wall 2	Ø16@150	Ø16@150	-	60
C12 - Inspection Opening Shielding Column	-	-	4Ø16	60
Approach Apron	Ø25@150	Ø25@150	-	60
Approach Apron Perimeter	Ø25@150	Ø25@150	2Ø10@150	60

(*) Exterior reinforcement (**) To assumed for the approach aprons

Compliance of codes and methods according to RG-0016 [50] is justified in the following Review Reports prepared following KGF-001 [40]:

- Review Report for the code ANSYS Mechanical used in Structural Calculations is included in Appendix A2.8 – REVIEW REPORT FOR CODE ANSYS.
- Review Report for the method for Structural Analysis is included in Appendix A2.13 – REVIEW REPORT FOR METHOD FOR STRUCTURAL.

3.16.9 Thermal Calculations

Thermal Calculations are included in Appendix A2.4 – THERMAL CALCULATIONS, including the detail description about scope, method of analysis, input data, assumptions, analysis, results, conclusions, listing of computer files and references. In order to facilitate the revision of the detailed design, a description about the calculations developed in the mentioned Appendix is included below.

3.16.9.1 Thermal Calculations – Purpose

The purpose of thermal calculations for the storage pad of the TISF of Koeberg NPP is to verify that the ASM is designed to prevent a negative impact on the HI-STAR 100 thermal performance, i.e., the thermal temperatures of the cask with the ASM shall be lower than the temperatures of the cask for the bounding case studied in HI-STAR 100 FSAR.

The thermal analysis of the HI-STAR 100 and the ASM on the pad is performed using a 3D computational fluid dynamics model through FLUENT CFD code pre-processor software [68]. Figure 68 shows the CFD models for the HI-STAR 100 standalone and installed inside the ASM.

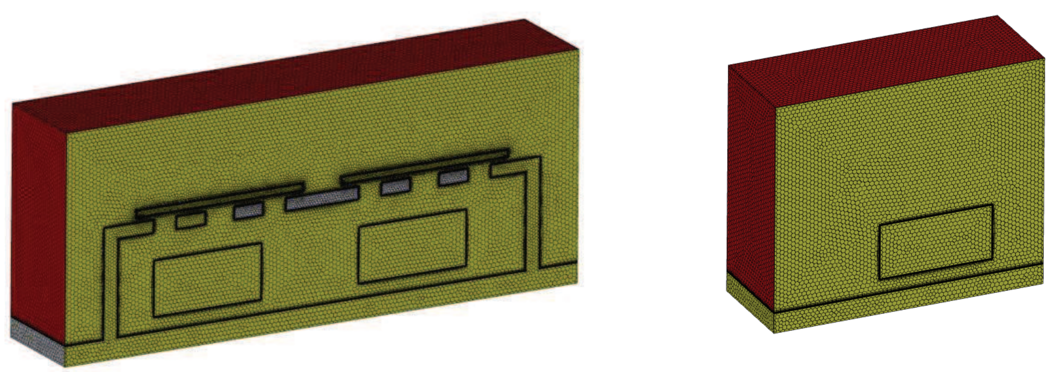

Figure 68: CFD Model for Thermal Analysis

Three cases are considered in the analysis:

- Case 1 is the HI-STAR 100 loaded with 20 kW to define the maximum acceptable volume average temperature of the cask. This case is the bounding case for spent fuel to be loaded according to HI-STAR 100 FSAR.
- Case 2 is the HI-STAR 100 with the ASM and loaded with 15 KW (maximum value according to the spent fuel loading plan at Koeberg) to verify that the volume average temperature of

the cask is below the maximum defined in Case 1.

- Case 3 is the HI-STAR 100 loaded with 15 kW, without ASM, to be used as a sensitivity analysis to evaluate the results from Case 1 and Case 2.

3.16.9.2 Thermal Calculations – Standards and Acceptance Criteria

The development of the CFD model follows the guidelines of NUREG 2152 [20]. The acceptance criterion for the thermal analysis is that the volume average temperature of the HI-STAR 100 with the ASM loaded with 15 kW (maximum heat load to be stored in a single cask at the TISF of Koeberg Nuclear Power Plant) shall be lower than the volume average temperature of the HI-STAR 100 loaded with 20 kW.

3.16.9.3 Thermal Calculations – Results, Conclusions and Recommendations

As to the final results, the volume average temperature of the HI-STAR 100 with the ASM and loaded with 15 kW is 39 °C below the HI-STAR 100 loaded with 20 kW case. Moreover, the installation of the ASM results in an impact of + 2 °C when compared to the HI-STAR 100 without the ASM and loaded with 15 kW case. Therefore, the HI-STAR 100 loaded with 20 kW is a bounding case of the HI-STAR 100 with the ASM and loaded with 15 kW, i.e. no negative impact of the ASM installation is expected. These differences are consistent when maximum cask temperatures are compared and conclusions remain the same.

Compliance of codes and methods according to RG-0016 [50] is justified in the following Review Reports prepared following KGF-001 [40]

- Review Report for the code ANSYS Fluent CFD used in Thermal Calculations is included in Appendix A2.8 – REVIEW REPORT FOR CODE ANSYS.
- Review Report for the method for Thermal Analysis is included in Appendix A2.14 – REVIEW REPORT FOR METHOD FOR THERMAL.

3.17 Impact on the Simulator and KIT

None.

3.18 Environmental Impact and Energy Efficiency

The Environmental Authorisation (EIA) provided by the Department of Environmental Affairs forms the basis of the environmental consideration for this project. The requirements as defined in the EIA shall be complied with during the design and construction of the facility. The environmental management requirements directly related to the TISF during the design phase are summarized in Table 25.

Table 25: Environmental Management and Mitigation Measures During the Design Phase According to Appendix Q EMPr [65]

Aspect	ID	Mitigation measure / Procedure	Compliance
Authorisations	1	Ensure that all required licenses and permits have been obtained before the start of construction. These include but may not be limited to: National Nuclear Regulator (NNR) approval.	This detailed design will be submitted to the NNR.
Waste management	9	Develop a waste management plan, laying out: • Expected type and amount of waste. • Measures to reduce waste. • Type and expected volume of recyclable waste. • Recycling facilities that will collect/receive waste. • Type of storage for different waste types. • Waste contractors that will collect waste.	Waste Management Plan is included in §3.8.10.
Stormwater management	10	Implement the Stormwater Management Plan.	Stormwater drainage is included in §3.8.4.
Visual	11	Reduce the footprint of the TISF and associated infrastructure to a workable minimum.	Justification about the necessary footprint and comparison with similar solutions is given in §3.5.4.
	12	Be sensitive towards the use of glass or material with a high reflectivity which may cause glare and increase visual impacts.	No glass or materials with high reflectivity is used in the design. The ASM reduces the visual impact of the HI-STAR 100 casks.
	13	Limit lighting only to essential activities and facilities. Direct lighting inwards and downwards towards activities and facilities to avoid light spillage and trespass.	Lighting will be designed limiting only to essential activities. The lighting necessary for inspection and maintenance will be installed inside the ASM.

Mitigation measures that are related to the TISF Detailed Design are included in Table 26.

Table 26: Radiation Monitoring Measures According to Appendix Q EMPr [65]

Aspect	ID	Mitigation measure / Procedure	Compliance
TISF Dose Rate Area Monitoring	3	Install radiation monitoring equipment at the TISF site. The monitoring equipment must include detectors with continuous monitoring and alarm capability if pre-determined thresholds are exceeded.	See §3.10.2
TISF Contamination Monitoring	5	Undertake periodic radiological monitoring of stormwater.	See §3.8.4.

3.19 Equipment qualification requirements

The TISF is separate to the plant and other external SSCs (e.g., the CSB and the OSGISF) and therefore will not impact the qualification of existing plant equipment.

3.20 Impact on Original Design Bases

The TISF is separate to the plant and other external SSCs (e.g., the CSB and the OSGISF) and therefore will not impact existing design basis.

3.21 Risk Assessment

There are no significant risks during the operation of the TISF since the same equipment and operations are involved (Goldhofer and Gantry Crane). The risk assessment will be revised and included in the Eskom safety case for NNR approval prior to loading operations.

The construction activities to be developed are those established for typical reinforced concrete civil works (earthworks, formwork activities, steel fixing, using of power tools, scaffolding erection & dismantling, placing concrete, crane lifting activities, laboratory activities).

A detailed risk assessment will be performed as part of the construction activities, including the guidance from SANS 12100 [55] and SANS 31010 [57], considering the risks which occur during the construction of the TISF. The risk assessment will be included in the Eskom safety case for NNR approval prior to constructions activities.

3.22 Part A Design Appendix list

Appendix A1 – DESIGN CONSIDERATION CHECKLIST

Appendix A2 – DESIGN CALCULATIONS

Appendix A3 – SAFETY SCREENING/SAFETY EVALUATION

Appendix A4 – CONTROL ROOM ALARM WINDOW CHANGE

Appendix A1 – DESIGN CONSIDERATION CHECKLIST

TAF / DESIGN NUMBER: 12010TISF-0017		Addressed	Not Applicable
Chemistry			
1.	Chemistry requirements such as provision for sampling and limitations on water chemistry.	☐	☒
Control & Instrumentation			
2.	Have KLM-011 and KLM-012 been considered with respect to the required accuracy of any new instrumentation?	☐	☒
3.	Instrumentation and control requirements including indicating instruments, controls and alarms required for operation, testing and maintenance. Other requirements such as the type of instrument, installed spares, range of measurement and location of indication should also be included.	☐	☒
4.	Microprocessor and Automation Design Checklist – Complete and attach 240-119531688 (KFU-019) if applicable.	☐	☒
5.	Was the EPRI Gold Card Report (1022990) for new circuit card systems considered while completing the PM Strategy Input Sheet?	☐	☒
Conventional Safety			
6.	Have all of the hazardous location requirements been addressed?	☒	☐
7.	Have the conventional safety risks that will be present during construction been considered? Does the design consider constructability and the construction process?	☒	☐
8.	Requirements to prevent undue risk to the health and safety of the public.	☒	☐
9.	Safety requirements for preventing personnel injury including such items as restricting the use of dangerous materials, escape provisions from enclosures, grounding of electrical systems and other conventional safety considerations.	☒	☐
Cyber Security			
10.	Consider if the design shall introduce changes to digital, network and communication systems associated with safety, security and emergency preparedness functions, if it will, then ensure all applicable technical controls as per 240- 118792614 Operational Technology Cyber Security Programme at Koeberg Operating Unit are applied accordingly.	☐	☒
11.	For information on plant digital systems regarding cyber security vulnerabilities contact the Koeberg Operational Technology Cyber Security Engineer to ensure that required actions and mitigations were taken to address the identified vulnerabilities in the design.	☐	☒
12.	Baseline configurations introduced by the modification shall be submitted to Koeberg Operational Technology Cyber Security Engineer, this shall include as a minimum, a current list of all components e.g., hardware, software, configuration of peripherals and software version release, as well as switch settings of the machine/hardware components.	☐	☒
Electrical			
13.	Diesel Generator Load Balance Performed.	☐	☒
14.	Electrical requirements such as source of power, voltage, impact on back up battery loading (in particular DTV), raceway requirements, electrical insulation and motor requirements.	☐	☒
15.	New electrical board loads calculated and original drawings updated with new values?	☐	☒

TAF / DESIGN NUMBER: 12010TISF-0017		Addressed	Not Applicable
Environment			
16.	Effect on Environmental Qualifications – Complete and attach KFU-021 if applicable.	☐	☒
17.	Environmental conditions anticipated during storage, construction and operation such as pressure, temperature, humidity, corrosiveness, site elevation, wind direction, nuclear radiation, electromagnetic radiation and duration of exposure.	☒	☐
Equipment Failure & Redundancy			
18.	Common-mode failures and other common-mode effects.	☒	☐
19.	Failure modes and effects considerations of structures, systems and components including a definition of those events and accidents for which they must be designed to withstand.	☒	☐
20.	Have KGU-035 and KGU-038 been considered with respect to Single Point Vulnerabilities, that is SPV's eliminated and /or no new SPV's introduced. Also, see SPV Master List on the NalApp for SPV components. Note: If any doubt exists that an SPV is affected, contact the SPV project owner.	☐	☒
21.	Redundancy, diversity and separation requirements of structures, systems and components.	☐	☒
Fire Protection			
22.	Fire protection or resistance requirements.	☐	☒
23.	For changes to a fire system, has concurrence from FRM been obtained?	☐	☒
24.	Was the impact of new installations to combustible loading of fire sectors described in KLV-001 Appendix 8, considered? When applicable, update Koeberg Fire Load Listing, KBA1222A001015, using 240-118672865 as guidance.	☐	☒
25.	For new or altered buildings, has a Fire Protection/Detection Assessment been completed in accordance with Eskom standard 240-54937439?	☐	☒
General			
26.	Basic functions of each system, structure, and component.	☒	☐
27.	Design process conditions such as pressure, temperature, fluid chemistry and radiation levels.	☒	☐
28.	Layout and arrangement requirements.	☒	☐
29.	Performance requirements such as capacity, rating, system output.	☒	☐
30.	Transportation, handling and storage requirements such as size, shipping weight and legal limitations.	☒	☐
Human Factors and Personnel			
31.	Adequate protection exists to prevent inadvertent activation of essential controls, e.g. emergency buttons?	☐	☒
32.	Effect of the design on the Control Room Human Engineering Factors.	☐	☒

TAF / DESIGN NUMBER: 12010TISF-0017		Addressed	Not Applicable
33.	Personnel requirements and limitations including the qualification and number of personnel available for plant operation, maintenance, testing and inspection and permissible personnel radiation exposures for specified areas and conditions.	☐	☒
Koeberg Processes and Programmes			
34.	Are the safety screening / evaluation and design input consideration checklist completed using the latest design scope changes?	☒	☐
35.	Determined the effect on Severe Accident Management Guidelines?	☐	☒
36.	Foreign Material Exclusion (FME) requirements during all intrusive mechanical work such as cutting, grinding and welding.	☐	☒
37.	Has this modification resulted in new classifications? Has the impact on technical specifications, procedures, transient files and programmatic controls been determined? Has the new classification been considered adequately for safety importance?	☒	☐
38.	Have all engineering programmes related documents and requirements been considered e.g. PER, EQ, IST, CAMP?	☒	☐
39.	Is the current design change being simultaneously implemented on the same system with another design change package and has the impact been assessed and been documented in both design change packages?	☐	☒
Maintenance			
40.	Accessibility, maintenance, repairs and in-service inspection requirements for the plant, including the conditions under which these will be performed.	☒	☐
41.	Has the PM Strategy Input Sheet (QFR-026) been sent to Reliability Engineering? (Engineering Request (ER) number to be included in the DCIF).	☐	☒
Materials & Surface Treatment			
42.	Avoided selecting materials that contain zinc in components to be installed in containment.	☐	☒
43.	Have surface treatment processes on new equipment been evaluated in relation to the elimination or reduction of high dose radioisotopes?	☐	☒
44.	Material requirements including such items as compatibility, electrical insulation properties, protective coating and corrosion resistance, including flow accelerated and microbiologically induced corrosion.	☐	☒
Mechanical & Civil			
45.	Have the appropriate drains been identified and are they being used?	☒	☐
46.	Hydraulic requirements such as pump suction and discharge elevations and pressures, allowable pressure drops and allowable fluid chemistry.	☐	☒
47.	Loads such as seismic, wind, thermal and dynamic.	☒	☐
48.	Mechanical requirements such as vibration, stress, shock and reaction forces.	☒	☐
49.	Structural requirements covering such items as equipment foundations and pipe supports.	☒	☐

	TAF / DESIGN NUMBER: 12010TISF-0017	Addressed	Not Applicable
	National Grid		
50.	Has the system operator been informed of any modification, in particular GEV, GEX, GSY, GPA and LGR (including LGR protection settings) to determine if it affects Transmission protection equipment settings?	☐	☒
51.	Impact on the South African Grid Code – Complete and attach 240-119530923 (KFU-018) if applicable.	☐	☒
52.	This modification must be evaluated to determine its impact on the Grid and the relevant offsite responsible authority such as the System Operator, Transmission, or Distribution must be informed, and concurrence requested?	☐	☒
	Operating Experience (OE)		
53.	Has EDF implemented a similar modification, has this information been considered in this design? If so, are the input parameters similar?	☐	☒
54.	Relevant Operating Experience.	☒	☐
55.	Was any EPRI guidance/report/study considered?	☐	☒
	Operational		
56.	Interface requirements including definition of the functional and physical interfaces involving structures, systems and components.	☒	☐
57.	Operational requirements under various conditions such as plant start-up, shutdown, power operation or emergency operation.	☒	☐
58.	Reactivity management considerations such as heat balance, boron concentration, burnup, poisons and control rod positioning.	☐	☒
	Radiation		
59.	Are any additional nuclear safety analyses necessary for the design and is there an update required to Koeberg analysis models and codes (e.g. PSA, MAAP, RELAP, and SCALE)?	☒	☐
60.	Considered if there is an effect of the design on the RP Migration Model.	☐	☒
61.	Radiation exposure to the public and to plant personnel (application of the ALARA principle). Complete and attach 240-119528368 (KFU-028) if applicable.	☒	☐
62.	Has the Radwaste Department been informed of any radwaste that will be generated during implementation of this design change? Note: Capture any recommendations provided by the Radwaste Department in the design package.	☐	☒
	Regulatory		
63.	Code reconciliation to ASME XI of new plant items not conforming to the DSE referenced construction code. Note: The use of the RCC-M code for the procurement of Safety Class 2 and 3 mechanical components and spare parts without the requirement for a reconciliation report is allowed. See NNR letter k27507N.	☐	☒
64.	Codes, standards and regulatory requirements including the applicable issue and/or addenda. If ASME III is used refer to the latest NRC 10 CFR 50.55a for any limitations of use.	☐	☒
65.	Compliance with the requirements of ANSI/ANS-58.8 Time Response Design Criteria for Safety-Related Operator Actions.	☐	☒

TAF / DESIGN NUMBER: 12010TISF-0017		Addressed	Not Applicable
Security & Access Control			
66.	Access and administrative control requirements for plant security.	☒	☐
Simulator			
67.	Has the simulator engineer been informed of this design change to the plant? Note: If any doubt exists that the design change has an impact on the simulator, contact the simulator engineer.	☐	☒
Software			
68.	Is the version of the software used for analysis in the design later than the version listed in 331-398 (KLA-022)? If so, update 331-398 (KLA-022)	☐	☒
69.	Software and programming requirements.	☐	☒
70.	Software Design Consideration Checklist – Complete and attach 240-119532043 (KFU-020) if applicable.	☐	☒
Testing			
71.	Test requirements including in-plant tests and the conditions under which they will be performed. Are ASME XI leak tests in lieu of hydro tests justified in the design.	☐	☒
Training			
72.	Has the Training Change Request (TCR) form (KFT-004) been sent to the Koeberg training department? (TCR number to be included in the DCIF). Note: This step is mandatory for all modifications.	☐	☒

Comments:

Redacted Contractor names in accordance with PAIA Chapter 4, Section 38

The design input requirements are correctly selected and reasonable

		22nd April 2024
COMPILER	SIGNATURE	DATE
		22nd April 2024
REVIEWER	SIGNATURE	DATE

Public

Appendix A2 – DESIGN CALCULATIONS

PAIA Chapter 4 Section 37

The detailed design calculations, including results, software models and applied calculation methodologies for the TISF design analyses are redacted / not included as they are KCC intellectual property.

The design calculations and results are summarised in the following sections:

- SHIELDING CALCULATIONS: Section 3.16.6
- SEISMIC CALCULATIONS: Section 3.16.7
- STRUCTURAL CALCULATIONS: Section 3.16.8
- THERMAL CALCULATIONS: Section 3.16.9
- SIDE DROP ANALYSIS: Section 3.13

Appendix A2.16 – TISF KOEBERG DETAILED DESIGN DRAWINGS

PAIA Chapter 4 Section 37

The following drawings are redacted as they are Contractor intellectual property (Refer to Section 3.16.4)

- 00857PL007 – SHAPE DRAWINGS AUXILIARY SHIELDING MODULE
- 00857PL008 – REBAR DETAIL 1
- 00857PL009 – REBAR DETAIL 2
- 00857PL010 – OPERATIONS

GENERAL NOTES:

1. THIS SET OF NOTES SHALL BE READ IN CONJUNCTION WITH ALL ASSOCIATED DRAWINGS & SPECIFICATIONS. SPECIFIC NOTES AND DETAILS ON DETAILED DRAWINGS SHALL TAKE PRECEDENCE OVER THESE GENERAL NOTES. THE DESIGN ENGINEER'S DRAWINGS SHALL BE READ IN CONJUNCTION WITH ALL RELEVANT CONSULTANTS' AND SPECIALIST DRAWINGS AND THE BILL OF QUANTITIES. DISCREPANCIES SHALL BE REFERRED TO THE RESPONSIBLE ENGINEER PRIOR TO CONSTRUCTION.

2. DRAWINGS SHALL NOT BE SCALED, ONLY GIVEN DIMENSIONS TO BE USED.

3. ALL CONSTRUCTION METHODS AND MATERIALS USED ARE TO BE IN ACCORDANCE WITH THE REQUIREMENTS OF SANS 10400 AND SANS 1200 AND ALL OTHER APPLICABLE SANS CODES OF PRACTICE. A NON-INCLUSIVE LIST FOLLOWS:
(i) SANS 1200 A (1986): GENERAL
(ii) SANS 1200 AA (1986): SMALL WORKS
(iii) SANS 1200 D (1988): EARTHWORKS
(iv) SANS 1200 G (1982): CONCRETE (STRUCTURAL)
(v) SANS 1200 GB (1984): CONCRETE (ORDINARY BUILDINGS)
(vi) SANS 1077 (2009): SEALING COMPOUNDS FOR THE BUILDING & CONSTRUCTION INDUSTRY
(vii) SANS 2001: CONSTRUCTION WORKS
(viii) SANS 10400: NATIONAL BUILDING REGULATIONS
(iv) SANS 10155 (2009): ACCURACY IN BUILDINGS

CONCRETE:

1. ALL STRUCTURAL USE OF CONCRETE TO BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE SPECIFICATIONS FOR CONCRETE DESIGN AND THE FOLLOWING:
(i) SANS 10100-1 THE STRUCTURAL USE OF CONCRETE PART 1: DESIGN
(ii) SANS 10100-2 THE STRUCTURAL USE OF CONCRETE PART 2 : MATERIALS AND EXECUTION OF WORK

2. CONCRETE FOR CONCRETE PAD MUST COMPLY WITH THE FOLLOWING MATERIAL PROPERTIES:
(i) MINIMUM CONCRETE COMPRESSIVE STRENGTH: 30 MPA
(ii) MAXIMUM COMPRESSIVE STRENGTH: 51.7 MPA
(iii) MINIMUM COVER: 60 MM
(iv) MAXIMUM W/C RATIO: 0.5
(v) MINIMUM CONTENT OF CEMENT (KG/M3): 300
(vi) MAXIMUM WATER PENETRATION DEPTH (UNE-EN 12390-8): 50 MM
(vii) AVERAGE WATER PENETRATION DEPTH (UNE-EN 12390-8): 30 MM
(viii) CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D OR CONCRETE WITH MORE THAN 6 % ADDED MICROSILICA OR MORE THAN 20 % ADDED FLY ASH.
(ix) PENETRON ADMIX SHALL BE ADDED TO THE CONCRETE MIX TO IMPROVE CORROSION RESISTANCE FOLLOWING THE PENETRON ADMIX DIRECTIONS FOR USE.

3. CONCRETE FOR ASM AND APPROACH APPRONS MUST COMPLY WITH THE FOLLOWING MATERIAL PROPERTIES:
(i) MINIMUM CONCRETE COMPRESSIVE STRENGTH: 30 MPA
(i) MINIMUM COVER: 60 MM
(ii) MAXIMUM W/C RATIO: 0.5
(iii) MINIMUM CONTENT OF CEMENT (KG/M3): 300
(iv) MAXIMUM WATER PENETRATION DEPTH (UNE-EN 12390-8): 50 MM
(v) AVERAGE WATER PENETRATION DEPTH (UNE-EN 12390-8): 30 MM
(vi) CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D OR CONCRETE WITH MORE THAN 6 % ADDED MICROSILICA OR MORE THAN 20 % ADDED FLY ASH.
(vii) PENETRON ADMIX SHALL BE ADDED TO THE CONCRETE MIX TO IMPROVE CORROSION RESISTANCE FOLLOWING THE PENETRON ADMIX DIRECTIONS FOR USE.

4. CONCRETE FOR DRAINAGE CHANNEL MUST COMPLY WITH THE FOLLOWING MATERIAL PROPERTIES:
(i) MINIMUM CONCRETE COMPRESSIVE STRENGTH: 25 MPA
(ii) PENETRON ADMIX SHALL BE ADDED TO THE CONCRETE MIX TO IMPROVE CORROSION RESISTANCE FOLLOWING THE PENETRON ADMIX DIRECTIONS FOR USE.

5. CONCRETE CUBE TESTS TO BE CARRIED OUT ON ALL POURS IN ACCORDANCE WITH SANS 1200 G AND SANS 2001-CC1 REQUIREMENTS, WITH SPECIFIC REFERENCE TO SAMPLING FREQUENCY. SAMPLES SHALL BE TAKEN AT LEAST ONCE PER DAY FOR EACH CLASS OF CONCRETE PLACED, OR AT LEAST ONCE FOR EACH 75 m 3 OF CONCRETE PLACED.

6. CONCRETE DURABILITY TESTING SHALL BE PERFORMED IN ACCORDANCE WITH THE ASSOCIATED SANS 3001-CO3 METHOD OR THE UCT DURABILITY TESTING PROCEDURE MANUAL.

7. ALL CONCRETE CORNERS SHALL BE FINISHED AS 30 X 45 DEG OR SIMILAR.

8. TOLERANCES ARE AS FOLLOWS:
(i) ALL CONCRETE THICKNESSES SHALL BE CONSIDERED AS MINIMUM REQUIRED EXCEPT FOR THE PAD WHICH SHALL BE CONSIDERED AS MAXIMUM REQUIRED.
(ii) PRECAST ITEMS, AIR VENTILATION OPENINGS AND IN-SITU ITEMS SURFACES IN CONTACT WITH PRECAST ITEMS REQUIRE SANS 2001 DEGREE OF ACCURACY I.
(iii) UNLESS NOTED ABOVE, SANS 2001 DEGREE OF ACCURACY II IS REQUIRED.

9. ALL CONCRETE JOINTS BETWEEN IN-SITU AND PRECAST CONCRETE PARTS SHALL BE SEALED WITH SIKAFLEX PRO-3 TO PREVENT WATER ENTRY INSIDE THE ASM.

10. THE STEEL FORMWORK FOR CONCRETE PRECAST PARTS SHALL BE LUBRICATED TO REDUCE ADHESION.

11. MORTAR USED FOR CONCRETE HOLES FILLING SHALL HAVE A DENSITY HIGHER THAN 2.3 G/CM3.

FILL:

1. ENGINEERED FILL MUST COMPLY WITH THE FOLLOWING SPECIFICATIONS:
(i) EXISTENT SOIL COMPACTED TO 95%MDD IN LAYERS OF NO MORE THAN 150 MM.

STEEL:

1. ALL CONCRETE REINFORCING STEEL SHALL BE DEFORMED BARS WITH MINIMUM 450 MPA YIELD STRENGTH. WELDING OF REINFORCING STEEL IS NOT PERMITED.

2. LAP SPLICES OF FLEXURAL REINFORCEMENT SHALL BE PERMITTED ONLY IF HOOP OR SPIRAL REINFORCEMENT IS PROVIDED OVER THE LAP LENGTH AS PER ACI 349-06 21.3.2.3

3. DEVELOPMENT LENGTH AND LAP SPLICE LENGTH MUST COMPLY WITH BOTH ACI 349 AND SABS 0144. GOOD CONDITIONS MEANS HORIZONTAL BARS WITH MORE THAN 300 MM FRESH CONCRETE BELOW, BAD CONDITIONS OTHERWISE.

4. MINIMUM DIAMETER OF BEND MUST COMPLY WITH BOTH ACI 346 AND SABS 0144. MINIMUM DIAMETER OF BEND FOR 25 MM AND SMALLER SHALL BE LARGER THAN OR EQUAL TO 6ø, 8ø FOR LARGER BARS.

OPERATIONS:

1. GOLDHOFER TRANSPORTER, HI-STAR 100 CASK AND GANTRY CRANE DRAWINGS ARE OBTAINED FROM:
(i) SLT 00850 – V0143 CSB LAYOUT AND LIFTING PLAN (VANGUARD RIGGING (PTY) LTD)
(ii) SLT 00849 – V0143 132.139KG WASTE CASK ON-SITE TRSP.COMB. GOLDHOFER PST-SL (45) 10 AXLE, 2-FILE

2. MAXIMUM LIFTING ANGLES FOR LIFTING SYSTEMS REFERS TO THE VERTICAL DIRECTION.

[redacted]

DEVELOPMENT LENGTH AND LAP SPLICE LENGTH FOR 30 MPA CONCRETE AND 450 MPA STEEL

BAR DIAMETER	DEVELOPMENT LENGTH				LAP SPLICE LENGTH	
	STRAIGHT		STD 90 DEG HOOK		STRAIGHT	
	GOOD CONDITIONS	BAD CONDITIONS	GOOD CONDITIONS	BAD CONDITIONS	GOOD CONDITIONS	BAD CONDITIONS
8	360	470	210	260	470	620
10	450	580	230	320	590	760
12	540	700	270	390	710	910
16	710	930	360	510	930	1210
20	1110	1440	450	640	1450	1880
25	1390	1800	560	800	1810	2340
32	1770	2310	710	1030	2310	3010

REBAR SUPPORT CHAIRS

TypeØ	Mark	No	Length	Shape	A	B	C	D	E	r	Mass each	All
Y10	APROACH	740	1417	83	350	230	350				0.87	643,8
Y16	CONCRETE PAD	1850	2488	83	350	780	350				3.93	7.270,5

TOTAL BARS FOR THE 3 APPROACH APRON AND 3 CONCRETE PADS

TABLE OF LIFTING SYSTEMS

PART NAME - LIFTING SYSTEM PURPOSE	QTY	ITEM	MATERIAL	ACCESORIES	MAXIMUM LIFTING ANGLE (º)	PROTECTION	LIFTING LINK
FRONT SHIELDING DOOR - LIFTING DURING OPERATIONS	4x	HD 6360-7,5-400	A4-80	6358-30 + 6363-30	30	6359-30	6367-30
FRONT SHIELDING DOOR - FORMWORK TILT-UP				6358-30 + 6363-30	FOR TILT-UP	6359-30	
ROOF SHIELDING - LIFTING DURING OPERATIONS	4x	HD 6360-7,5-400	A4-80	6358-30 + 6363-30	20	6359-30	
ROOF SHIELDING - FORMWORK TILT-UP	3x	TPA-FS 22,0-62	HOT-DIP GALVANIZED	TPA-A1 26,0	FOR TILT-UP	FILLED WITH MORTAR	TPA R1 26,0
TOP COVER - LIFTING DURING CONSTRUCTION	4x	TPA-FS 5,0-18	HOT-DIP GALVANIZED	TPA-A1 5,0	30		TPA R1 5,0
TOP COVER - FORMWORK TILT-UP	3x	TPA-FS 5,0-18	HOT-DIP GALVANIZED	TPA-A1 5,0	FOR TILT-UP		
INSPECTION OPENING SHIELDING ROOF - LIFTING DURING CONSTRUCTION	4x	TPA-FS 5,0-18	HOT-DIP GALVANIZED	TPA-A1 5,0	30		
INSPECTION OPENING SHIELDING ROOF - FORMWORK TILT-UP	3x	TPA-FS 5,0-18	HOT-DIP GALVANIZED	TPA-A1 5,0	FOR TILT-UP		

NOTE: QUANTITY IS SHOWN AS REQUIRED FOR EACH INDIVIDUAL PART NAME

CONTROL DE CAMBIOS / REVISION LOG

REV	DESCRIPCIÓN/DESCRIPTION	DIBUJADO POR/ DRAWN BY	VERIFICADO POR/ CHECKED BY	APROBADO POR/ APPROVED BY	FECHA/DATE
00	FIRST ISSUE	PNI	DRS	SSG	04.12.2023
01	GENERAL REVIEW	PNI	DRS	SSG	20.12.2023
02	GENERAL MODIFICATIONS	DGG	DRS	SSG	29.02.2024
03	GENERAL REVIEW	DGG	DRS	SSG	08.07.2024

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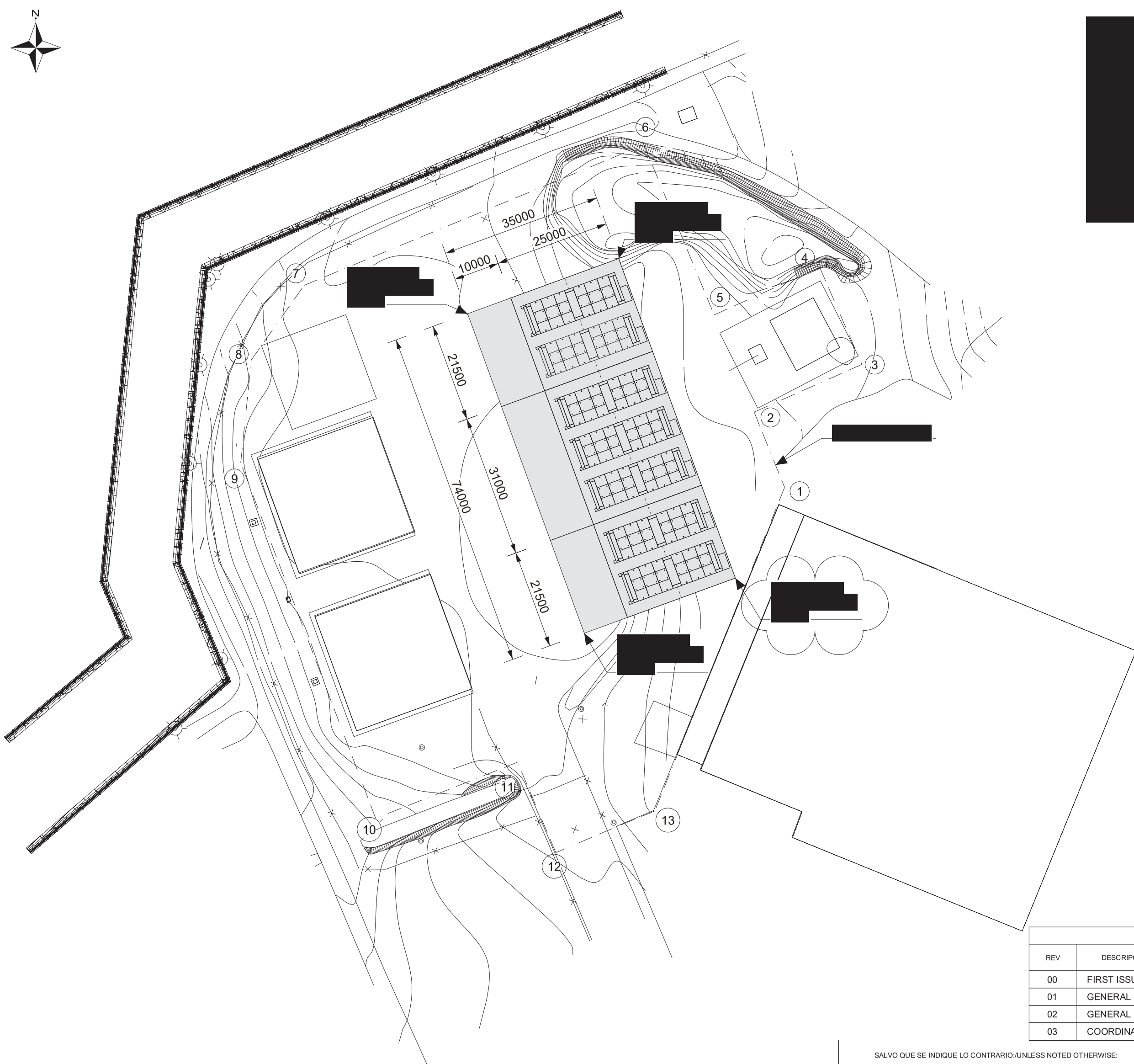
MEDIDAS EN PULGADAS SE MUESTRAN [ ]/INCH DIMENSIONS SHOWN IN [ ]
NO ESCALAR EL PLANO/DO NOT SCALE THE DRAWING

TÍTULO/TITLE: KOEBERG NPS TISF
NOTES
GENERAL NOTES

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION

ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
-	00857	00857PL004	1 OF 1	03



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GENERAL VIEW
1:1000

CONTROL DE CAMBIOS / REVISION LOG

REV	DESCRIPCIÓN/DESCRIPTION	DIBUJADO POR/ DRAWN BY	VERIFICADO POR/ CHECKED BY	APROBADO POR/ APPROVED BY	FECHA/DATE
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03	COORDINATES REVIEW	DGG	DRS	SSG	08.07.2024

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TÍTULO/TITLE: KOEBERG NPS TISF
TISF LAYOUT
GENERAL VIEW

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION

ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
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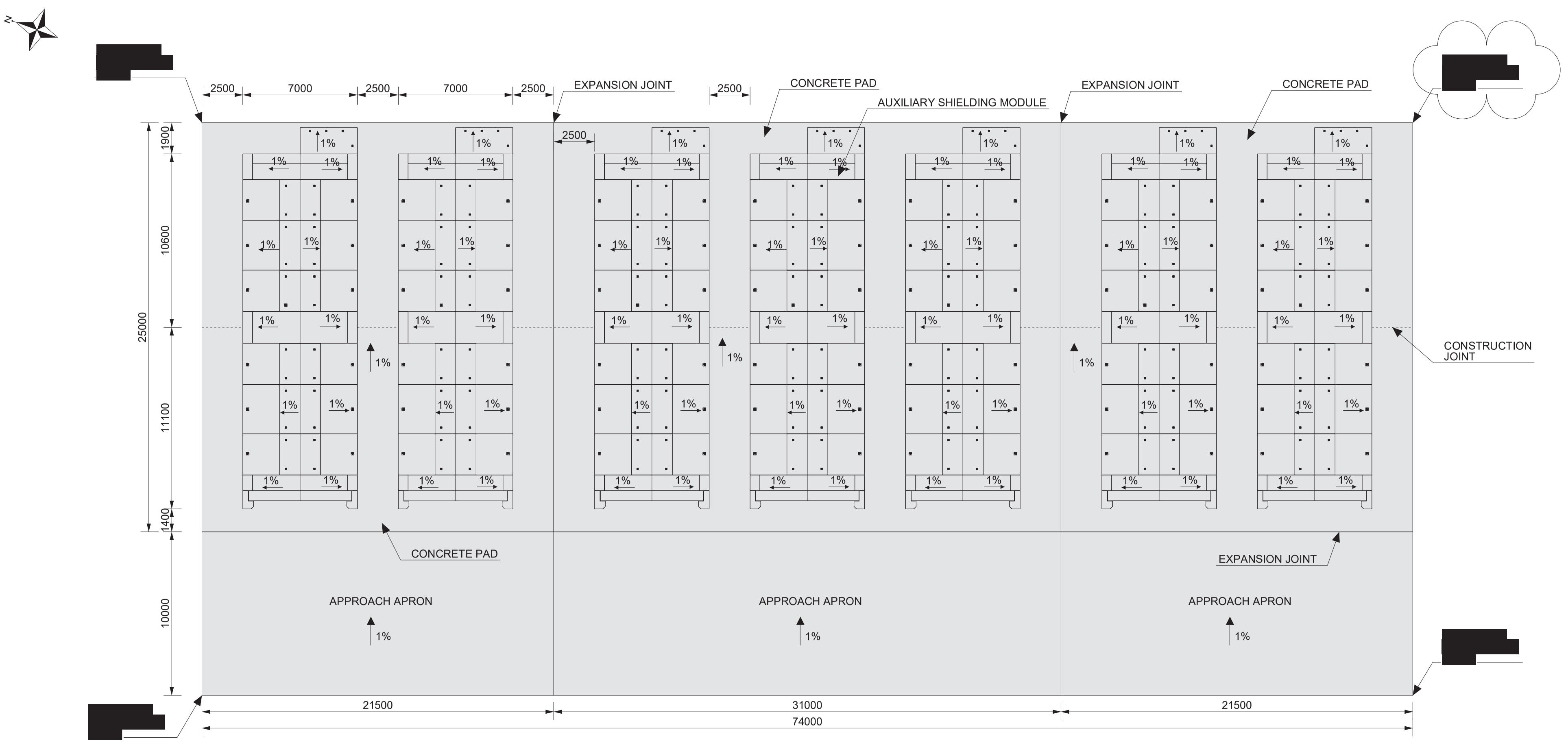
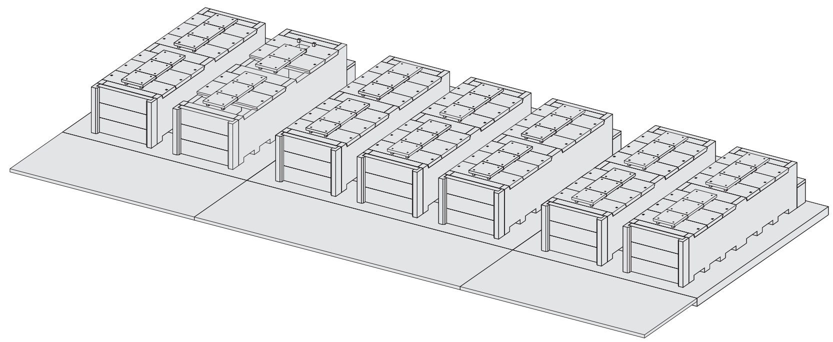


GENERAL VIEW
1:250



GENERAL VIEW
1:500

CONTROL DE CAMBIOS / REVISION LOG

REV	DESCRIPCIÓN/DESCRIPTION	DIBUJADO POR/ DRAWN BY	VERIFICADO POR/ CHECKED BY	APROBADO POR/ APPROVED BY	FECHA/DATE
00	FIRST ISSUE	PNI	DRS	SSG	04.12.2023
01	GENERAL REVIEW	PNI	DRS	SSG	20.12.2023
02	DRAINAGE SLOPES	DGG	DRS	SSG	29.02.2024
03	COORDINATES REVIEW	DGG	DRS	SSG	08.07.2024

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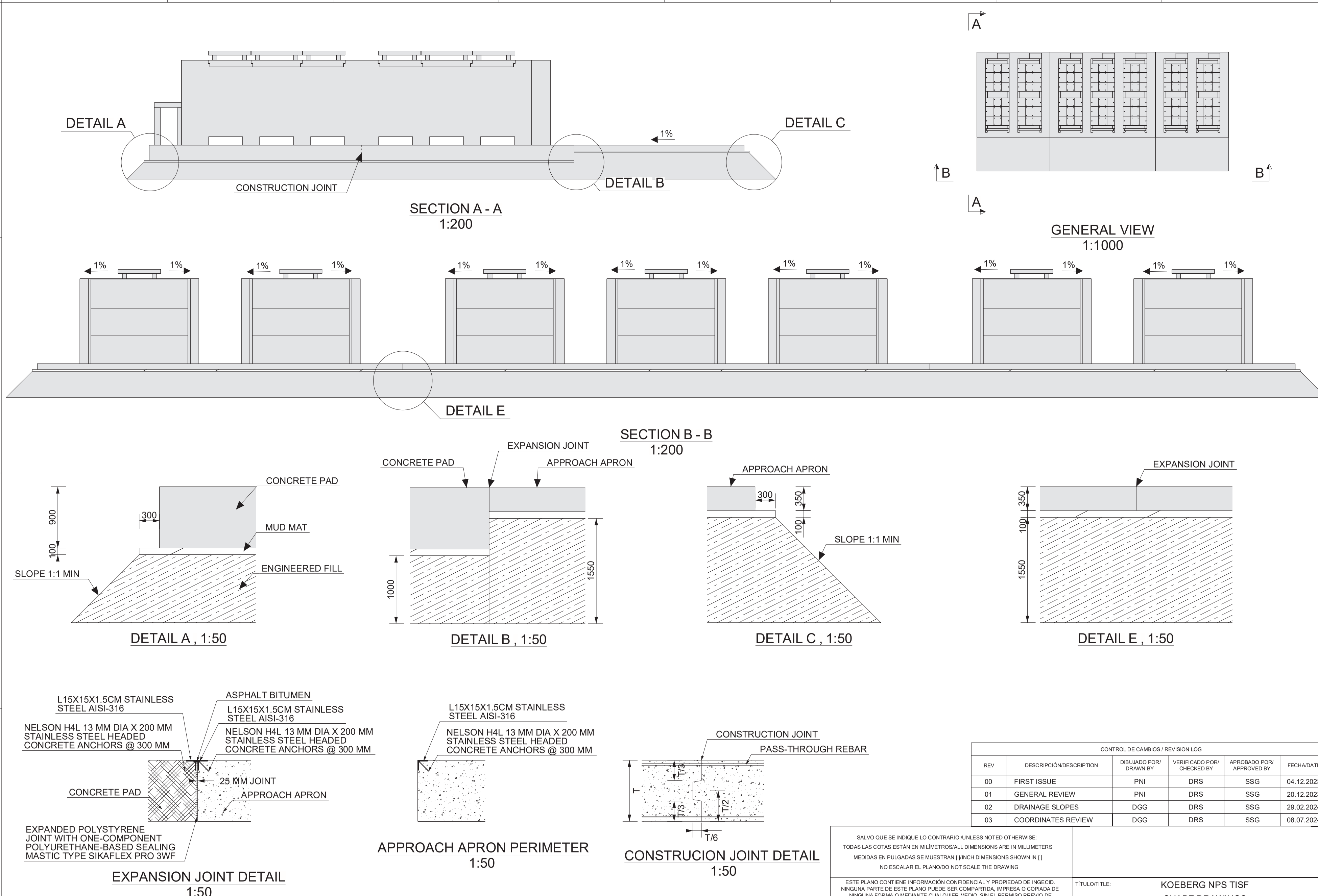
TÍTULO/TITLE: KOEBERG NPS TISF
SHAPE DRAWINGS
GENERAL VIEW

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION	ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
	-	00857	00857PL006	1 OF 3	03



CONTROL DE CAMBIOS / REVISION LOG

REV	DESCRIPCIÓN/DESCRIPTION	DIBUJADO POR/ DRAWN BY	VERIFICADO POR/ CHECKED BY	APROBADO POR/ APPROVED BY	FECHA/DATE
00	FIRST ISSUE	PNI	DRS	SSG	04.12.2023
01	GENERAL REVIEW	PNI	DRS	SSG	20.12.2023
02	DRAINAGE SLOPES	DGG	DRS	SSG	29.02.2024
03	COORDINATES REVIEW	DGG	DRS	SSG	08.07.2024

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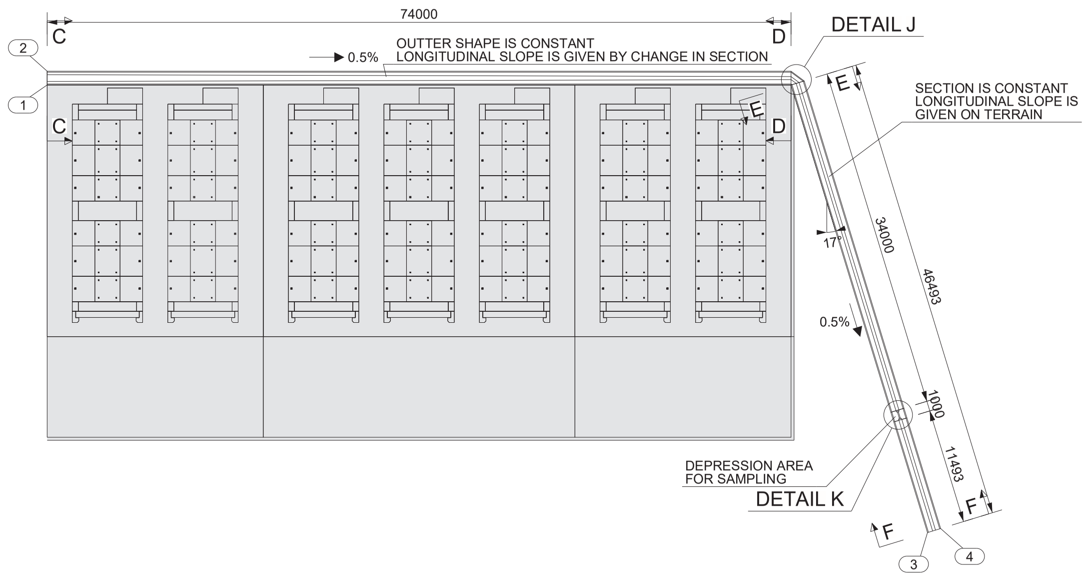
NO ESCALAR EL PLANO/DO NOT SCALE THE DRAWING

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION

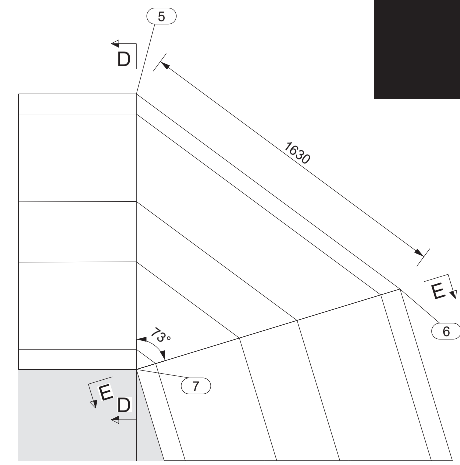
TÍTULO/TITLE: KOEBERG NPS TISF SHAPE DRAWINGS GENERAL VIEW

ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
-	00857	00857PL006	2 OF 3	03

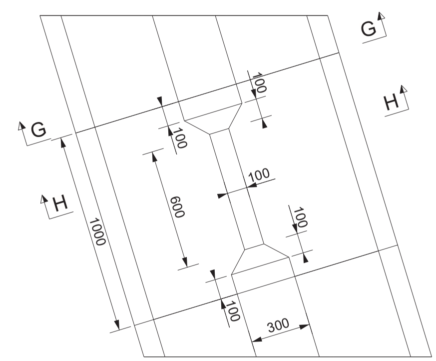
[redacted]



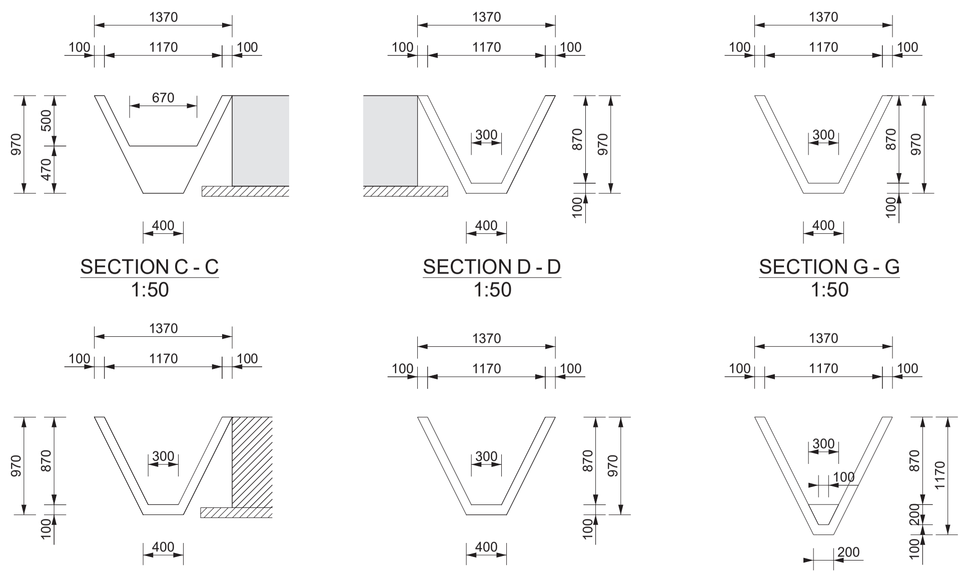
STORMWATER DRAINAGE CHANNEL LAYOUT
1:500



DETAIL J , 1:25



DETAIL K , 1:25



SECTION C - C
1:50

SECTION D - D
1:50

SECTION G - G
1:50

SECTION E - E
1:50

SECTION F - F
1:50

SECTION H - H
1:50

CONTROL DE CAMBIOS / REVISION LOG

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02	DRAINAGE SLOPES	DGG	DRS	SSG	29.02.2024
03	COORDINATES REVIEW	DGG	DRS	SSG	08.07.2024

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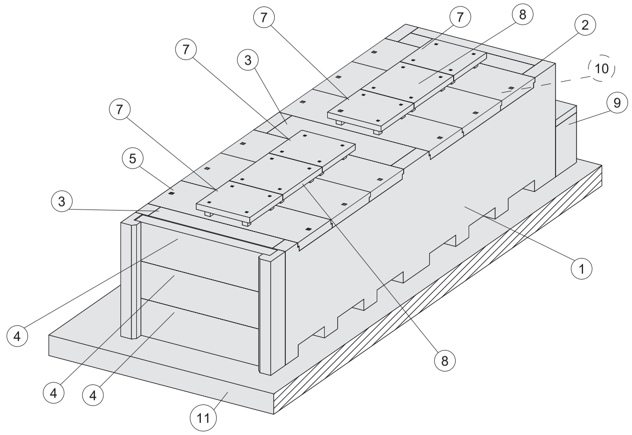
TÍTULO/TITLE: KOEBERG NPS TISF SHAPE DRAWINGS GENERAL VIEW

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION

ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
-	00857	00857PL006	3 OF 3	03

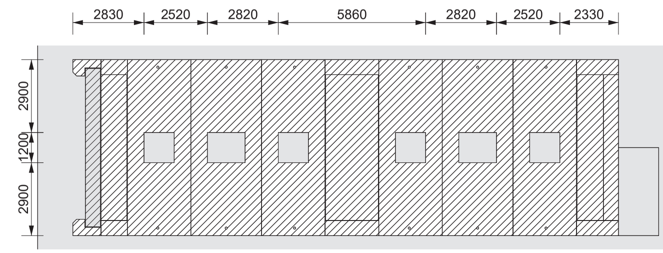


GENERAL VIEW
1:200

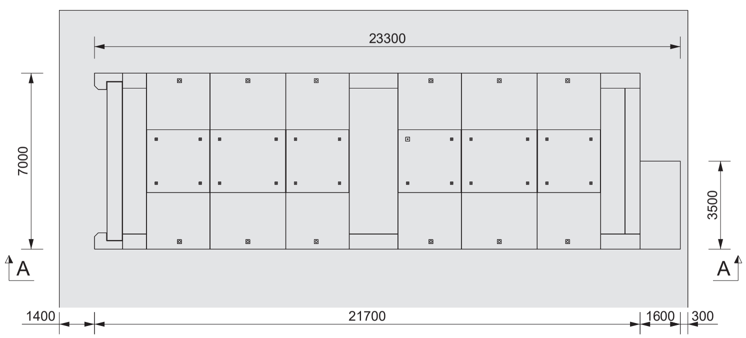
PART NUMBER, NAME AND WEIGHT:

1 - EAST AND WEST WALLS, 284.25 TON
2 - REAR WALL, 40.5 TON
3 - ROOF (WALLS), 29.25 TON
4 - FRONT SHIELDNG DOOR, 15.75 + 15.25 + 15.75 TON
5 - ROOF SHIELDING TYPE 1, 19.5 TON (1 UNIT)
6 - ROOF SHIELDING TYPE 2, 22 TON (1 UNIT)
7 - TOP COVER TYPE 1, 4 TON (1 UNIT)
8 - TOP COVER TYPE 2, 4.75 TON (1 UNIT)
9 - INSPECTION OPENING SHIELDING WALLS, 11.5 TON
10 - INSPECTION OPENING SHIELDING ROOF, 4.25 TON
11 - CONCRETE PAD, 1209.25 + 1743.75 + 1209.25 TON

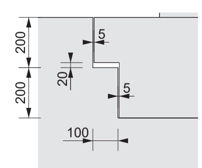
Redacted detail related spent fuel cask storage in accordance with PAIA Chapter 4, Section 37



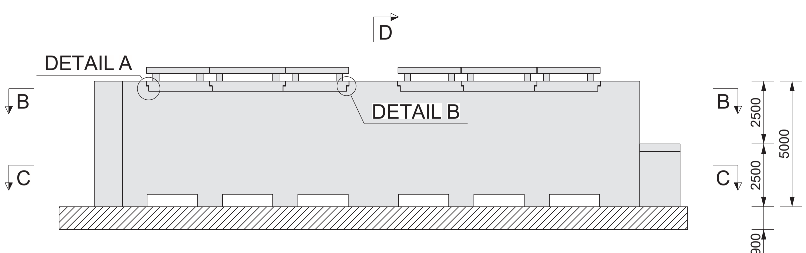
SECTION B - B
1:200



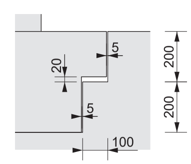
GENERAL VIEW
1:200



DETAIL A , 1:20



SECTION A - A
1:200



DETAIL B , 1:20

CONTROL DE CAMBIOS / REVISION LOG

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03	GENERAL REVIEW	DGG	DRS	SSG	08.07.2024

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NO ESCALAR EL PLANO/DO NOT SCALE THE DRAWING

INGECID

TÍTULO/TITLE: KOEBERG NPS TISF
SHAPE DRAWINGS
AUXILIARY SHIELDING MODULE

PROYECCIÓN DEL TERCER ÁNGULO/ THIRD ANGLE PROJECTION

ESCALA/SCALE:	PROYECTO/PROYECT NO.	PLANO/DRAWING NO.	HOJA/SHEET	REV.
-	00857	00857PL007	1 OF 5	03

Appendix A3 – SAFETY SCREENING/SAFETY EVALUATION

Appendix A3.1 – SAFETY SCREENING S2023-0056

Eskom	**Safety Screening** Safety Evaluation Process KAA-709 (240-143604773), Appendix 3	Template Identifier	240-43921804	Rev	6
		Document Identifier	240-146184895 KFA-047	Rev	4
		Effective Date	13 December 2022		
		Review Date	December 2025		

No: S2023-0056 **Rev.** 0

Reason for Revision: Revision 0

CONCLUSION

Is a Safety Evaluation Required (according to section 4.0 or 5.0)? Yes Safety Evaluation no: **E**2023-0001

Is NNR approval required (according to Section 6.0 or 7.0)? Yes

PREPARED BY: Redacted Contractor names in accordance with PAIA Chapter 4, Section 38

Signature: *2024-03-27*

(Preparer, Reviewer and Approver to be authorised in accordance with KTA-005)

INDEPENDENTLY REVIEWED BY:

Signature: *2024-03-27*

(Reviewer to be authorised as a Safety Evaluator)

APPROVED BY:

Signature: 2024-03-27

(Approver must not be the reviewer and must be authorised as ~~a~~ Safety Screener or Safety Evaluator)

If approved by the preparer (compiler), and it screens out (i.e. no Safety Evaluation required), state here why a different approver was not available.

1.0 Description

1.1 **This Safety Screening is for** a Full Modification

Activity or Condition No.: 12010 – Transient Interim Storage Facility Spent Fuel Cask Storage Pad

Title: Koeberg Transient Interim Storage Facility - Detailed Design

Brief Description of the Activity or Plant Condition:

The detailed design of the Transient Interim Storage Facility (TISF) includes a cask storage area that can accommodate a maximum of fourteen HI-STAR 100 spent fuel storage casks. The TISF cask storage area consists of an approach apron, reinforced concrete storage pad and seven Auxiliary Storage Modules (ASMs).

The TISF is a radiation zone at Koeberg that is currently used for the interim storage of the Original Steam Generators (OSGs) in the Original Steam Generator Interim Storage Facility (OSGISF). The detailed design of the TISF ensures that the combined radiation dose at the TISF boundary from the OSGISF, the CSB and the HI-STAR 100 casks stored inside the ASMs is less than 0,5 microSv/h.

The ASM is designed to provide additional shielding of the HI-STAR 100 spent fuel casks to comply with NNR dose rate requirements at the TISF boundary. The ASMs have a capacity to each house two loaded HI-STAR 100 casks and each module has a lockable access door to allow for personnel access. The HI-STAR 100 casks will be stored horizontally inside the ASMs on cradles that rest on the concrete pad. The inside of each ASM will be fitted with lighting to provide visibility within the structures.

2.0	**Editorial Change or Re-Review**
2.1	*Is this an editorial change?* **Not Editorial** *(see the Editorial Changes form [KAA-709, Appendix 2])* *Editorial changes are defined in the Editorial Changes form: state the applicable Editorial Change condition(s) and provide a short explanation why sections 3, 4.2 to 4.5 and 5 can be skipped. Section 4.1 must be answered for an editorial change.* Click here to enter text.
2.2	*Is this a re-review?* **Not a Re-review** *If a Screening or Evaluation has previously been compiled for this change, provide a short explanation why sections 3, 4 and 5 can be skipped, and why the previous Screening/Evaluation remains valid or is valid for the additional process, in terms of both impact and applicability. Reference the original Screening/Evaluation*: S , E Click here to enter text.

3.0	**KLA-001 (331-94) Classification – Importance Category**
3.1	*What parameters, SSCs or documents are affected by this activity or condition?* TISF, OSGISF, OSGs, CSB, the HI-STAR 100 spent fuel casks, the spent fuel assemblies stored in the HI-STAR 100 casks, storage pad, ASMs
3.2	*Importance classification of items identified in 3.1 above*: (include the highest classification) CSR *G:\Nuclear Engineering\Design Eng\KLA_001\KLA-001.pdf*

4.0 Impact on the DESIGN or the LICENSING BASIS

Note: During the period of installation of the new Steam Generators use both the pre-SGR and the post-SGR versions of the SAR, OTS, SRSM and KCS as applicable.

4.1	*Is the activity or condition a change to, or does it impact on, one of the following:*	
4.1.1	*Operating Technical Specifications, SRSM or Chemistry Specifications?*	No
4.1.2	*Radiation Protection Licencing Requirements* (*238-54 Radiation Protection Licensing Requirements*)?	No
4.1.3	*Severe Accident Management Guides (SAMGs) or Emergency Plan (EP)?*	No
4.1.4	*Emergency Operating Procedures (EOPs)?*	No
4.2	*Does the proposed activity or condition involve a change to an SSC that* ***affects the design*** *as described in the SAR and DSE?*	Yes
4.3	*Does the proposed activity or condition involve a change to a procedure that* ***affects how*** *design base (SAR and DSE described) SSC* ***design functions are performed or controlled****?*	Yes
4.4	*Does the proposed activity or condition involve* ***revising or replacing an*** *SAR described* ***evaluation methodology*** *that is used in establishing the design bases or used in the safety analysis?*	Yes
4.5	*Does the proposed activity or condition involve a* ***test or experiment not described in the SAR*** *where an SSC is utilised or controlled in a manner that is outside the reference bounds of the design for that SSC, or is inconsistent with analyses or descriptions in the SAR?*	No

Note: If ANY answer in Section 4.0 is "Yes" then a Safety Evaluation is required.

Conclusion and supporting arguments justifying the responses:

4.1.1: The introduction of the concrete storage pad and ASMs for the storage of the HI-STAR 100 spent fuel casks does not require any changes to OTS, the SRSM or Chemistry Specifications. Any blockages of the air vents on the ASMs during normal operation shall be identified through regularly scheduled operator walkdowns. The accident analysis for the ASM air vent blockage accident concluded the spent fuel peak cladding temperature limits would only be exceeded after more than 60 hours which allows sufficient time for operator intervention if blockage of the ASM air vents is observed during operator plant walkdowns.

4.1.2: The assessment of the contribution of the TISF, including the cask storage pad and ASMs, to the total site dose confirms that the dose to plant personnel and the public remains within the bounds of the existing site Nuclear License. The detailed design of the TISF to allow the storage of the HI-STAR 100 spent fuel casks on the storage pad and in the ASMs therefore does not challenge the Radiation Protection Licensing Requirements (238-54). In addition, the current PSA assumes that 161 casks are stored on an open TISF which is enveloping for the 14 casks to be stored in the ASMs.

4.1.3: The introduction of the concrete storage pad and ASMs for the storage of the HI-STAR 100 spent fuel casks does not require any changes to the SAMGs or the Emergency Plan provisions for the protection of site personnel or the public specified in KAA-811 (The Integrated Koeberg Nuclear Emergency Plan). The classification of events in accordance with KEP-056 (Nuclear Emergency Plan Duties of the Operating Shift) is not affected by the design of the TISF. The radiological consequences of previously analysed cask accidents are bounding for cask storage on the concrete pad and in the ASMs. Any damage to the cask neutron shielding, for example due to fire or tornado damage, will be addressed in accordance with KEP-088 (Emergencies Affecting Spent Fuel in Storage Casks). The potential blockage of the ASM vents is assessed to determine the period within which the vents should be cleared following the applicable external event and KEP-088 will be updated to reflect this time. However, the EP of the plant and casks remains unchanged (e.g. make safe, barricade, RP monitoring, retrieval, etc.).

4.2: The addition of the spent fuel cask storage pad with ASMs in the TISF must be described in the NIL-01 SAR. The ASMs will be constructed modularly in two phases.

4.3: The procedures to move the casks onto the TISF and placement in the ASMs have to be developed based on the approved analyses included in the TISF storage pad detailed design once the detailed design has been fully approved.

4.4: The computer code used for radiation shielding calculations (SCALE MAVRIC) is different from the code that was previously used (MCNP) for dose calculations for the HI-STAR 100 storage casks in the SAR. The computer code used for seismic analysis, P-CARES, is not in the SAR.

5.0 General

Will or could the activity or condition:

5.1	*affect the ability of the operator to assess or control the nuclear safety status of the plant?*	No
5.2	*affect the nuclear safety response of the plant to normal evolutions, anticipated operational occurrences, or accidents?*	No
5.3	*affect the qualification or operational characteristics of installed important to safety components?*	No
5.4	*increase the potential for the release of radioactive material to the environment or have an impact on the activity migration model?*	No
5.5	*increase the potential for an initiating event? (guidance: KAA-709 Initiating Event Review List)*	No
5.6	*introduce a new common-cause failure?*	Yes

Comments justifying the responses:

5.4: The potential for radio-active release from spent fuel dry storage casks has already been assessed for the casks stored in the CSB. However, the TISF is designed to be seismically stable under both design basis and design extension condition earthquakes. The activity migration model is not affected in a manner different from that which has already been assessed for the existing spent fuel dry storage casks in the CSB.

The TISF is designed to provide cooling for the dry storage casks by means of natural air circulation and to maintain the desired thermal behaviour of the casks. The facility has been designed to cope with natural disasters that the Koeberg site may be subjected to such as tornado's, flooding, tsunamis and seismic events.

5.6: The design of the air openings in the ASM modules makes them vulnerable to blockage, for example from debris deposited by flooding or tsunami. This could potentially disrupt air cooling to all the casks that are stored in all the ASMs in the TISF.

Note that, although the implementation of this activity is not in conflict with NIL-01 (refer to section 7.1), it is in conflict with NIL-44.

Is a Safety Evaluation required for another reason? No

If Yes, state the reason

<u>Notes</u>: *If ANY answer in Section 4.0 or 5.0 is "Yes" then a Safety Evaluation is required.*
KAA-709 Appendix 5 or the KAA-709 Initiating Event Review List may be used
(G:\Nuclear Engineering\Design Eng\SAFEVAL\Forms)

6.0 SAR Impact

Note: During the period of installation of the new Steam Generators use both the pre-SGR and the post-SGR versions of the SAR, OTS, SRSM and KCS as applicable.

SAR Sections Reviewed: I-3.0; I-4.0; *I-6.0; II-1.7; II-8.1; III-5.1; III-5.5*

SAR Update Request raised? Yes *Number*: UR-2503

Find the Update Request form at g:\SAR\SAR Update Request Form

7.0 NNR Approval

Is the activity or condition:

7.1	*in conflict with an NIL-01 Licence Condition, LDs, RDs or subsequent LCRs?*	No
7.2	*a change to a document that needs NNR approval?*	Yes
7.3	*a modification that requires approval according to the requirements of LD-1012?*	Yes

Use the Licence Impact form to assist in answering the above:
G:\Nuclear Engineering\Design Eng\SAFEVAL\Forms\Licence Impact KFA-049 240-146211153

Copies of NIL-01, LDs, RDs and LCRs can be found on G:\Nuclear Engineering\Design Eng\SAFEVAL\Nuclear Licence

Appendix A3.2 – SAFETY EVALUATION E2023-0001

No: E2023-0001 **Rev. 0**

Reason for Revision: Revision 0

CONCLUSION

Based on information entered into this Safety Evaluation, does or can the activity or condition:

- identify a **USQ** ('Yes' to any question in sections 4, 5, 6, 7, 8 or 9)? **S**afety **J**ustification No: J - — No S J required
- require a change or addition to the SAR (section 2.5 in this document)? — Change SAR
- involve a change to the OTS, KCS or SRSM (section 3.0 in this document)? — No OTS, KCS or SRSM change
- involve a change to the SAMGs or EPs (section 7.2 in this document)? — No SAMG or EP change
- involve a change to the EOPs (section 9.0 in this document)? — No EOP change
- require NNR approval for the proposed activity or condition (section 10.0)? — Activity or condition needs NNR approval

If any of the above are answered "Yes", the activity or condition needs to be discussed with the Koeberg Licensing Group before taking any further action.

PREPARATION, REVIEWS and APPROVAL

Is an additional review required by Subject Matter Experts (SMEs) or groups other than the preparer's group? Yes
(SMEs need not be authorised as Safety Screeners or Safety Evaluators.)
SMEs or groups: Design Engineering, System Engineering, Kobus Smit, RP

Prepared by: Redacted Contractor names in accordance with PAIA Chapter 4, Section 38 — Tractebel — 2024-04-11
Signature

PSA Review (sections 4, 7 and 8)	**Additional Review** (if required)	**Additional Review** (if required)
Reviewer: G Dongmo	*Reviewer*: K Makhothe S Pietersen	*Reviewer*: A Lawrence T Moila K Smit
Signature	*Signature*	*Signature* Lawrence
Group: **PSA Group**	*Group*: Nuclear Engineering RP	*Group*: Des Eng Sys Eng SME NE-MRG
Date: 2024-04-18	*Date*: 2024-04-18 2024-04-18	Date: 2024-04-18
EOP Review (section 9)	**Independent Review**	**Approval by** KORC KOSC KAPS
Reviewer: P Ireland	*Reviewer*: Redacted Contractor names in accordance with PAIA Chapter 4, Section 38	*Approver*: M. VALAITHAM
Signature	*Signature*	*Signature*
Group: **OPG**	*Group*: TRACTEBEL	
Date: 2024-04-18	*Date*: 2024/04/12	*Date*: 2024-04-19

1.0 INTRODUCTION

A Safety Evaluation is required for: Full modification

Activity or Condition No: 12010 - Transient Interim Storage Facility Spent Fuel Cask Storage Pad

Title: Koeberg Transient Interim Storage Facility - Detailed Design

Associated Safety Screening: S2023-0056, *questions requiring a Safety Evaluation*: n/a

Brief Description of Activity or Plant Condition:
The detailed design of the Transient Interim Storage Facility (TISF) includes a cask storage area that can accommodate a maximum of fourteen HI-STAR 100 spent fuel storage casks. The TISF cask storage area consists of an approach apron, reinforced concrete storage pad and seven Auxiliary Storage Modules (ASMs).

The ASM is designed to provide additional shielding of the HI-STAR 100 spent fuel casks to comply with NNR dose rate requirements at the TISF boundary. The ASMs have a capacity to each house two loaded HI-STAR 100 casks and each module has a lockable access door to allow for personnel access. The HI-STAR 100 casks will be stored horizontally inside the ASMs on cradles that rest on the concrete pad. The inside of each ASM will be fitted with lighting to provide visibility within the structures. The layout of the TISF is shown below:

PAIA Chapter 4, Section 38

Image redacted as it shows the exact locations of the spent fuel storage facilities at the Koeberg TISF

2.0 DESCRIPTION

2.1 Describe the activity or condition being evaluated, and its expected effects.

The TISF is a radiation zone at Koeberg that is currently used for the interim storage of the Original Steam Generators (OSGs) in the Original Steam Generator Interim Storage Facility (OSGISF). The detailed design of the TISF ensures that the combined radiation dose rate at the TISF boundary from the OSGISF, the CSB and the HI-STAR 100 casks stored inside the ASMs is less than 0,5 microSv/h.

The ASMs provide an intermediate solution between an open storage pad and a storage building. The ASM has been designed as a structure consisting of a concrete shield with the capacity to house two loaded HI-STAR 100 casks. The top covers and the front cover of the ASM are installed using the same gantry crane that is used for the handling of the casks. The ASMs are designed to provide sufficient radiation shielding of the HI-STAR casks housed inside the ASMs to comply with the radiation dose limit at the TISF boundary. For inspection and maintenance tasks, the ASM includes a labyrinthic entrance for personnel to easily access the inside of the ASM.

The ASMs are designed to maintain the thermal behaviour of the HI-STAR 100 storage casks within their design limits. At the bottom of the ASM there are inlet vent openings and on the roof there are outlet vent openings to ensure natural air circulation and cooling of the casks. Each of these openings will be securely covered by a grille to prevent the ingress of external elements.

The ASM structures are designed to withstand design extension condition (DEC) seismic events, high winds and tornado, and flooding and tsunami events.

Regulatory authorisation for the TISF is covered by NIL-44 which is still to be updated with the TISF cask storage information. This safety evaluation considers the requirements of both NIL-01 and NIL-44.

2.2 *Identify the parameters and systems affected or potentially affected by the activity or condition (including common-cause effects).*

The following SSCs are potentially affected by the TISF detailed design: TISF, OSGISF, OSGs, CSB, concrete storage pad, ASMs, the HI-STAR 100 spent fuel casks, and the spent fuel stored in the HI-STAR 100 casks.

The parameters of the HI-STAR 100 spent fuel casks that are potentially affected by the TISF detailed design include confinement, shielding and heat removal.

The location of the inlet vent openings at the bottom of the ASM walls can potentially lead to a common cause failure of natural air circulation and consequent overheating of all the Hi-STAR 100 spent fuel casks stored inside the ASMs.

2.3 *Identify the credible failure modes associated with the activity or condition.*

- Loss of cooling of the HI-STAR 100 casks inside the ASMs
- Loss of shielding of the HI-STAR 100 casks inside the ASMs
- ASM top cover drop onto the HI-STAR 100 casks inside the ASM
- Burial of the HI-STAR 100 casks inside the ASMs under debris
- Damage to the HI-STAR 100 casks due to:
  - Explosion
  - Fire
  - Cask drops
  - Tornado missile strikes
  - Flooding
  - Lightning strike
  - Landslides
  - Extreme ambient temperature
  - Earthquakes
  - Tsunamis

2.4 *Identify the accidents in SAR III-4.3.2 to III-4.7.1 reviewed for impact by the activity or condition.*
'G:\Nuclear Engineering\Design Eng\SAFEVAL\Forms\KAA-709 Initiating Event Review List' may be used.

Note: During the period of installation of the new Steam Generators use both the pre-SGR and the post-SGR versions of the SAR, OTS, SRSM and KCS as applicable.

SAR III-4.4.5 - Fuel handling accident (cask drop outside the fuel building).

The following accidents form part of the design basis and design extension accidents in the Koeberg SAR II-8.1.6:

- Geological and geotechnical hazards
- Explosion
- Fire
- Tornado winds and missiles
- Flood
- Lightning strike
- Extreme environmental temperature
- Earthquake
- Burial under debris

- Cask handling during storage activities
- Tip-over
- 100% Fuel rod rupture

2.5 *Provide references reviewed for this safety evaluation.*

1) 12010TISF-0017, Detailed Design of the Koeberg TISF – First Storage Area
2) NIL-01
3) NIL-44
4) KAA-811, The Integrated Koeberg Nuclear Emergency Plan
5) KEP-056, Nuclear Emergency Plan Duties of the Operating Shift
6) KEP-088, Emergencies Affecting Spent Fuel in Storage Casks

SAR sections reviewed:

Note: During the period of installation of the new Steam Generators use both the pre-SGR and the post-SGR versions of the SAR, OTS, SRSM and KCS as applicable.

SAR I-3.0; I-4.0; I-6.0; II-1.7; II-8.1; III-5.1; III-5.5

In addition, SAR change notice CN-317 was reviewed.

SAR Update Request raised? Yes *Number*: UR 2503

Note: NNR approval is required for SAR updates (indicate in 'CONCLUSION' above)

2.6 *Other discussion, if applicable.*

- The safety evaluation is for the Koeberg TISF detailed design 12010TISF-0017.
- Proposed SAR updates are contained in UR-2503.
- Detailed calculations are in Section 3.16 of the Detailed Design.
- The evaluation is against both NIL-01 and NIL-44 requirements.

3.0 Impact on DESIGN BASIS or LICENSING BASIS

Is the activity or condition a change to, or does it affect, any of the following:

3.1 *Operating Technical Specifications (OTS), Chemistry Specifications (KCS) or the Safety Related Surveillance Manual (SRSM)?* No

3.2 *Radiation Protection Licencing Requirements (RPLR) (238-54 Radiation Protection Licensing Requirements)?* No

Comment on the responses above:

3.1: The introduction of the concrete storage pad and ASMs for the storage of the HI-STAR 100 spent fuel casks does not require any changes to OTS, the SRSM or Chemistry Specifications. Any blockages of the air vents on the ASMs during normal operation shall be identified through regularly scheduled operator walkdowns of the TISF. The accident analysis for the ASM air vent blockage accident concluded the spent fuel peak cladding temperature limits would only be exceeded after more than 60 hours which allows sufficient time for operator intervention if blockage of the ASM air vents is observed during normal operation.

3.2: The detailed design of the TISF ensures that the combined radiation dose rate at the TISF boundary from the OSGISF, the CSB and the HI-STAR 100 casks stored inside the ASMs is less than 0,5 µSv/h in accordance with KAA-637 and 238-36 (1 mSv annual effective dose limit for an exposure of 2000 hours, a 40-hour week for 50 weeks in one year in accordance with RD-0022 for visitors and non-occupationally exposed workers). The detailed design of the TISF to allow the storage of the HI-STAR 100 spent fuel casks on the storage pad and in the ASMs therefore does not challenge the Radiation Protection Licensing Requirements (238-54). In addition, the current PSA assumes that 161 casks are stored on an open TISF which is enveloping for the 14 casks to be stored in the ASMs.

Notes:

Severe Accident Management Guides (SAMGs) and Emergency Plan (EP) are addressed in section 7.2.

Emergency Operating Procedures (EOPs) are addressed in section 9.0.

No: E2023-0001 **Rev. 0**

Note: When answering sections 4.0 to 8.0, below during the period of installation of the new Steam Generators use both the pre-SGR and the post-SGR versions of the SAR, OTS, SRSM and KCS as applicable.

4.0 Effect on ACCIDENTS and MALFUNCTIONS previously evaluated in the SAR (PSA Group to review)

*4.1 Does the proposed activity or condition result in **more than a minimal increase** in the **frequency of occurrence** of an **accident** previously evaluated in the SAR? (KGA-025, Appendix 2, section 2.0)* No

Explanation: The assumed frequencies of occurrence for the relevant accidents in the Koeberg SAR listed in section 2.4 of this safety evaluation do not increase due to the detailed design of the TISF.

*4.2 Does the proposed activity or condition result in **more than a minimal increase** in the **likelihood of occurrence of a malfunction** of an important to safety **SSC** previously evaluated in the SAR? (KGA-025, Appendix 2, section 3.0)* No

Explanation: The detailed design of the TISF ASM introduces the risk of a top cover of the ASM structure falling onto and damaging a HI-STAR 100 cask when the top cover is installed onto the ASM. This risk is addressed in the design of the lifting embedments of the ASM top covers and the fasteners used to fix the top covers to the ASM structure. If one of the four lifting embedments should fail during lifting operations of the ASM top cover, the remaining three embedments have sufficient capacity to withstand the demand created by the failed lifting embedment. The TISF gantry crane is single failure proof, and is also the equipment that has been used inside the CSB for the loading of the HI-STAR 100 casks. The mass of the heaviest ASM top cover is 27,5 tons which is within the handling capacity of the gantry crane and is also lighter than the 128,6 tons combined weight of the HI-STAR 100 cask and cradle. The fastening bolts that fix the top covers to the ASM structure are designed for design extension conditions including 0,5 g earthquakes. The structural analysis and design of the ASM, as discussed in Appendix A2.3 of the TISF detailed design, therefore addresses the risk of top cover drop for design basis conditions.

The detailed design of the TISF ASM introduces the risk that blockage of the air vent openings can lead to a loss of natural air circulation and decay heat removal from the casks. This accident is bounded by the safety analysis of the burial under debris accident for the HI-STAR 100 casks which showed that, for this accident, overheating of the casks only occurs after more than 60 hours.

*4.3 Does the proposed activity or condition result in **more than a minimal increase** in the **consequences (radiological)** of an **accident** previously evaluated in the SAR? (KGA-025, Appendix 2, section 4.0)* No

Explanation: The cask accidents analysed in the SAR remain conservatively bounding for the detailed design of the TISF, and there is therefore no change to the consequences of those accidents.

The severity of the impact of certain external events such as fire, tornado, flood, explosion and lightning on the HI-STAR 100 casks will be reduced due to the protection provided by the ASM structure.

*4.4 Does the proposed activity or condition result in **more than a minimal increase** in the **consequences (radiological)** of a **malfunction of an** important to safety **SSC** previously evaluated in the SAR? (KGA-025, Appendix 2, section 5.0)* No

Explanation: The detailed design of the TISF is not expected to lead to cask failure as discussed in section 4.2 of this evaluation. There will therefore be no change to fission product releases from the casks as a result of the design of the TISF, and no change to the radiological consequences of the cask accidents previously analysed in the SAR.

5.0 Impact on FISSION PRODUCT BARRIERS as described in the SAR

5.1 Does the proposed activity or condition result in a ***design basis limit*** *of a* ***fission product barrier*** *as described in the SAR being* ***exceeded or altered****? (KGA-025, Appendix 2, section 8.0)* No

Comments: The fission product barriers that can potentially be affected by the TISF ASM detailed design are the integrity (leak-tightness) of the HI-STAR 100 casks due to physical damage by top cover drop, and the cladding of the fuel pins of the spent fuel assemblies in the casks due to overheating of the casks if there is an interruption of natural air ventilation due to blockage of the air vents.

The prevention of top cover drops via proper rigging practices of the TISF ASMs is expected to prevent confinement boundary leakage from the HI-STAR 100 casks.

Furthermore, the air vent blockage accident is successfully mitigated to prevent overheating of the spent fuel casks via remote temperature monitoring of the interior of the ASMs.

6.0 Impact on EVALUATION METHODS described in the SAR

6.1 Does the proposed activity or condition result in a ***departure from a method of evaluation*** *described in the SAR used in establishing the* ***design basis or in the safety analysis****? (KGA-025, Appendix 2, section 9.0)* No

Comments: The TISF is to be included in the SAR for the first time as part of the implementation of the TISF detailed design. Since the TISF was not previously described in the SAR, there is no analysis of record in the SAR for the TISF and hence there can be no departure from methods of evaluation in the SAR for the TISF. The TISF detailed design does not change any of the methods of evaluation used to establish the existing design bases or safety analyses for Koeberg as currently described in the SAR. However, it is noted that while the TISF detailed design uses some methods of evaluation that have previously been approved by the NNR for similar applications, there are also some new methods of evaluation that have not previously been approved by the NNR.

The TISF detailed design uses the following analysis codes that have previously been used in the Koeberg SAR for the evaluation and licensing of the HI-STAR 100 casks:
- LS-DYNA for seismic response analysis,
- ANSYS for 3D finite element analysis, and
- FLUENT for computational fluid dynamics.

Since Eskom and the NNR are familiar with these codes from previous project submissions, Eskom will only verify the models and assumptions made in the TISF detailed design studies for Koeberg application.

Radiation shielding calculations were performed with the SCALE-MAVRIC code. While SCALE-ORIGIN has previously been approved by the NNR for decay heat and fission product inventory calculations, the use of SCALE-MAVRIC has not previously been approved by the NNR for radiation shielding calculations. The Eskom KGF-001 code review and acceptance report for the SCALE-MAVRIC code is documented in the detailed design attachment Appendix A2.7 (00857IV001). Included in the report, as an attachment, is a completed NNR RG-0016 compliance matrix checklist. This validation and verification report for the use of the SCALE-MAVRIC code for Koeberg applications is under review by the NNR for incorporation into the SAR.

The TISF seismic and soil interaction analysis was performed using P-CARES for seismic studies which is not included in the SAR. The Eskom KGF-001 code review and acceptance report for the P-CARES code is documented in the detailed design attachment Appendix A2.9 (00857IV003). Included in the report, as an attachment, is a completed NNR RG-0016 compliance matrix checklist. This validation and verification report for the use of the P-CARES code for Koeberg applications is under review by the NNR for incorporation into the SAR.

7.0 Impact on BEYOND DESIGN BASIS ACCIDENTS (PSA Group to perform)

7.1 Is there a more than minimal increase in baseline risk in the Koeberg Risk Assessment? (KGA-025, Appendix 2, section 10.0) No

Comments: The risk assessment for additional metal casks [PSA-R-T15-08, Revision 4], considered a comprehensive and generic list of initiating events developed by Electric Power Research Institute (EPRI), and screens out seismic events and assumes that casks will be stored in a seismically qualified open TISF.

The initiating events considered for spent fuel dry storage in PSA-R-T15-08 include Cask Loading Errors, Cask Drop Events with and without SFP liner break, Cask Seal Leaks and Heavy Aircraft Crash.

A re-analysis of the risk assessment was conducted in PSA18-0043 for cask storage in the CSB and screened in the seismic event as an initiator. The PSA was subsequently updated for cask storage on the TISF pad 1 storage area and it screens out seismic initiating events since the both the storage pad and the ASMs will be seismically designed to withstand the SSE (0.3g) and DEC (0.5g) earthquakes according to the TISF design.

Thus, the official PSA baseline in PSA18-0043 Revision 9 assumes, i) sixteen (16) casks being stored in the CSB, and ii) seven (7) cask movements per year which eventually will lead to fourteen (14) casks stored on the TISF.

Note that, while the studies assume seven (7) cask movements per year, Koeberg is restricted to physically moving a maximum of five (5) casks per year in order not to create an accident of a different type than previously analysed in the SAR. Therefore, the risk results for five (5) cask movements per year are enveloped by the assumption of 7 cask movements per year.

For the proposed TISF cask storage area activities performed each year, the activities involve cask movements of up to 7 casks resulting in 30 casks stored on site both in the CSB and TISF. The total station risk including TISF pad 1 storage area risk is assessed in [PSA18-0043, Revision 9].

Table 1 below indicates that each of the risk metrics (peak and average site personnel and public risks) due to the TISF pad 1 storage area is less than the KGA-025 criteria, i.e. 10% of the remaining margin between the NNR risk limit and the baseline risk as calculated in the baseline risk [PSA18-0043, Revision 6]. Therefore, there is not a more than minimal increase in the baseline risk because of the TISF pad 1 storage area activities.

It can be concluded that there is not a more than minimal increase in Koeberg baseline risk because of the TISF cask activities.

Risk metric	Total Station Risk excluding TISF Pad 1 (PSA18-0043, Rev 6) - Baseline Risk	Total Station Risk including TISF Pad 1 (PSA18-0043, Rev 9)	TISF Pad 1 - risks	KGA-025 criteria: 10% of the remaining margin
Peak Public Risk (fatalities/year)	1.17E-07	1.20E-07	3.00E-09	4.88E-07
Average Public Risk (fatalities/person/year) - Using 2008 National Population	1.03E-09	1.04E-09	1.00E-11	8.97E-10
Average Public Risk (fatalities/person/year) - Using 2025 National Population	2.37E-09	2.38E-09	1.00E-11	7.63E-10
Peak Site Personnel Risk (fatalities/year)	7.56E-06	7.62E-06	6.00E-08	4.24E-06
Average Site Personnel Risk (fatalities/person/year)	4.07E-06	4.12E-06	5.00E-08	5.93E-07

7.2 *Is there, or would there be, a more than minimal impact on:*
(KGA-025, Appendix 2, section 11)

- *Severe Accident Management Guidelines (SAMGs)?* No
- *Emergency Plan (EP)?* No

Comments: The SAMGs do not consider cask accidents and are therefore not affected by the TISF detailed design.

In accordance with KGA-025, there is no more than a minimal impact on the Emergency Plan since the PSA shows that increased risk to the public is less than 10% (Refer to section 7.1).

8.0 Potential for creation of a NEW type of UNANALYSED EVENT (PSA Group to review)

8.1 *Does the proposed activity create a possibility of an accident of a different type than previously evaluated in the SAR? (KGA-025, Appendix 2, section 6.0)* No

Comments: The air vent blockage accident is bounded by the analysis of the burial under debris accident in the Koeberg SAR for the HI-STAR 100 casks.

The top cover drop accident is not considered credible due to the design of the top cover embedments, the capacity of the single-failure-proof gantry crane, and the application of proper rigging practices for the movement of the ASM top covers.

8.2 *Does the proposed activity create a possibility of a malfunction of an important to safety SSC with a different result than any previously evaluated in the SAR? (KGA-025, Appendix 2, section 7.0)* No

Comments: The detailed design of the TISF does not change the result of the burial under debris accident that was previously analysed in the Koeberg SAR for the HI-STAR 100 casks, which showed that overheating of the casks only occurs after more than 4,5 days which allows sufficient time for the 60 hour recovery time calculated for the blockage of the ASM vents.

9.0 Impact on EMERGENCY OPERATING PROCEDURES (EOPs) (OPG to perform)

9.1 *Is there, or would there be, a more than minimal impact on the Emergency Operating Procedures? (KGA-025, Appendix 2, section 12)* No

Comments: There is no impact on any EOPs or related operating methodologies because no EOPs are linked to the Transient Interim Storage Facility.

10.0 NNR Approval

Is this activity or condition:

- *in conflict with an NIL-01 Licence Condition, LD, RD or subsequent LCRs?* No
- *a change to a document or procedure which needs NNR approval?* Yes
- *a modification that requires NNR approval according to the requirements of LD-1012?* Yes

Use the NNR Approval Impact form to assist in answering the above:
G:\Nuclear Engineering\Design Eng\SAFEVAL\Forms\Licence Impact KFA-049 240-146211153

Copies of NIL-01, LDs, RDs and LD-1012 can be found on G:\Nuclear Engineering\Design Eng\SAFEVAL\Nuclear Licence

11.0 Safety Evaluation Conclusion

Based upon the evaluation in sections 4.0 to 10.0, update CONCLUSION on page 1.

Appendix A4 – CONTROL ROOM ALARM WINDOW CHANGE

Not Applicable.

4. PART B – MANUFACTURING AND INSTALLATION SPECIFICATION

4.1 Scope

This specification describes the manufacturing and installation of the design described in Part A of this document.

4.2 References – Installation

4.2.1 Contractor Specific References

4.2.1.1 H&S Plan

[84] HEALTH AND SAFETY PLAN FOR THE SPENT FUEL TRANSIENT INTERIM STORAGE FACILITY PROJECT.

[85] HSE Readiness Reports

[86] MS-HS-001 Site Establishment

[87] MS-HS 002 Formwork Activities

[88] MS-HS 003 Steel Fixing

[89] MS-HS-004 Hot Work Activities

[90] MS-HS-005 Use of Power Tools

[91] MS-HS-006 Scaffolding Erection & Dismantling

[92] MS-HS-007 Placement of Concrete

[93] MS-HS-008 Lifting Activities

[94] MS-HS-009 Troxler Operations

[95] MS-HS-010 Laboratory Activities

[96] MS-HS-011 Excavations MN

[97] MS-HS-012 Clear and Grub MN

[98] MS-HS-013 Backfill and Layerworks MN

[99] RA-HS-002 Formwork Activities

[100] RA-HS-003 Steel Fixing

[101] RA-HS-004 Hot Work Activities

[102] RA-HS-005 Use of Power Tools

[103] RA-HS-006 Scaffolding Erection & Dismantling

[104] RA-HS-007 Placement of Concrete

[105] RA-HS-008 Lifting Activities

[106] RA-HS-009 Troxler Operations

[107] RA-HS-010 Laboratory Activities

4.2.1.2 Waste Management and Environmental Management Plan

[108] ENV 006 – WASTE MANAGEMENT PLAN (WMP)

[109] OUR.ENV 3.4.1 – CONTRACTORS ENVIRONMENTAL MANAGEMENT PLAN (CEMP)

4.2.1.3 Quality Management Plan

[110] NQMS-QAS-PLA 001 Contract Quality Management Plan (CQMP)

[111] NQMS-QAS-PLA 003 Construction Quality Plan (CQP)

[112] NQMS-QAS-MS-001 Concrete Cube Making, Curing and Testing

[113] NQMS-QAS-MS-002 Bulk Earthworks

[114] NQMS-QAS-MS-006 Precast Elements

[115] NQMS-QAS-MS-007 Insitu Concrete Works

[116] NQMS-QAS-MS-008 Excavation of Existing Underground Services

[117] NQMS-PRC-019 Supplier Approval Process

[118] ITP 001 – General Requirements

[119] ITP 002 – Earthworks

[120] ITP 003 – Drainage

[121] ITP 004 – Reinforced Concrete Structures

[122] ITP 005 – Structural Steel Erection

[123] ITP 006 – Precast Elements

[124] ITP 007 – (Insitu) Concrete Works (Pad, Walls and Roof)

[125] ITP 008 - Survey

4.2.2 Normative

The following references are applicable to the construction of the TISF:

[126] KAA-501: Modifications to Plant, Plant structures or Operating Parameters that Affect the Design Base.

[127] KSA-132: Lifting and Rigging Program

[128] OHSA No 85/93: Occupational Health and Safety Act No 85 of 1993.

[129] SANS 10108:2002: The classification of hazardous locations and the selection of apparatus for use in such locations.

[130] SANS 9001: Quality Management Systems – Requirements.

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

[132] SANS 10100: The structural use of concrete

[133] SANS 10400: The application of the National Building Regulations

[134] SANS 1200 A 1986 General

[135] SANS 1200 C 1980 Site clearance

[136] SANS 1200 D 1988 Earthworks

[137] SANS 1200 G 1982 Concrete (structural)

[138] SANS 1200 H 1990 Structural steelwork

All standards referenced in the above-mentioned standards shall be adhered to. The latest revision of the above standards shall be applied.

4.2.3 Informative

[139] Topographical Survey (P1094 - KNPS WBHO Topo_1-Rev0)

4.3 Quality Assurance

The KCC Quality Management System used is based on the ISO 9001:2015 and ISO 3834 systems. Further requirements as set out in the ASME-NQA-1 [131] ('NQA-1') Standard are also applied to this project according to KCC Contract Quality Management Plan [110]. All work performed will be according to Eskom's specifications, drawings and the contract quality requirements.
The Construction Quality Management Plan [110] is established specifically for the TISF Construction. The classifications in terms of quality level and safety level are as follows:

- Quality Level: Q2
- Safety Level: L3

4.4 Interfaces with Existing Plant

The location of the TISF is separate from that of the plant, but in the vicinity of the CSB and the OSGISF:

- Interfaces with the CSB: The construction activities to be developed in the vicinity of the CSB are those established for typical reinforced concrete civil works (earthworks, formwork activities, steel fixing, using of power tools, scaffolding erection & dismantling, placing concrete, crane lifting activities). These activities have already been developed at the TISF site during the OSGISF construction without adverse impact to the CSB.

- Interfaces with the OSGISF: The Approach Aprons are included within the OSGISF Turning Circle, so it will be necessary to excavate, backfill and concrete this structure within this area. Once constructed the Approach Aprons will allow manoeuvring of the Kamag 25 system for the Original Steam Generators transport. If any activity for the OSGISF has to be developed during the construction of the TISF, the Project Team shall provide KCC with a work instruction on the way forward as to guarantee no interference between activities.

Existing services: After clearing and grubbing the area, a below surface survey scan will be executed, as described in NQMS-QAS-MS-008 [116]. These activities are included in ITP 002 [119] and ITP 008 [125]. If any services are detected,

KCC will inform the Project Team and work will not commence around the detected equipment until the Project Team provides KCC with Excavation permit. Excavation of existing underground services will be executed in accordance with NQMS-QAS-MS-008.
KCC will establish site within the boundary provided by Eskom (see Figure 29 in Part A). KCC site establishment is described in MS-HS-001 Site Establishment [86]. This method statement explains the location and layout of the construction camp for the works. The area identified does not interfere with the TISF Construction Area and any construction related activities for Eskom. The site establishment identified allows safe access for employees from Eskom's security main gate. The connection of water and electricity at the site establishment is in close proximity of Eskom's supply. The site establishment is situated close by to KCC's Construction Area allowing easier access to the construction areas in order to manage all construction and safety related activities (see Figure 1).

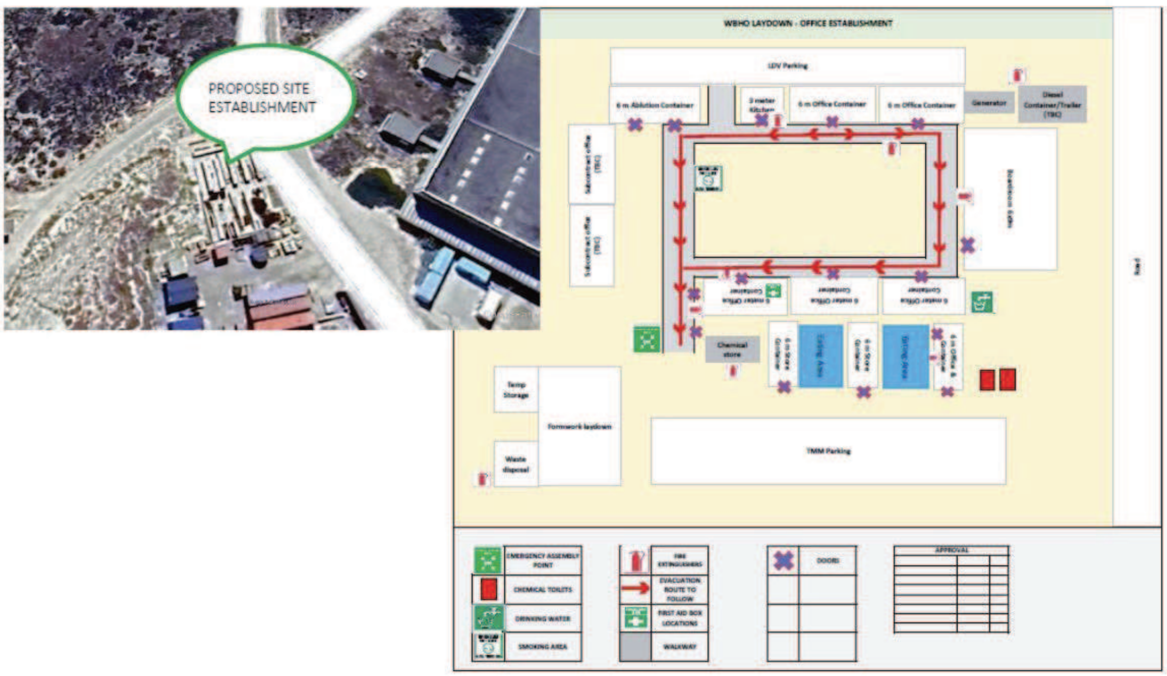


Figure 1: Site Establishment Proposed for TISF

4.5 Manufacturing and Preparation

This section describes all the work that can be done prior to the start of the construction activities:

- Concrete mix design and certificate of compliance: The ready-mix concrete supply for the Concrete Pad shall guarantee the following specifications. Since an upper bound for the concrete compressive strength is required, it is necessary to develop an adequate mix-design and provide certificate of compliance prior to pouring the concrete based on the necessary tests. Concrete pad mix requirements are shown in Table 1.

Table 1: Concrete Pad Mix Requirements for Design

Concrete Pad	Minimum cube concrete compressive strength: 30 MPa Maximum cube concrete compressive strength: 51.7 MPa Minimum cover: 60 mm Maximum w/c ratio: 0.5 Minimum content of cement (kg/m^3): 300 Maximum water penetration depth (UNE-EN 12390-8): 50 mm Average water penetration depth (UNE-EN 12390-8): 30 mm CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash.

- Concrete mix design and certificate of compliance: The ready-mix concrete supply for the ASMs shall guarantee the following specifications. ASMs mix design requirements are shown in Table 2

Table 2: ASMs Mix Requirements for Design

Concrete Pad	Minimum cube concrete compressive strength: 30 MPa Minimum density: 2.2994 t/m3 Maximum density: 2.5 t/m3 Minimum cover: 60 mm Maximum w/c ratio: 0.5 Minimum content of cement (kg/m3): 300 Maximum water penetration depth (UNE-EN 12390-8): 50 mm Average water penetration depth (UNE-EN 12390-8): 30 mm CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash.

- Execution of precast components of the design. The front and roof cover components are designed as precast reinforced concrete components that could be manufactured off-site and prior to the main construction. All QA, QC and specification requirements applied to the contract applies equally to work performed off-site.
- Existing underground services survey. In case some services are identified by the underground services survey, it is necessary to wait for Eskom work instruction, so it is important to execute this activity as soon as possible to allow for removal, re-routing or isolation for removal of existing services.

- All supervision and labour compliant to work in the Project site after completion of all FFD requirements.
- All plant and equipment inspected, approved, and registered for use on the Project site.
- All site establishment plans submitted and approved and implemented accordingly.
- All weekly HSE readiness reports submitted and approved updating the progress of the HSE requirements [85].
- All work permits in place and all approved.
- Vetting & approval of all major subcontractors and suppliers in accordance with NQMS-PRC-019 [117]. Vetting and approval Certificates of all subcontractors and suppliers will be included in the Construction Safety file The major subcontractors and suppliers are identified in Part C.
- Setting out of all structures according to the approved design centre lines and elevations by the Project Land Surveyor and the locations shall be agreed with the Eskom's Representative. This activity is included in ITP 004 [121] and ITP 007 [124]. These ITPs will be closely monitored for the setting out.

4.6 Installation

4.6.1 Working Areas

The working areas are:

- Storage Area: It is the area defined to store the 14 HI-STAR 100 casks. It includes the Concrete Pads and the ASMs (see Figure 3).
- Turning Circle: Area that shall allow the manoeuvring of the OSGs and HI-STAR 100 casks transport equipment (see Figure 2).
- Approach Aprons (see Figure 3): Reinforced concrete area in front of the Storage Area and within the Turning Circle that allows to perform the operations at the TISF with the transport and handling equipment, and serves as preparation/laydown area, if necessary.
- Stormwater Drainage (Trapezoidal Drainage Channel): System to manage the stormwater run-off from the Approach Aprons, Storage Area and existing soil, avoiding the accumulation of water in the TISF area. (see Figure 4).

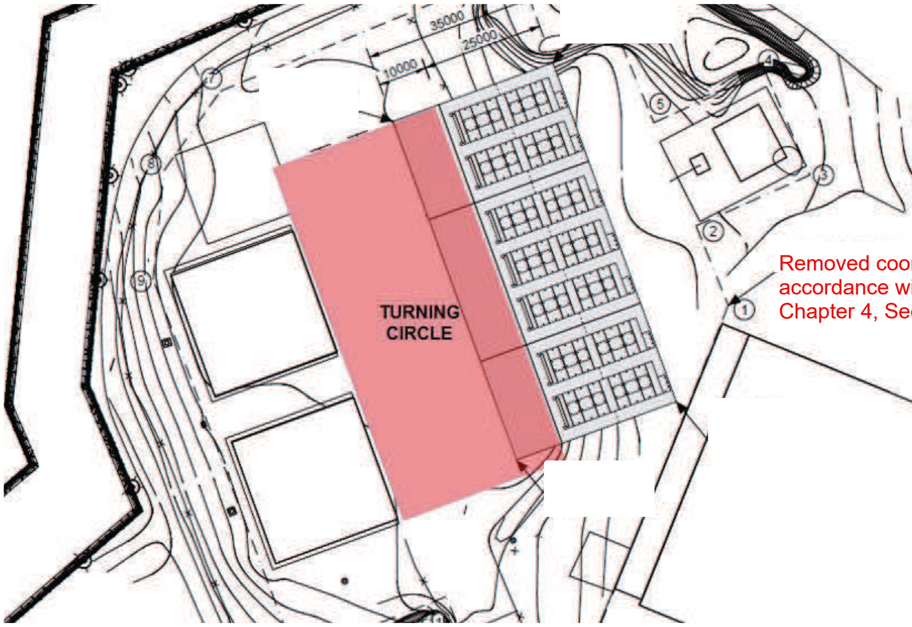


Figure 2: Turning Circle

Removed coordinates in accordance with PAIA Chapter 4, Section 38 (b)

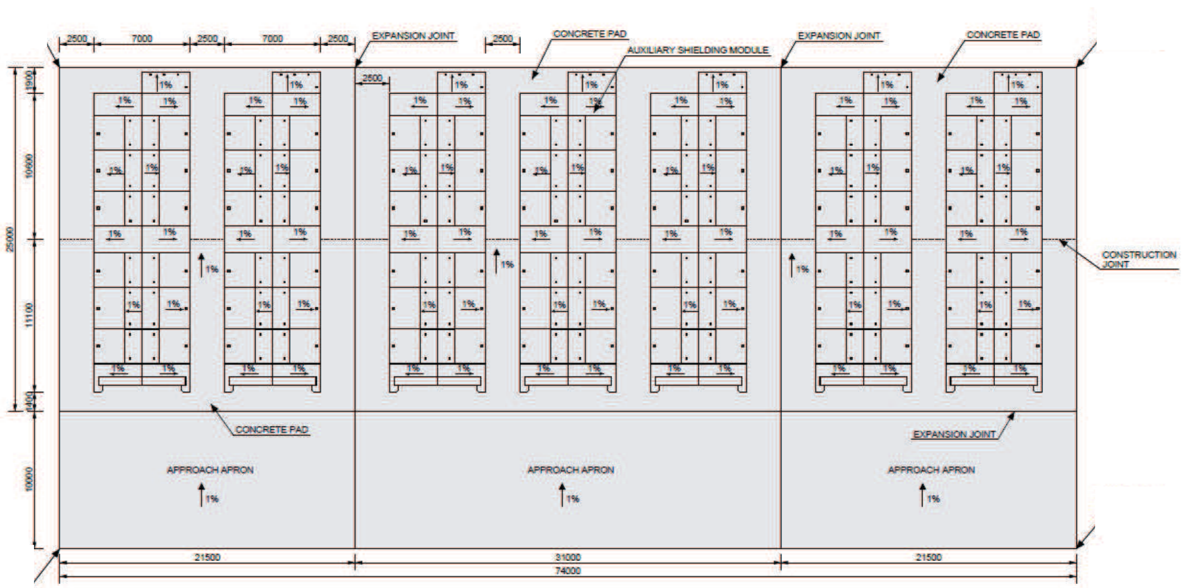


Figure 3: Storage Area (Concrete Pads + ASMs) and Approach Aprons

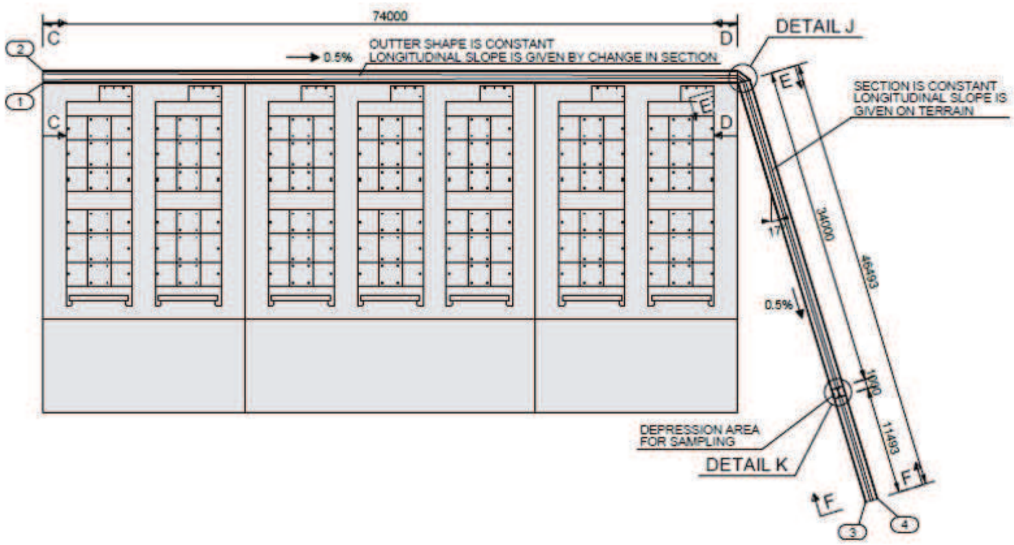


Figure 4: Stormwater Drainage (Trapezoidal Drainage Channel)

4.6.2 TISF Modular Construction

The TISF Storage Area will accommodate a maximum of 14 HI-STAR 100 casks. The construction of the first Concrete Pad (including the ASMs) for the first four casks shall be completed by before outage 227. Concrete Pads and Approach Aprons are identified in Figure 5.

The construction activities include:

- Bulk Earthworks.
- Construction of Concrete and Approach Apron Pads.
- Execution of off-site precast components of the ASMs.
- Construction of the ASMs within the Concrete Pads.

Construction activities will be paused during the first HI-STAR 100 cask loading campaign of four casks before Outage 227 and the necessary measures will be established to ensure safe movement of the cask, as per the TISF Implementation Safety Case.

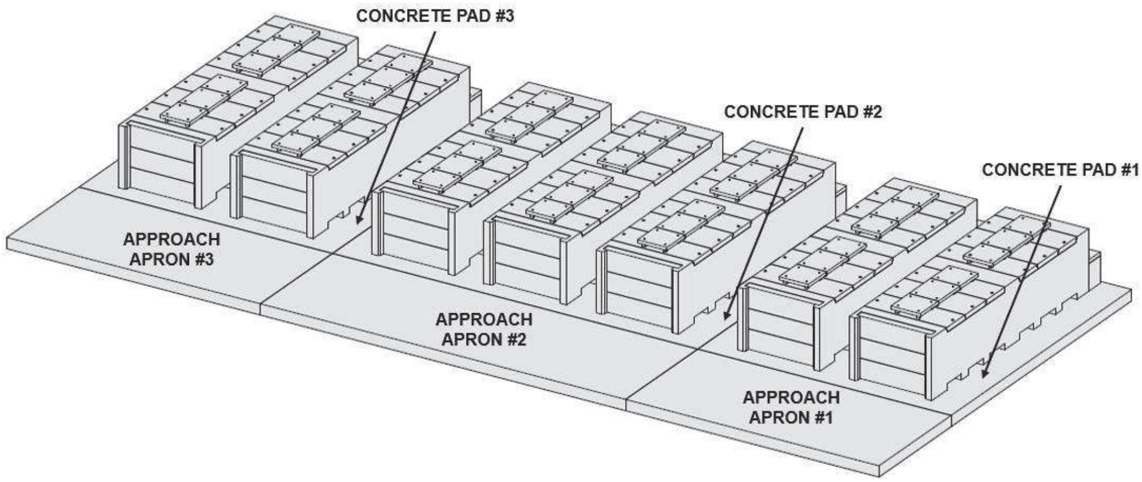


Figure 5: Identification of Concrete Pads and Approach Aprons

4.6.3 Bulk Earthworks

4.6.3.1 Stockpile Area

Construction of a Stockpile Area for storage of topsoil and excess excavated material inside the TISF boundary. A cleared and level footprint of 100 m x 100 m needs to be constructed with safe access for 10 m^3 dumper trucks to enter, dispose material and exit.

4.6.3.2 Site Clearance

Site clearance will be performed in accordance with Clear and Grub Method Statement [97]. Clear and grub is included in ITP 002 [119]. Before, clear and grub, it is required that the Land Surveyor carry out a tach survey in order to create a Digital Terrain Model (DTM). The DTM will be the basis for the computation of quantities. This activity has however been covered in the Topographical Survey conducted [139].

A baseline pad level survey will be performed progressively as the 3 Concrete Pads are being constructed. This means that 3 level surveys will be performed in total to define the baseline. Each level survey will be performed in accordance with ITP 008 [125].

4.6.3.3 Conservation of Topsoil

It is required to remove the existent topsoil, which will have variable thickness. Conservation of Topsoil will be performed in accordance with Excavation Method Statement [96]. Removal of topsoil is included in ITP 002 [119]. The topsoil will be stripped by means of a Motor Grader and loaded onto 10 m^3 dumper trucks by means of a Front-End Loader (FEL) or Excavator. The stripped topsoil material will be hauled along an agreed route to the stockpile area.

Once the topsoil has been dumped at the Stockpile Area it will then be shaped by a FEL in order to keep a neat appearance of the Stockpile Area. The levelling of topsoil is not a continuous operation but rather an ‘as and when required’ occurrence. The FEL will be alternated between the loading of stripped topsoil material and the levelling of the stockpile.

Topsoil will be cut in the following sequence (Remove 400 mm Thick Layer):

- Stockpile Area.
- Storage Area.

The following equipment will be utilized to cut and stockpile the topsoil:

- Motor Grader x1.
- Front End Loader x1.
- 10 m^3 dumper trucks x3.
- 20 t Excavator x1.

4.6.3.4 Bulk Excavation

Excavation of in-situ material is required to various depths at each area. Excavation will be performed in accordance with Excavation Method Statement. Excavation of unsuitable soil is included in ITP 002. The excavation will be done in two phases starting first with the Concrete Pad and followed by the Approach Aprons. The following depth of excavation is required at:

- Storage Area: Cut in-situ material an average of 2 m deep and haul to stockpile area.
- Approach Apron: Cut 2 m deep and haul to stockpile area.

The following equipment will be utilised to excavate the in-situ material and haul to stockpile area:

- 20 t Excavator x2.
- 10 m^3 dumper trucks x3.

4.6.3.5 Bulk Backfill

Backfilling will be done in accordance with Backfill and Layerworks Method Statement [98]. Re-grading and compaction of existing soil to the design level and fill layer with suitable material are included in ITP 002. Backfilling will be done in layers of 150 mm and compacted with a 10 t smooth drum roller. The final layer will be tested by means of Sand Replacement Test to the engineer’s required density. The following depth of bulk backfilling is required at:

- Concrete Pad: 1.100 m deep existent soil compacted to 95 % MDD.
- Approach Apron: 1.100 m deep existent soil compacted to 95 % MDD.

All commercial material sourced from off-site suppliers will be hauled to site and stockpiled as per lead times required.

The following equipment will be utilised to execute the bulk backfill operation:

- Motor Grader x1.
- Front End Loader x1.
- 20T Excavator x1.

- 10KL Watercart x1.
- TLB (Tractor Loader Backhoe) x1.
- 10 m^3 dumper trucks x3.
- 10T Smooth Drum Roller x1.
- 2.5T Ride-On Roller x1.

4.6.4 Concrete Works

4.6.4.1 Precast Roof Slab, Vents and ASM door (Off-Site Precast)

Precast Elements will be performed in accordance with Precast Elements Method Statement [114].

The formwork will be designed by a temporary works designer.

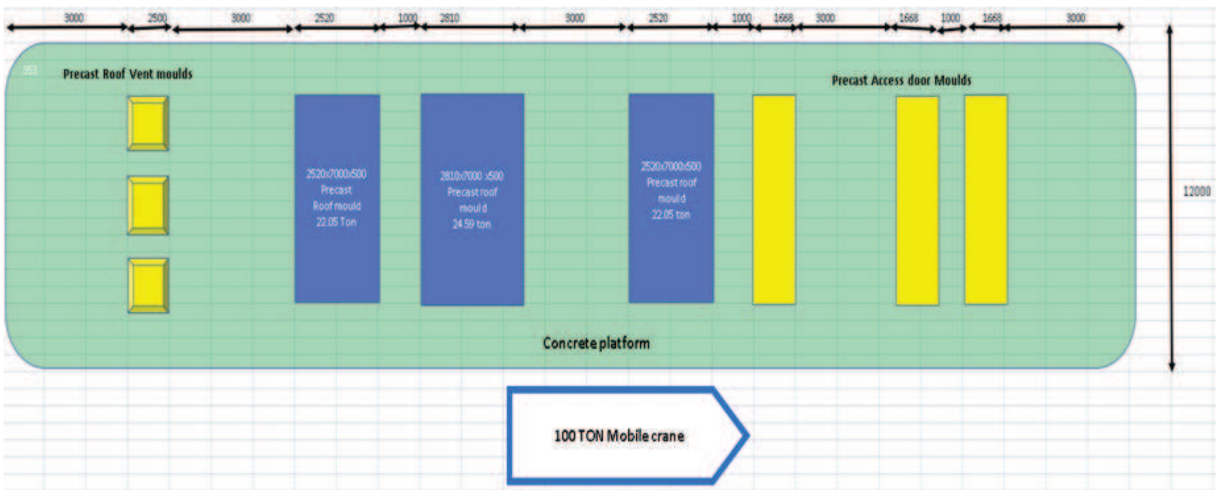


Figure 6: Precast Area

A Precast Area of approximately 402 m^2 will be identified within close proximity to the Koeberg Nuclear Power Station to allow for inspections as per the Precast Elements Method Statement [114] and ITP 006 [123]. The Precast Area is shown in Figure 6.

The Precast Area will be levelled with a motor grader and compacted.

A temporary slab with a minimum thickness of 200 mm will be cast to allow placement of the precast formwork. Typical precast formwork for the precast formwork for the Roof Slab, Roof Vent and Door is shown in Figure 7, Figure 8 and Figure 9, respectively.

The formwork will be premanufactured to the correct measurements. Installation of the formwork can commence as per the Temporary Works Designer. Fixing of reinforcing steel is executed in parallel with the formwork installation. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface.

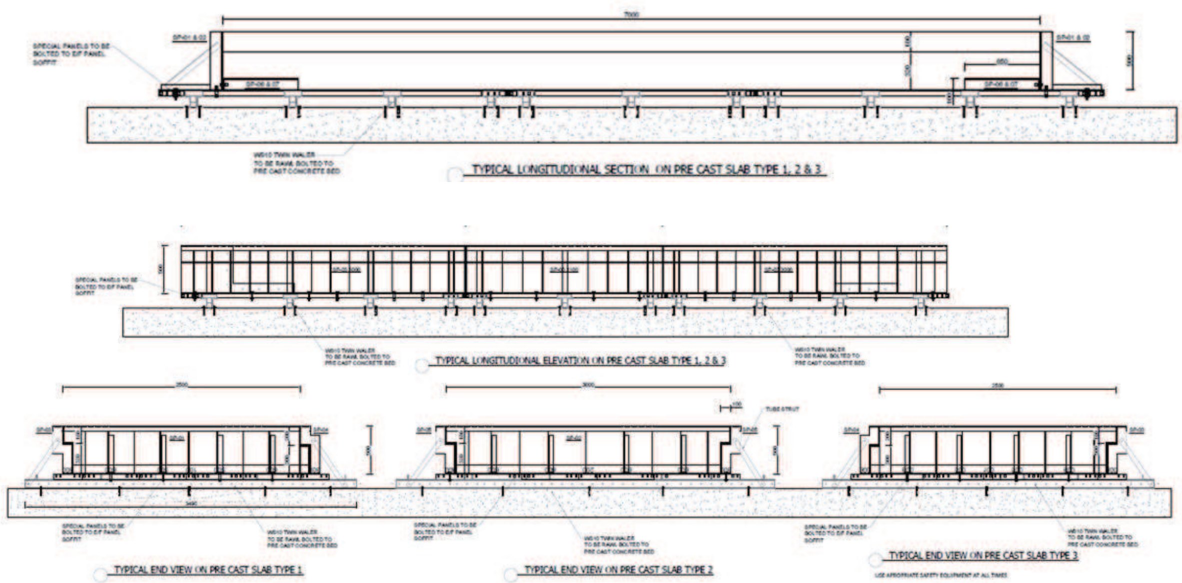


Figure 7: Precast Roof Slab

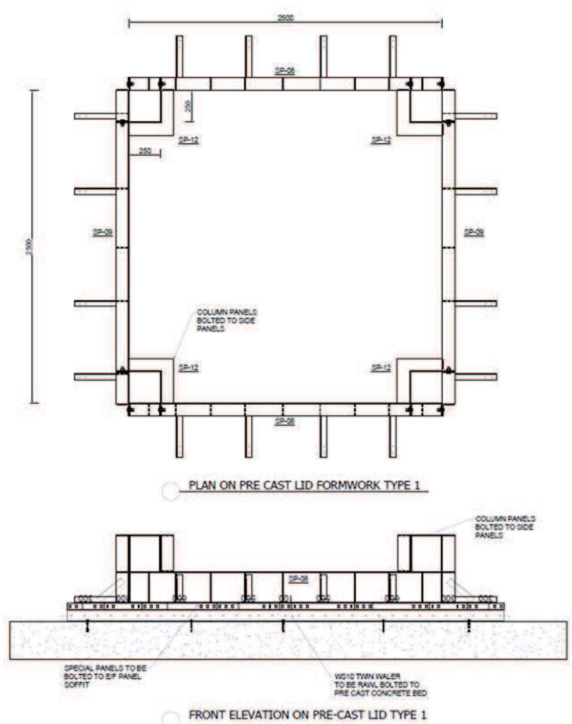


Figure 8: Precast Roof Vent

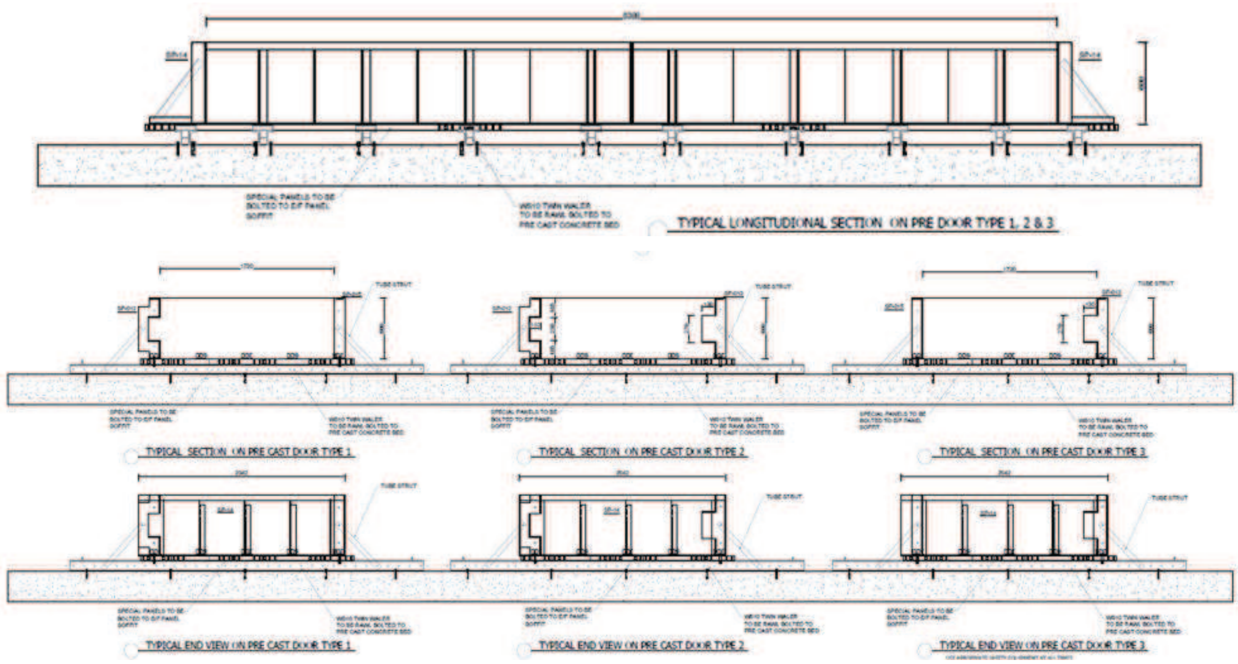


Figure 9: Precast Door

After the formwork and reinforcing steel is installed as per the design requirements the installation is confirmed by the Contractor, Design Engineer and confirmed by the Employer's representative, in accordance with ITP 006.

After all the required pre-pour inspections have been completed the concrete for the Precast Elements can be placed.

4.6.4.2 Concrete Pad (In-Situ Works)

The construction of the Concrete Pad and Approach Aprons will be performed in accordance with In-Situ Concrete Works Method Statement [115] and ITP 007 [124]. The construction of the reinforced Concrete Pads, with a total extension of 1850 m^2 will be executed in a modular manner as described in Section 4.6.2.

In order to keep the concrete pours manageable and to enable to start the first ASM immediately after Concrete Pad #1 has been cast the following aspects are considered:

- The Approach Aprons will follow the same sequence as Concrete Pad #1 to Concrete Pad #3.
- The land surveyor will set out the Concrete Pad position in accordance with the approved design centre lines and elevations, as indicated in ITP 007.
- After completion of the bulk backfilling, a 10 MPa blinding concrete layer of 100 mm thick is placed to the underside of foundation level, as shown in Figure 10.

The outside corners of the Concrete Pad are marked out onto the blinding concrete and the perimeter lines connected accordingly.

Installation of the formwork can commence as per the design compiled by the Temporary Works Designed of the formwork supplier. Formwork design plan and section is given in Figure 11 and Figure 12. These formwork details are included in Appendix B4 – IN-SITU CONCRETE FORMWORK DESIGN.

Figure 10: Blinding

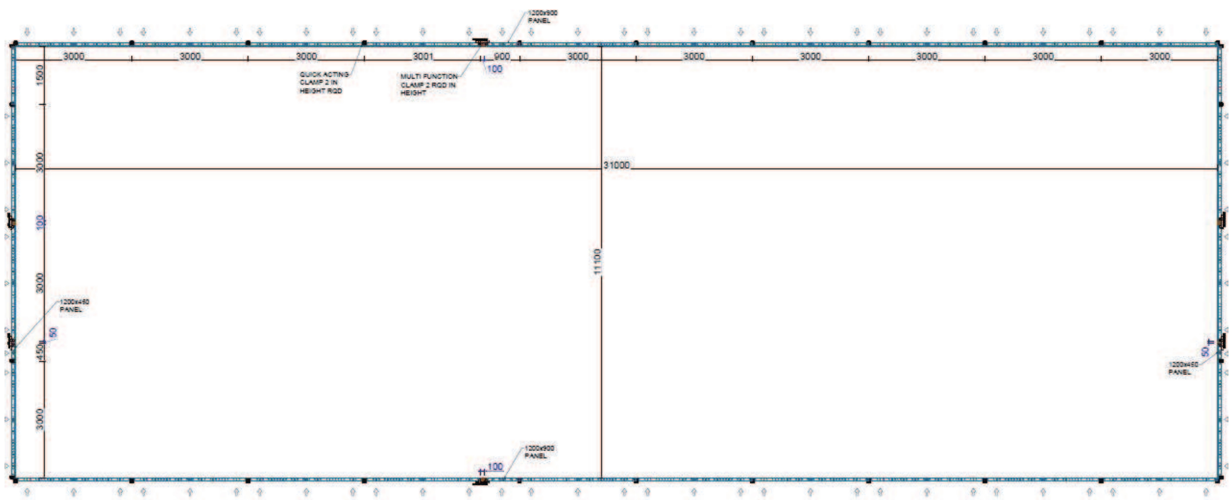


Figure 11: Formwork Design Plan

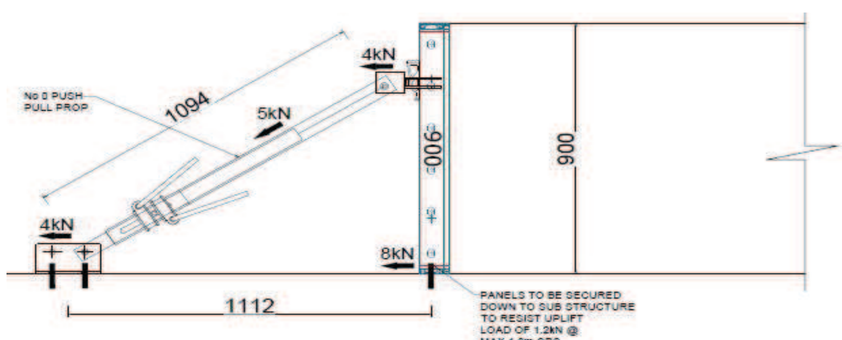


Figure 12: Formwork Design Section

Fixing of reinforcing steel is executed in parallel with the formwork installation, as shown in Figure 13. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface. An example of rebar fixing is shown in Figure 14.

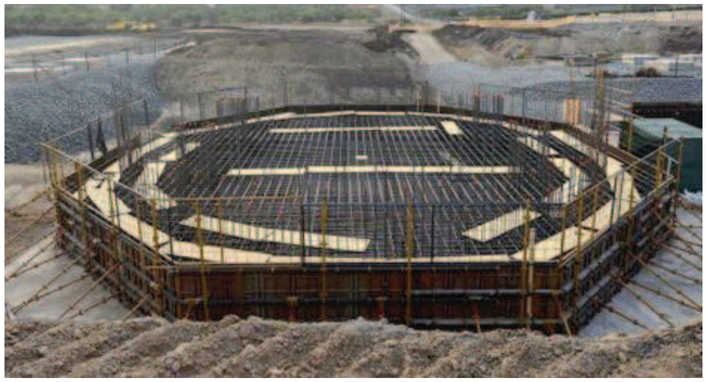


Figure 13: Formwork and Rebar Installed

Figure 14: Rebar Fixing

After the formwork and reinforcing steel is installed as per the design requirements the installation is confirmed by the Contractor, Design Engineer and confirmed by the Employer's representative, as indicated in ITP 007.

After all the required pre-pour inspections have been completed the concrete for the Concrete Pad can be placed.

The following planning applies regarding the various concrete pours:

- 30 MPa (in cubic compressive strength) ready-mix concrete will be supplied by an approved supplier in accordance with a previously approved mix design.
- It is envisaged that 12 spinner trucks of a capacity of between 6 m^3 and 8 m^3 will be required to complete a pour in a single shift.
- Concrete will be placed by means of direct discharge as well as with concrete boom pumps.

Truck mounted boom pumps will be provided by the ready-mix concrete supplier. It is envisaged that 2 pumps will be used with the intention of the pumps being backups to each other in the event of a breakdown.

- All concrete received will be tested and sampled as required by the specification and indicated in ITP 007.
- The forecasted time to complete the pour will be 10 hours with a late shift required to float the top of base and cure as required.

Formwork will be removed within 3 days of casting and the exposed formed surfaces coated with an approved water-based curing compound.

Post concrete pour inspection will be conducted as per ITP 007 before backfilling against the Concrete Pad can commence.

4.6.4.3 ASM Walls (In-Situ Works)

Construction of ASM Walls consist of two reinforced concrete side walls of 195 m^2 each and an end wall of 63 m^2. This activity will take place after completion of the Concrete Pad #1 as explained in Section 4.6.4.2. Figure 15 shows ASM Walls.

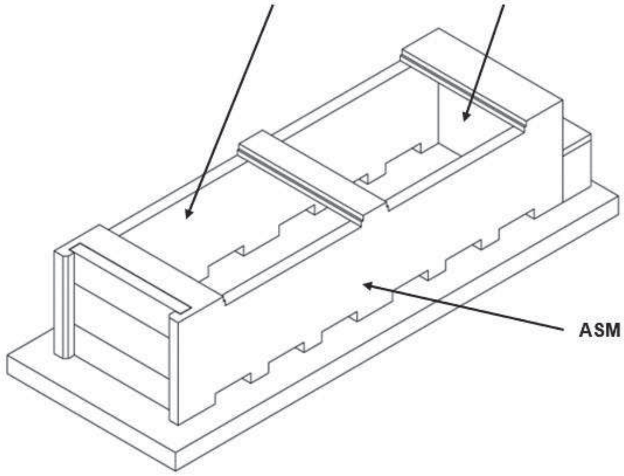


Figure 15: ASM Walls

The land surveyor will set out the outside corner wall position in accordance with the approved design centre lines and elevations, as indicated in ITP 007.

The outside corners of the ASM Walls are marked out onto the concrete and the perimeter lines connected accordingly. Joint preparation by scabble the surface to allow bond between wall and floor.

Installation of the formwork and scaffolding can commence as per the design compiled by the Temporary Works Designed of the formwork supplier. The design of the ASM Formwork is included in Appendix B4 – IN-SITU CONCRETE FORMWORK DESIGN.

Fixing of reinforcing steel is executed in parallel with the formwork installation. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface.

After the formwork and reinforcing steel is installed as per the design requirements the installation is confirmed by the Contractor, Design Engineer and confirmed by the Employer's representative, as indicated in ITP 007.
After all the required pre-pour inspections have been completed the concrete for the Concrete Pad can be placed.
The following planning applies regarding the various concrete pours:

- 30 MPa (in cubic compressive strength) ready-mix concrete will be supplied by an approved supplier in accordance with a previously approved mix design.
- Concrete will be placed by means of by means of a 30 t crane and bucket compacted and floated to level.
- All concrete received will be tested and sampled as required by the specification and indicated in ITP 007.

Formwork will be removed within 10 days of casting, back propped until 70% strength is achieved, and the exposed formed surfaces coated with an approved water-based curing compound.
Post concrete pour inspection will be conducted as per ITP 007 before the Roof Slab can commence.

4.6.4.4 Roof Slab (In-Situ Works)

After completion of the ASM In-Situ walls, the Roof Slab will continue.

Installation of the scaffolding and formwork can commence as per the design compiled by the Temporary Works Designed of the formwork supplier.

Fixing of reinforcing steel is executed after the formwork installation. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface.

After the formwork and reinforcing steel is installed as per the design requirements the installation is confirmed by the Contractor, Design Engineer and confirmed by the Employer's representative, as indicated in ITP 007.

After all the required pre-pour inspections have been completed the concrete for the Roof Slab can be poured.

The following planning applies regarding the various concrete pours:

- 30 MPa (in cubic compressive strength) ready-mix concrete will be supplied by an approved supplier in accordance with a previously approved mix design.
- Concrete will be placed by means of by means of a 30 t crane and bucket compacted and floated to level.
- All concrete received will be tested and sampled as required by the specification and indicated in ITP 007 .

Formwork will be removed within 10 days of casting, back propped until 70% strength is achieved and the exposed formed surfaces coated with an approved water-based curing compound.

Post concrete pour inspection will be conducted as per ITP 007 .

4.6.4.5 ASM Lockable Access Door

After completion of the ASM Walls, the formwork and scaffolding can be removed. The Access Door Walls are free-standing from the ASM, and they are not joint together with rebar. The construction of the Access Door Walls will be performed in accordance with In-Situ Concrete Works Method Statement [115] and ITP 007.

The installation of the formwork and scaffolding can commence.

Fixing of reinforcing steel is executed in parallel with the formwork installation. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface.

An opening suitable for the pedestrian door will be formed in the formwork to allow the installation of the Access Door after completion of the walls. As the Access Door has no shielding requirements, a suitable model with ventilation can be selected in agreement with Eskom to improve the ventilation of the ASM.

After the formwork and reinforcing steel is installed and confirmed by the Contractor, Design Engineer and the Employer's representative the concrete can be placed, as indicated in ITP 007.

Following the pour and removal of the formwork, the precast roof can be placed, and the Access Door can be secured into position.

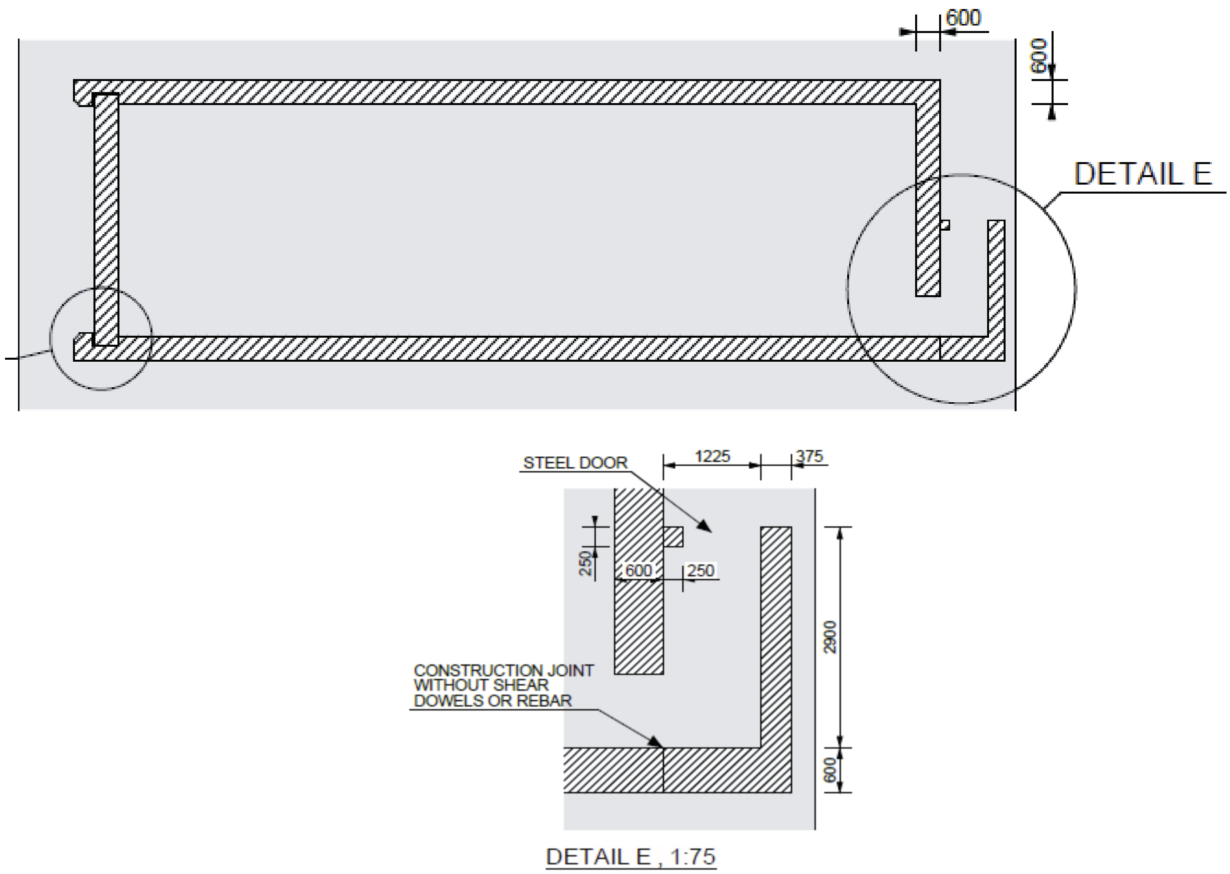


Figure 16: ASM Access Door

4.6.5 Precast Roof Panels Installation and Rigging

4.6.5.1 Receive Access

Hand-over certificate from the civil construction team indicating the as-built positions of the walls as well as the top of concrete levels.

4.6.5.2 Rigging Study & Lifting Plan

Before any attempt is made to off-load or install any form of pre-cast elements the execution of a rigging study and lifting plan is required in accordance with KSA-132 [127].

This will assist in determining the size and capacity of the crane required to execute the works, as well as the size and capacity of rigging equipment required.

The rigging study should take into account all factors of the working area that may restrict crane operations and account for it when capacities are determined.

Input data required for a rigging study may include:

- Boom angle.
- Operating radius.
- Boom length.
- Height of lift.
- Weight of lift.
- Physical crane dimensions.
- Dimensions of items being lifted.

4.6.5.3 Deliveries of Precast Elements

Roof slabs needs to be delivered to site in sequence of installation, mainly due to storage restraints and to minimize double handling.

Care must be taken to ensure that all off-site fabrication is done according to specification and all required parties suitably release the pre-cast panels before attempting to dispatch it to site. All members to be marked for identification in accordance with detailed drawings and installed according to general arrangements and assembly drawings.

4.6.6 Surface Drainage Channels

The construction of the Surface Drainage Channels will be performed in accordance with In-Situ Concrete Works Method Statement and ITP 007. The land surveyor will set out the position of the Trapezoidal Drainage Channel in accordance with the approved design centre lines and elevations, as indicated in ITP 007.

After completion of the bulk excavation (see Figure 17), the Trapezoidal Drainage Channel need to be excavated to the correct profile by hand trimming and TLB (see Figure 18).

Figure 17: Bulk Excavation of Trapezoidal Drainage Channel

Figure 18: Excavation to the Correct Profile

Installation of the formwork can commence as per the design compiled by the Temporary Works Designed of the formwork supplier.

Fixing of reinforcing steel is executed in parallel with the formwork installation. It is important to ensure the correct cover to reinforcing steel is achieved at the bottom, sides as well as top of concrete surface.

After the formwork and reinforcing steel is installed as per the design requirements the installation is confirmed by the Contractor, Design Engineer and confirmed by the Employer's representative, as indicated in ITP 007.

After all the required pre-pour inspections have been completed the concrete for the Trapezoidal Drainage Channel can be placed. Trapezoidal Channel concrete pouring is shown in Figure 19.

Figure 19: Trapezoidal Channel Concrete Pouring

The Trapezoidal Drainage Channel will be poured in alternating panels of 3 m long with the infill panels, thereafter, as shown in Figure 20.
The following planning applies regarding the various concrete pours:

- 25 MPa (in cubic compressive strength) ready-mix concrete will be supplied by an approved supplier in accordance with a previously approved mix design.
- Concrete will be placed by means of direct discharge or by means of 30 t crane and bucket.
- All concrete received will be tested and sampled as required by the specification.
- Pours can be executed during weekdays and will be completed in a normal shift.

Figure 20: Trapezoidal Drainage Channel Concrete Pouring in Alternating Panels

Formwork will be removed within 1 day of casting and the exposed formed surfaces coated with an approved wax-based curing compound. Trapezoidal Drainage Channel curing is shown in Figure 21.

Figure 21: Trapezoidal Drainage Channel Curing

Post concrete pour inspection will be conducted as per ITP 007 before backfilling against the Trapezoidal Drainage Channel can commence.

Figure 22: Finished Trapezoidal Drainage Channel

4.7 Marking and Identification

Not Applicable.

4.8 Verifications and Tests

4.8.1 Tests Required

4.8.1.1 Concrete Compressive Strength

Concrete Pad	Minimum cube concrete compressive strength: 30 MPa Maximum cube concrete compressive strength: 51.7 MPa
Concrete ASM and Approach Aprons	Minimum cube concrete compressive strength: 30 MPa

4.8.1.2 ASM Concrete Density

- ASM Concrete Minimum density: 2.2994 t/m^3 (SANS 6251).
- ASM Concrete Maximum density: 2.5 t/m^3 (SANS 6251).

4.8.1.3 Concrete Durability

- Minimum cover: 60 mm.
- Maximum w/c ratio: 0.5.
- Minimum content of cement (kg/m^3): 300.
- Maximum water penetration depth (UNE-EN 12390-8): 50 mm.
- Average water penetration depth (UNE-EN 12390-8): 30 mm.
- Type of cement: CEM III/A, CEM III/B, CEM IV, CEM II/B-V, CEM II/A-D or concrete with more than 6 % added microsilica or more than 20 % added fly ash.
- To ensure a proper concrete design mix, a 28-day cube concrete compressive strength test will be performed to verify the compliance with the design strength requirements before the pouring of concrete for the Storage Pad.

4.8.1.4 Concrete Slump Test

- Consistency: 100-150 mm in Slump Test (SANS 5862-1).

4.8.1.5 Engineering Fill compaction

The Concrete Pad shall rest over a engineering fill of 1 m with granular base material (gravel/sand) and compacted to a minimum of 95 percent of the Maximum Dry Density.

4.8.2 Description of Tests

4.8.2.1 Concrete Compressive Strength

- SANS 5863 Concrete Tests – Compressive Strength of Hardened Concrete.

4.8.2.2 Concrete Density

- SANS 6251 Concrete Tests – Density of Hardened Concrete.

4.8.2.3 Concrete Durability

- EN 12390-8 Testing hardened concrete - Part 8: Depth of penetration of water under pressure.

4.8.2.4 Concrete Slump Test

- SANS 5862-1 Concrete Tests – Consistence of Freshly Mixed Concrete – Slump Test.

4.8.2.5 Dry Density by Sand Replacement Method

- Maximum Dry Density as indicated in ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort.
- Dry Density by Sand Replacement Method as per ASTM D4914/D4914M Standard Test Methods for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit.

4.9 Documentation

- Drawings Issued for Construction: Appendix A2.16 – TISF KOEBERG DETAILED DESIGN DRAWINGS (00857PL004 to 00857PL010)
  - 00857PL004 – NOTES
  - 00857PL005 – TISF LAYOUT
  - 00857PL006 – SHAPE DRAWINGS GENERAL VIEW
  - 00857PL007 – SHAPE DRAWINGS AUXILIARY SHIELDING MODULE
  - 00857PL008 – REBAR DETAIL 1
  - 00857PL009 – REBAR DETAIL 2
  - 00857PL010 – OPERATIONS
- Drawings As-Built
- QA Records

Drawings PL008 to 010 and some drawings in PL007 have been redacted as they are Contractor intellectual property. (Refer to Appendix A2.16)

4.10 Packaging, Shipping, Receiving, Storage and Handling

Not Applicable.

4.11 Part B Manufacturing and Installation Specification Appendix list

Appendix B1 – CABLE SPECIFICATIONS AND ROUTES

Appendix B2 – TRIGRAMME ALLOCATION / DELETION LETTER

Appendix B3 – KIT INPUT ALLOCATION LETTER AND KIT DATABASE MOFICATION FORM, KFU-PC-009

Appendix B4 – IN-SITU CONCRETE FORMWORK DESIGN

Appendix B1 – CABLE SPECIFICATIONS AND ROUTES

Not Applicable.

Appendix B2 – TRIGRAMME ALLOCATION / DELETION LETTER

Eskom	Trigramme and Cable Request Form	Document Identifier	331-282	Rev	1
		Effective Date	March 2023		
		Review Date	March 2026		

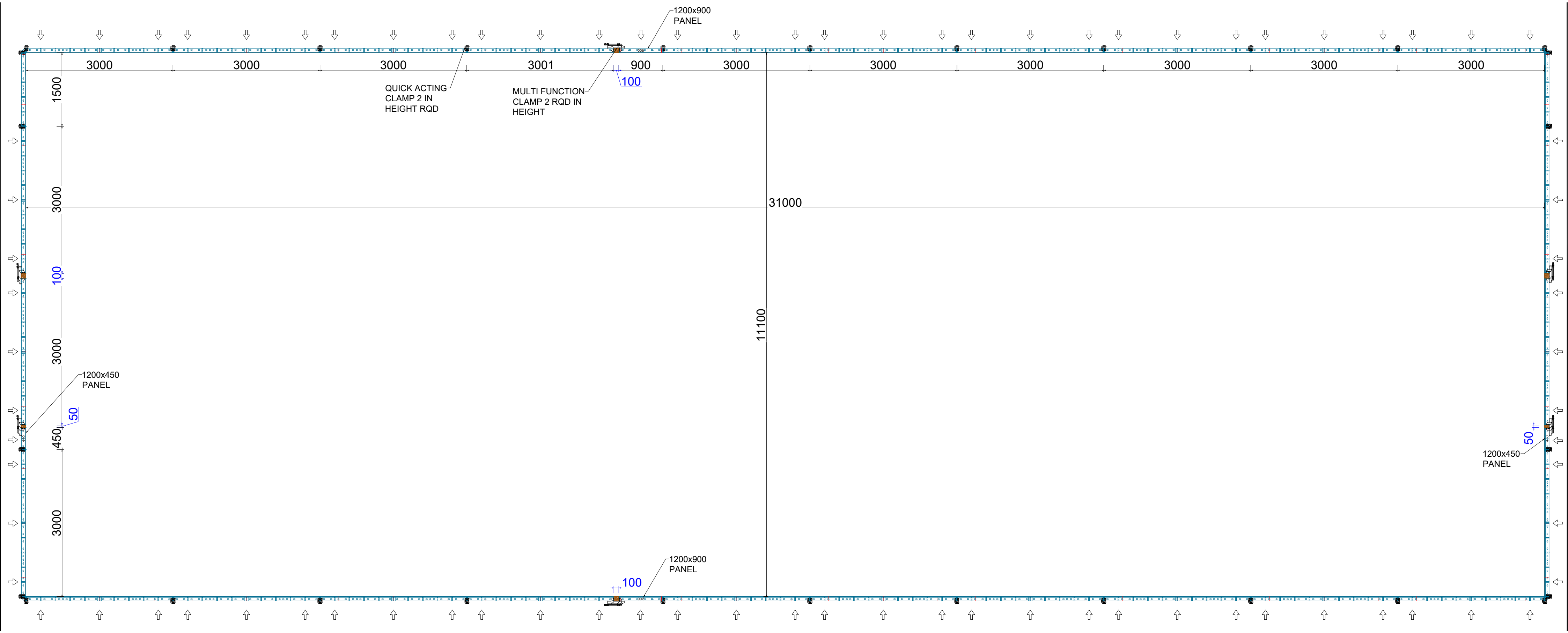
Date:	10 April 2024	Our Reference:	T0762-HQG (Rev.1)
Your Reference:	12010 -Detailed Design of the Koeberg TISF – First Storage Area (**System & Classification changed in Rev.1)**	Modification No:	12010 - Transient Interim Storage Facility

TRIGRAMMES TO BE ADDED				CLASSIFICATION						
TRIGRAMME	DESCRIPTION	PARENT LINK	LOCATION	CLASS No.	SA	SE	Q	ER	IMP	INITIALS
9 HQG 001 OS	Transient Interim Storage Facility Concrete Storage Pads	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 002 OS	Transient Interim Storage Facility Approach Aprons	9 HQG	North end of KNPS Site	0100/90Q	NSF	NC	Q3	NEV	NSA	MT
9 HQG 001 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 002 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 003 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 004 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 005 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 006 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
9 HQG 007 BG	Transient Interim Storage Facility Auxiliary Shielding Module	9 HQG	North end of KNPS Site	C0007/24C	LS	ND	Q2	NEV	SR	MT
Elsabé Perrang				Mfundo Tyaliti						
CONFIGURATION MANAGEMENT				DESIGN ENGINEERING						

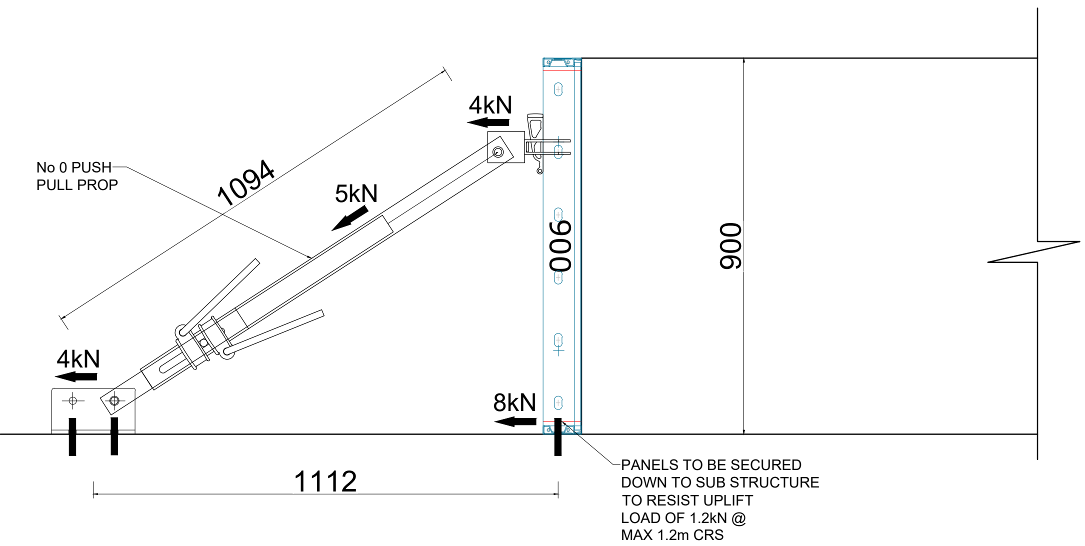
Appendix B3 – KIT INPUT ALLOCATION LETTER AND KIT DATABASE MOFICATION FORM, KFU-PC-009

Not applicable.

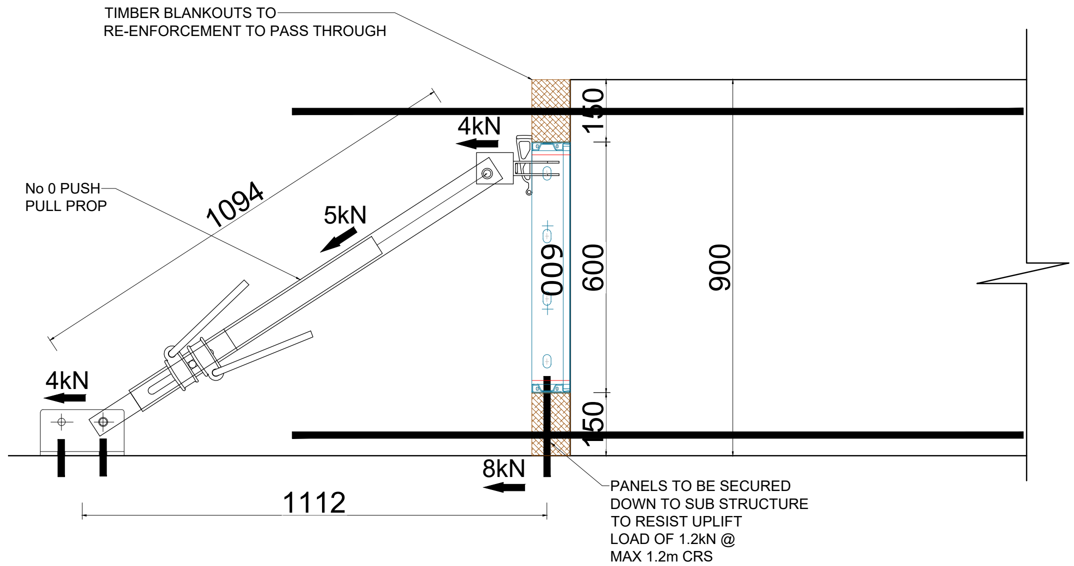
Appendix B4 – IN-SITU CONCRETE FORMWORK DESIGN



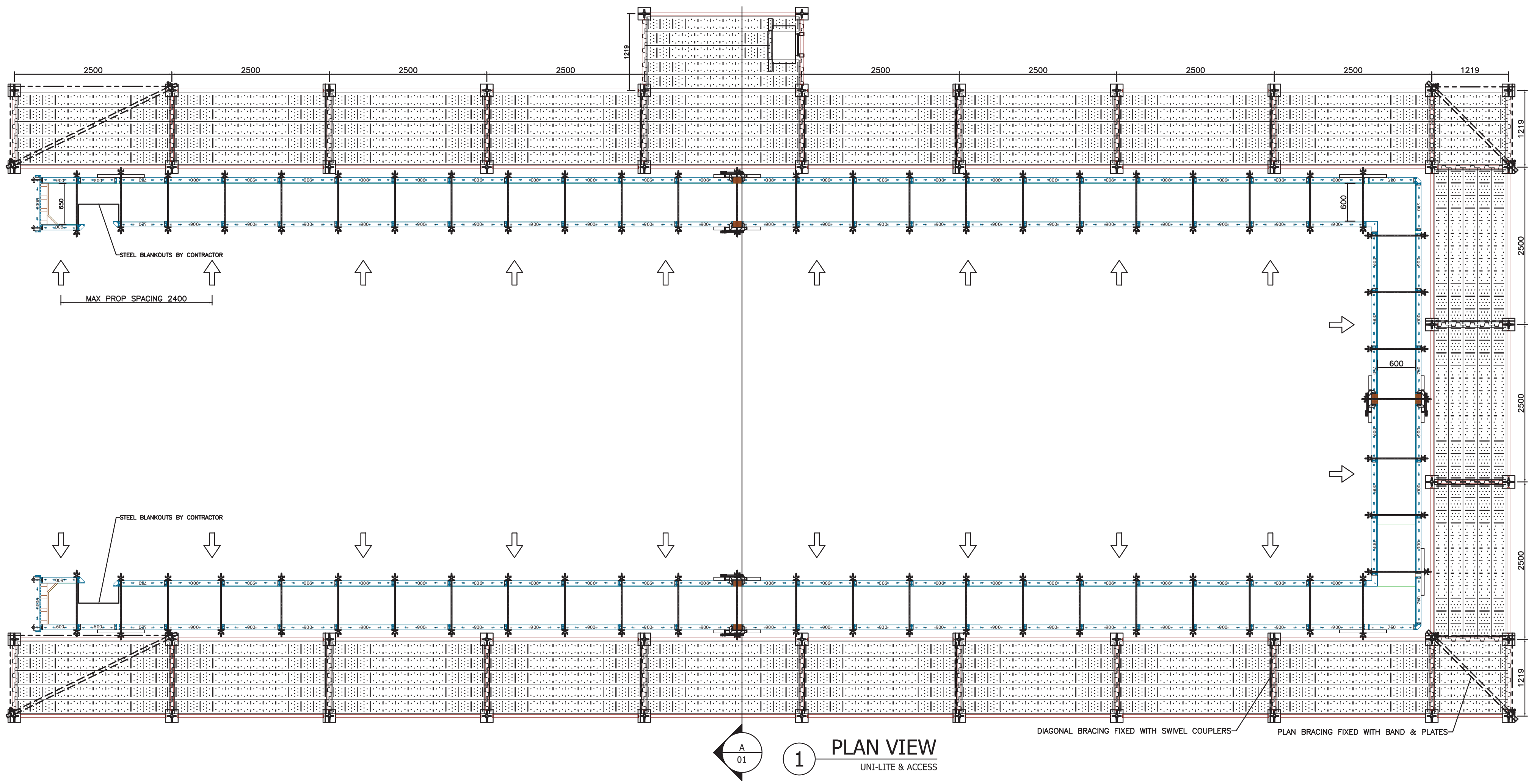
1200x900
PANEL
3000
3000
3000
3001
900
3000
3000
3000
3000
3000
3000
100
QUICK ACTING
CLAMP 2 IN
HEIGHT RQD
MULTI FUNCTION
CLAMP 2 RQD IN
HEIGHT
1500
3000
31000
100
11100
3000
1200x450
PANEL
50
450
50
1200x450
PANEL
3000
1200x900
PANEL
100



TYPICAL CONSTRUCTION JOINT SECTION

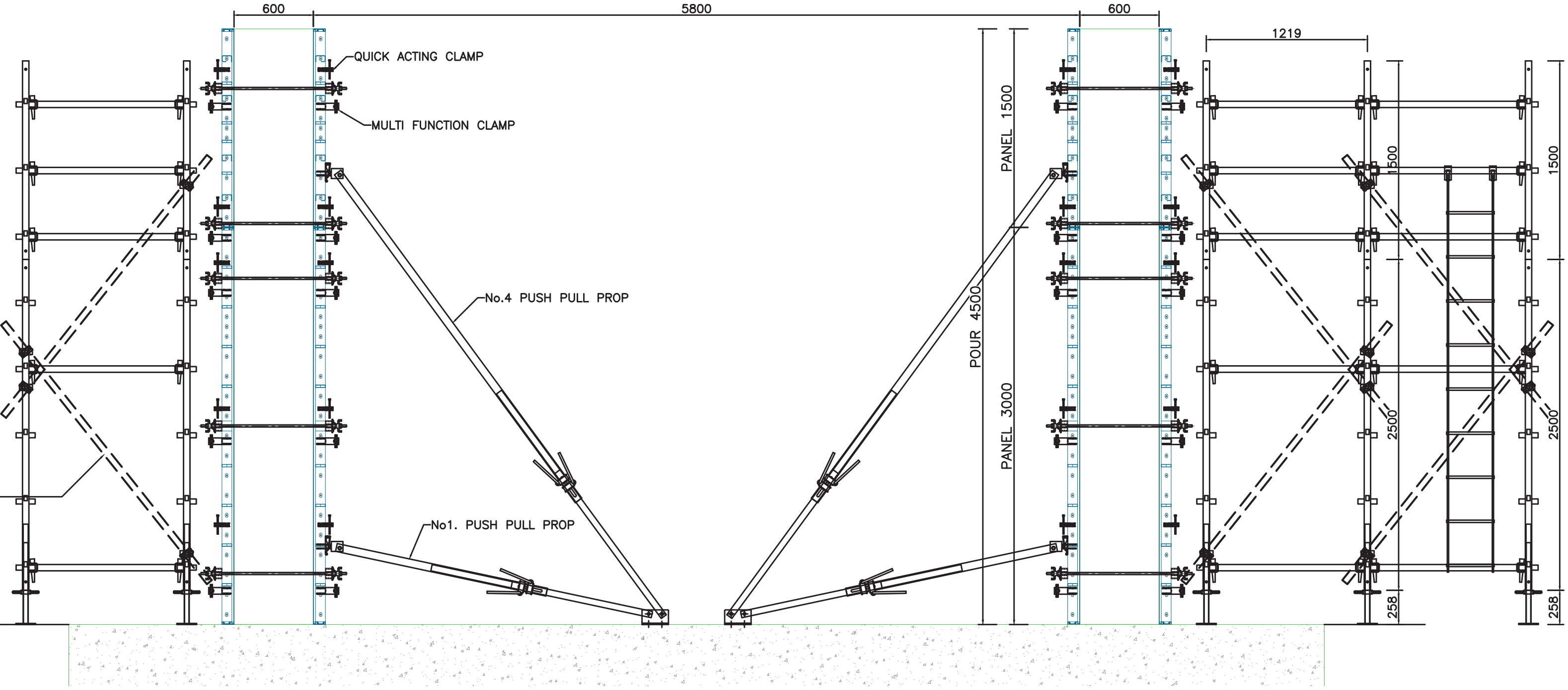


TYPICAL EXPANSION JOINT SECTION



PLAN VIEW

UNI-LITE & ACCESS



SECTION VIEW A

UNI-LITE & ACCESS

5. PART C – PROCUREMENT SPECIFICATION

Table 1: Bill of Materials

No.	DESCRIPTION	QTY	UMC	CLASS	SPECIFICATION No.
1	30 MPa cube concrete compressive strength (Concrete Pad, fc < 51.7 MPa)	1665	m^3	0029/99Q, NSF/NC/Q3/NEV	C.o.C SANS 1200G, SABS 878
2	30 MPa cube concrete compressive strength (ASMs and Approach Aprons)	892	m^3		
3	Rebar 450 MPa	954981	kg	0041/89Q, NSF/NC/Q4/NEV	SANS 920
4	25 MPa cube concrete compressive strength (trapezoidal channel)	15.8	m^3	0029/99Q, NSF/NC/Q3/NEV	C.o.C SANS 1200G, SABS 878
5	Steel embedments (bolt anchors and plates)	280	unit	0041/89Q, NSF/NC/Q4/NEV	C.o.C
6	Lifting anchors	168	unit	0041/89Q, NSF/NC/Q4/NEV	C.o.C

5.1 Part C Procurement Specification Appendix List

Appendix C1 – DATASHEETS

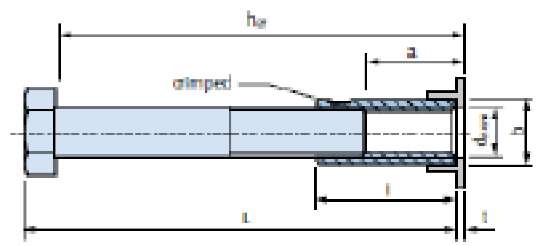
Appendix C1 – DATASHEETS

BOLT ANCHORS

Bolt Anchor 1988 A4-50 / A4-80

ETA-13/0401

1988 A4-50 and 1988 A4-80



Anchor description

The bolt anchor 1988 A4 consists of a bolt (hot-dip galvanized, quality 8.8) with a screwed and crimped sleeve.
The sleeve has an internal metric ISO thread and is manufactured from stainless steel (strength class A4-50 or strength class A4-80). For identification a white/black plastic clip is attached (t=2mm).

Please download our calculation software to calculate the load capacity of this anchor according to CEN/TS 1992-4-1/2.
www.halfen.com → downloads → software.
For information about our software see page 40.

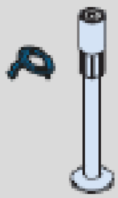
Order no.	d_{nom} × L [mm]	h_{ef} [mm]	a [mm]	b [mm]	l [mm]	$N_{Rd,c}$ [kN] C20/25	$N_{Rd,c}$ [kN] C45/55	$V_{Rd,c}$ [kN] C20/25	$V_{Rd,c}$ [kN] C45/55
	Dimensions					Design loads for tension ①		Design loads for shear ①	
Bolt anchor 1988 A4-50 incl. identification clip (white)									
0020.010-00060	M12 x 100	94.0	25	15.5	35	15.0	15.0	9.0	9.0
0020.010-00061	M12 x 150	144.0	25	15.5	35	15.0	15.0	9.0	9.0
0020.010-00062	M16 x 140	132.0	31	21	45	26.2	26.2	15.7	15.7
0020.010-00063	M16 x 220	212.0	31	21	45	26.2	26.2	15.7	15.7
0020.010-00064	M20 x 150	139.0	37	26	55	35.6	35.6	21.4	21.4
0020.010-00065	M20 x 180	169.0	37	26	55	35.6	35.6	21.4	21.4
0020.010-00066	M20 x 270	259.0	37	26	55	35.6	35.6	21.4	21.4
Bolt anchor 1988 A4-80 incl. identification clip (black)									
0020.010-00016	M12 x 100	94.0	25	15.5	35	16.7	36.8	24.0	24.0
0020.010-00017	M12 x 150	144.0	25	15.5	35	16.7	36.8	24.0	24.0
0020.010-00018	M16 x 140	122.0	31	21	45	29.8	63.7	47.2	47.2
0020.010-00019	M16 x 220	212.0	31	21	45	29.8	65.6	47.2	47.2
0020.010-00020	M20 x 150	139.0	37	26	55	46.5	68.9	73.2	73.2
0020.010-00021	M20 x 180	169.0	37	26	55	46.5	92.3	73.2	73.2
0020.010-00067	M20 x 270	259.0	37	26	55	46.5	102.4	73.2	73.2
0020.010-00022	M24 x 200	187.0	48	32	70	67.0	107.5	106.2	106.2
0020.010-00023	M30 x 240	223.0	62	40	90	94.4	140.0	168.7	168.7

① The design load is the calculation value according to CEN/TS 1992-4-1/2 for tensile or shear force in plain concrete without load-reducing influences.
Values only apply for cracked concrete; no dense reinforcement (risk of shell spalling).
Design loads are valid for permanent fixings and are not permitted for lifting!

HALFEN HD SOCKET LIFTING SYSTEM

Product Range HD Anchors

HD Anchor



	Load class	Article name	Order no. 0740.130-
Socket zinc-plated	1,3	6360-1,3-130	00001
Socket zinc-plated	2,5	6360-2,5-140	00040
Socket zinc-plated	2,5	6360-2,5-200	00002
Socket zinc-plated	4,0	6360-4,0-258	00003
Socket zinc-plated	5,0	6360-5,0-325	00004
Socket zinc-plated	7,5	6360-7,5-400	00005
Socket zinc-plated	10,0	6360-10,0-475	00006
Socket zinc-plated	12,5	6360-12,5-550	00007
Socket zinc-plated	15,0	6360-15,0-575	00008
Socket zinc-plated	25,0	6360-25,0-630	00041
Socket stainless steel A4	1,3	6360-1,3-130 A4	00009
Socket stainless steel A4	2,5	6360-2,5-200 A4	00010
Socket stainless steel A4	4,0	6360-4,0-258 A4	00011
Socket stainless steel A4	5,0	6360-5,0-325 A4	00012
Socket stainless steel A4	7,5	6360-7,5-400 A4	00013
Socket stainless steel A4	10,0	6360-10,0-475 A4	00014
Socket stainless steel A4	12,5	6360-12,5-550 A4	00015
Socket stainless steel A4	15,0	6360-15,0-575 A4	00016

HD Plate anchor

	Load class	Article name	Order no. 0740.180-
Zinc-plated	1,3	6370-1,3	00001
Zinc-plated	2,5	6370-2,5	00002
Zinc-plated	4,0	6370-4,0	00003
Zinc-plated	5,0	6370-5,0	00004
Zinc-plated	7,5	6370-7,5	00005
Stainless steel A4	1,3	6370-1,3 A4	00006
Stainless steel A4	2,5	6370-2,5 A4	00007
Stainless steel A4	4,0	6370-4,0 A4	00008
Stainless steel A4	5,0	6370-5,0 A4	00009
Stainless steel A4	7,5	6370-7,5 A4	00010

HD Short anchor

	Load class	Article name	Order no. 0740.120-
Socket zinc-plated	1,3	6360-1,3-070	00017
Socket zinc-plated	2,5	6360-2,5-090	00018
Socket zinc-plated	4,0	6360-4,0-125	00019
Socket zinc-plated	5,0	6360-5,0-140	00020
Socket zinc-plated	7,5	6360-7,5-185	00038
Socket stainless steel A4	1,3	6360-1,3-070 A4	00021
Socket stainless steel A4	2,5	6360-2,5-090 A4	00022
Socket stainless steel A4	4,0	6360-4,0-125 A4	00023
Socket stainless steel A4	5,0	6360-5,0-140 A4	00024
Socket stainless steel A4	7,5	6360-7,5-185 A4	00039

HD Plain anchor

	Load class	Article name	Order no. 0740.190-
Zinc-plated	1,3	6376-1,3	00001
Zinc-plated	2,5	6376-2,5	00002
Zinc-plated	4,0	6376-4,0	00003
Zinc-plated	5,0	6376-5,0	00004
Zinc-plated	7,5	6376-7,5	00005
Zinc-plated	10,0	6376-10,0	00006
Socket stainless steel A4	1,3	6376-1,3 A4	00007
Socket stainless steel A4	2,5	6376-2,5 A4	00008
Socket stainless steel A4	4,0	6376-4,0 A4	00009
Socket stainless steel A4	5,0	6376-5,0 A4	00010
Socket stainless steel A4	7,5	6376-7,5 A4	00011
Socket stainless steel A4	10,0	6376-10,0 A4	00012

HD Rod anchor

	Load class	Article name	Order no. 0740.140-
Socket zinc-plated	1,3	6361-1,3-300	00001
Socket zinc-plated	2,5	6361-2,5-400	00002
Socket zinc-plated	4,0	6361-4,0-520	00003
Socket zinc-plated	5,0	6361-5,0-540	00004
Socket zinc-plated	7,5	6361-7,5-700	00005
Socket zinc-plated	10,0	6361-10,0-800	00006
Socket zinc-plated	12,5	6361-12,5-920	00007
Socket zinc-plated	15,0	6361-15,0-1100	00008
Socket stainless steel A4	1,3	6361-1,3-300 A4	00009
Socket stainless steel A4	2,5	6361-2,5-400 A4	00010
Socket stainless steel A4	4,0	6361-4,0-520 A4	00011
Socket stainless steel A4	5,0	6361-5,0-540 A4	00012
Socket stainless steel A4	7,5	6361-7,5-700 A4	00013
Socket stainless steel A4	10,0	6361-10,0-800 A4	00014
Socket stainless steel A4	12,5	6361-12,5-920 A4	00015
Socket stainless steel A4	15,0	6361-15,0-1100 A4	00016

HD Rod anchor, offset

	Load class	Article name	Order no. 0740.220-
Socket zinc-plated	5,0	6361G-5,0-540	00001
Socket zinc-plated	7,5	6361G-7,5-700	00002
Socket zinc-plated	10,0	6361G-10,0-800	00003
Socket zinc-plated	12,5	6361G-12,5-920	00004
Socket zinc-plated	15,0	6361G-15,0-1100	00005

6. PART D - OTHER ATTACHMENTS

Appendix D1 – DOCUMENTATION CHANGE IDENTIFICATION FORM (DCIF)

Appendix D2 – ALARA SCREENING FORM

Appendix D3 – PROJECT TEAM CONCURRENCE

Appendix D1 – DOCUMENTATION CHANGE IDENTIFICATION FORM (DCIF)

MODIFICATION / TAF NUMBER:	Modification No. 12010TISF-0017

DOCUMENTS			
Reference	Rev	Title	Change Ref Number
Revised Documents			
240-166149425	1	The civil inspection programme	GA 43878
KAH 002	8	Radiation Surveillance Program	GA 43884
KBA 0002Z011006	Z2	Site Plan General Layout	GA 43879
240-166150507	1	Management of Non-License Binding Civil Monitoring Programme Surveillances at KNPS	GA 43880
KEP-088	7	Emergencies Affecting Spent Fuel in Storage Casks	GA 43883
Withdrawn Documents			
New Documents			
TBC	0	SAR update – New Section	UR 2503
00857PL004	0	NOTES	GA 43881
00857PL005	0	TISF LAYOUT	GA 43881
00857PL006	0	SHAPE DRAWINGS GENERAL VIEW	GA 43881
00857PL007	0	SHAPE DRAWINGS AUXILIARY SHIELDING MODULE	GA 43881
00857PL008	0	REBAR DETAIL 1	GA 43881
00857PL009	0	REBAR DETAIL 2	GA 43881
00857PL010	0	OPERATIONS	GA 43881

DOCUMENTS TO BE CONSIDERED		Update	Update Considered, Not Required	Not Applicable
1.0	**DSE DOCUMENTS**			
1.1	Logic Diagrams	☐	☐	☒
1.2	Control Loops	☒	☐	☒
1.3	Controls Available to the Operator	☐	☐	☒
1.4	Information Available to the Operator	☐	☐	☒
1.5	Valve Lists	☐	☐	☒
1.6	Data Sheets	☐	☐	☒
1.7	Control and Instrumentation	☐	☐	☒
1.8	Flow Diagrams	☐	☐	☒
1.9	Instrumentation Diagrams	☐	☐	☒
1.10	KIT Unit Description	☐	☐	☒
1.11	Relay Racks	☐	☐	☒
1.12	Actuators List	☐	☐	☒
1.13	General Design & Operating Parameters	☐	☐	☒
2.0	**ELECTRICAL AND INSTRUMENTATION**			
2.1	Measure Connecting Diagrams	☐	☐	☒
2.2	Control Connecting diagrams	☐	☐	☒
2.3	Control and Regulation Measurement Tapes	☐	☐	☒
2.4	Electrical Materials Location	☐	☐	☒
2.5	Feeder Diagrams and Lists	☐	☐	☒
2.6	Alarm lists (KBAxx22E021003; KBAxxKSC900, 910) and diagrams	☐	☐	☒
2.7	Process Inst., System Piping Way	☐	☐	☒
2.8	Materials Lists	☐	☐	☒
2.9	KIT Listing	☐	☐	☒
2.10	Cable Pulling Listing	☐	☐	☒
2.11	Main Cable Racks	☐	☐	☒
2.12	Individual Cable Racks	☐	☐	☒
2.13	Mechanical Diagrams for Instrumentation	☐	☐	☒
2.14	EDG Power Balance KBA1217000090/91	☐	☐	☒
3.0	**SETPOINT MANUAL**			
3.1	NSSS Setpoint Manual	☐	☐	☒
3.2	BNI Setpoint Manual	☐	☐	☒
3.3	Other Setpoint Documents	☐	☐	☒
4.0	**SPECIFICATIONS**			
4.1	Contractor Specifications	☒	☐	☐
4.2	Eskom Specifications	☒	☐	☐
5.0	**CLASSIFICATIONS**			
5.1	Component Classifications	☒	☐	☐
5.2	Parts Classifications	☐	☐	☒
5.3	Software Classifications	☐	☐	☒

DOCUMENTS TO BE CONSIDERED

		Update	Update Considered, Not Required	Not Applicable
6.0	**MECHANICAL ERECTION DRAWINGS**			
6.1	Mechanical Installation Drawings	☐	☐	☒
6.2	Pump Installation Drawings	☐	☐	☒
6.3	Material Location Drawings	☐	☐	☒
7.0	**PIPING DRAWINGS**			
7.1	General Installation Drawings	☐	☐	☒
7.2	Support Books	☐	☐	☒
7.3	Isometric Drawings	☐	☐	☒
7.4	Penetration Drawings	☐	☐	☒
7.5	Tank Drawings	☐	☐	☒
7.6	Bottle Level	☐	☐	☒
8.0	**VENTILATION SYSTEM DRAWINGS**			
8.1	Electrical Materials Location	☐	☐	☒
8.2	Mechanical Materials Location	☐	☐	☒
8.3	Isometric Drawings	☐	☐	☒
9.0	**MAINTENANCE**			
9.1	Maintenance Basis Documents (Component Eng. controls updates)	☐	☐	☒
9.2	Service Notifications	☐	☐	☒
9.3	Maintenance Manuals	☒	☐	☐

		Update	Update Considered, Not Required	Not Applicable
10.0	**IMPORTANT CALCULATIONS**			
10.1	Secondary Heat Balance	☐	☐	☒
10.2	Setpoint Calculations	☐	☐	☒
11.0	**SAFETY ANALYSIS REPORT (SAR)**	☒	☐	☐
12.0	**OPERATING TECH. SPECS (OTS)**	☐	☐	☒
13.0	**OTHER LICENCE DOCUMENTS**	☐	☐	☒
14.0	**OPERATING PROCEDURES**	☐	☐	☒
14.1	KWB-AA-xx	☐	☐	☒
14.2	KWB-1AA-xx	☐	☐	☒
14.3	KWB-2AA-xx	☐	☐	☒
14.4	KWB-9AA-xx	☐	☐	☒
14.5	KWB-1-LAS-xx	☐	☐	☒
14.6	KWB-2-LAS-xx	☐	☐	☒
14.7	KWB-F-xx	☐	☐	☒
14.8	KWB-FP-xx	☐	☐	☒
14.9	KWB-PT-xx	☐	☐	☒
14.10	KWB-G-xx	☐	☐	☒
14.11	KWB-GS-xx	☐	☐	☒
14.12	KWB-OP-xx	☐	☐	☒
14.13	KWB-R-xx	☐	☐	☒

DOCUMENTS TO BE CONSIDERED

		Update	Update Considered, Not Required	Not Applicable
14.14	KWB-RT-xx	☐	☐	☒
14.15	KWB-S-xx	☐	☐	☒
	INCIDENT/ACCIDENT CONDITIONS			
14.16	KWB-E-xx	☐	☐	☒
14.17	KWB-ECA-xx	☐	☐	☒
14.18	KWB-ES-xx	☐	☐	☒
14.19	KWB-FR-xx	☐	☐	☒
14.20	KWB-I-xx	☐	☐	☒
15.0	**SEVERE ACCIDENT MANAGEMENT GUIDELINES – KGG - xxx**	☐	☐	☒
16.0	**OTHER NON OPS PROCEDURES**			
16.1	Maintenance Procedures – KWM-xx	☐	☐	☒
16.2	Chemistry Procedures – KWC-xx	☐	☐	☒
16.3	Radwaste Procedures – KWW-xx	☐	☐	☒
16.4	Test Procedures – KWR-xx	☐	☐	☒
16.5	Training Procedures	☐	☐	☒

		Update	Update Considered, Not Required	Not Applicable
16.6	Administrative Procedures	☒	☐	☐
16.7	Lists – 331-94 (KLA-001), etc. Hazardous Locations Listings	☐	☐	☒
16.8	Offsite Procedures Check with IPS Co-Ordinator for applicability i.e. OPS Support.	☐	☐	☒
16.9	KBA0000 G00 032 – List of Systems	☐	☐	☒
17.0	**SAFETY RELATED SURVEILLANCE MANUAL (SRSM) VALIDATION**			
17.1	Test Procedures – KBA 0022 - SRM-xx-TR	☐	☐	☒
18.0	**ELECTRONIC DATABASES**			
18.1	PERICLES (DE controls the updates)	☐	☐	☒
18.2	CLASSIFICATION DATABASE (Specifications Engineering controls the updates)	☒	☐	☐
18.3	Human Operator Critical Actions Database (Nuclear Analysis controls the update)	☐	☐	☒
18.4	Hazloc Locations Database	☐	☐	☒
18.5	Torque Setting Database (Component Engineering)	☐	☐	☒
18.6	EQ (Equipment Qualification) Database	☐	☐	☒

DOCUMENTS TO BE CONSIDERED

		Update	Update Considered, Not Required	Not Applicable
19.0	**ENGINEERING PROGRAM REQUIREMENTS**			
19.1	Cable Ageing Management	☐	☐	☒
19.2	Pressure Equipment Regulation	☐	☐	☒
19.3	Environmental Qualification	☐	☐	☒
19.4	In-Service Testing	☐	☐	☒
19.5	In-Service Inspection	☐	☐	☒
19.6	Steam Generator	☐	☐	☒
19.7	Flow Accelerated Corrosion	☐	☐	☒
19.8	Thermal Performance	☐	☐	☒
19.9	Civil Monitoring	☒	☐	☐
19.10	Microbiologically Induced Corrosion	☐	☐	☒
19.11	Atmospheric Stress Corrosion Cracking	☐	☐	☒
19.12	Corrosion Management	☐	☐	☒
19.13	Boric Acid Corrosion	☐	☐	☒

		Update	Update Considered, Not Required	Not Applicable
20.0	**PROTECTION DESIGN FILES (PDFs)**			
20.1	File No. 0 – Preliminary File	☐	☐	☒
20.2	File No. 1 – Reactor Nuclear Protection	☐	☐	☒
20.3	File No. 2 – Reactor Protection Against Overpower and DNB	☐	☐	☒
20.4	File No. 3 – Protection Against Abnormal Pressure and Temperature Variations in the Reactor Coolant System	☐	☐	☒
20.5	File No. 4 – Protection Against Reactor Coolant Flow Reductions	☐	☐	☒
20.6	File No. 5 – Reactor Protection Against Steam Generator Feedwater System Malfunctions	☐	☐	☒
20.7	File No. 6 – Protection Against Steam Generator Water or Steam Pipe Rupture	☐	☐	☒

Appendix D2 – ALARA SCREENING FORM

UNIT:	9 HQF	MODIFICATION NUMBER:	12010
DESCRIPTION OF MODIFICATION:	The proposed Transient Interim Storage Facility will consist of a spent fuel cask storage area that includes a reinforced Concrete Pad with seven Auxiliary Shielding Modules (ASMs).		

	DOES THIS DESIGN CHANGE INVOLVE:	YES	NO
A.	Activities that must be performed in, or require entry to, a current or future radiologically controlled area?	☒	☐
B.	Support activities such as cable runs, piping runs, hose runs, or air line runs that pass through a current or future radiologically controlled area?	☒	☐
C.	Receiving, shipping, releasing, discharging, processing, conveying, moving, or sampling of radioactive material?	☐	☒
D.	Calibrations involving radioactive material?	☐	☒
E.	Any process radiation monitoring system, area radiation monitoring system, or airborne radioactivity monitoring system or equipment	☐	☒
F.	Shielding changes?	☒	☐
G.	Any system or component that does or could contain, convey, or use radioactive materials?	☐	☒
H.	A change in a plant system, feature or condition that could increase radioactive effluents and/or onsite or offsite radiation dose levels? If "Yes " to question H, then an offsite radiation dose checklist must be completed.	☐	☒
I.	Use of special tooling, mock-ups, or equipment requiring radiological controls?	☐	☒
J.	Establishing plant conditions with potential radiological impacts, such as: decontamination, equipment isolation, tagouts, depressurization, draining, or flushing?	☐	☒
	Any "Yes" response requires an ALARA Design Review (complete pages 2 to 7).	☒	☐
	COMMENTS:		

	NAME	SIGNATURE	DATE
PREPARED BY:	M Tyaliti	[signature]	2024/03/06
REVIEWED BY: (ALARA)	E Ellis	[signature]	2024-03-08

UNIT:	9 HQF	**MODIFICATION NUMBER:**	12010
DESCRIPTION OF MODIFICATION:	The proposed Transient Interim Storage Facility will consist of a spent fuel cask storage area that includes a reinforced Concrete Pad with seven Auxiliary Shielding Modules (ASMs).		
DESIGN ENGINEER:	M Tyaliti		
Subject Design / Modification is acceptable from an ALARA perspective	YES ☐	NO ☐	
REVIEWED BY:	**E Ellis** / **ALARA REVIEWER**	[signature] / **SIGNATURE**	**2024-03-08** / **DATE**

ALARA REVIEW CHECKLIST

1.	**Maintenance and Operations**	**YES**	**NO**	**N/A**
1.1	Permanent platforms, walkways, stairs or ladders are provided to permit accessibility.	☒	☐	☐
1.2	Serviceable components are capable of being isolated and drained.	☐	☐	☒
1.3	Flange connections are provided for quick removal of high maintenance components.	☐	☐	☒
1.4	Insulation design allows for rapid removal.	☐	☐	☒
1.5	Surveillance can be performed from outside a high radiation area through the use of TV camera, viewing port, or remote readout.	☐	☐	☒
1.6	Built-in rigging is provided to facilitate component handling.	☒	☐	☐
1.7	Components are designed to facilitate flushing and decontamination.	☐	☐	☒
1.8	Components are designed and selected with consideration for long service life, ease of removal, and frequency of maintenance.	☒	☐	☐
1.9	Serviceable components are easily accessible with adequate work space, laydown areas, and lighting.	☒	☐	☐
1.10	Design features prevent personnel from inadvertently entering high radiation areas (in excess of 1000 mrem/h).	☒	☐	☐
1.11	Special provisions are made for ease of maintenance and operation of equipment.	☒	☐	☐
1.12	Layout of components/systems is in accordance with FSAR radiation zone classifications.	☒	☐	☐
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists).	☐	☐	☐

2.	**Shielding**	**YES**	**NO**	**N/A**
2.1	Has shielding analysis been performed? If yes, give calculation number.	☒	☐	☐
2.2	Entrances to high radiation areas are adequately shielded (e.g., labyrinth).	☒	☐	☐
2.3	Radioactive equipment is separated by shielding from non-radioactive equipment.	☒	☐	☐
2.4	Shield penetrations are minimized in size and number.	☒	☐	☐
2.5	Shield penetrations are located high on the wall and in a corner to avoid line-of-sight streaming.	☒	☐	☐
2.6	If the answer to 2.5 is NO, are the penetrations adequately shielded or sealed (e.g., use of high density sealant or equivalent)?	☐	☐	☒
2.7	Permanent shielding is employed, to the degree feasible, to prevent the need for temporary shielding.	☒	☐	☐
2.8	If permanent shielding is not feasible, provisions are made to allow temporary shielding during maintenance evolutions.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
3.	**Contamination Control**	**YES**	**NO**	**N/A**
3.1	Corrosion resistant material is used for piping and equipment.	☒	☐	☐
3.2	Low cobalt material is used for piping and equipment in contact with primary coolant.	☐	☐	☒
3.3	Curbs are provided to control the spread of liquid spills.	☐	☐	☒
3.4	There are radioactive floor drains inside the curbs.	☐	☐	☒
3.5	Floors slope toward the drains.	☐	☐	☒
3.6	Easily decontaminable coatings have been specified.	☐	☐	☒
3.7	Ventilation is provided to control airborne activity.	☐	☐	☒
3.8	Drain lines are sloped continuously and backflooding is prevented.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)	☐	☐	☐

4.	**Liquid Systems - Tanks, Pumps, Sumps**	**YES**	**NO**	**N/A**
4.1	Pumps are located apart from tanks they serve.	☐	☐	☒
4.2	Pumps are fitted with catch basins which are properly drained.	☐	☐	☒
4.3	Pump castings are provided with equipment drains.	☐	☐	☒
4.4	Pump seals are covered to prevent contaminated liquid from being slung away from the pump.	☐	☐	☒
4.5	Vents are provided.	☐	☐	☒
4.6	Pumps requiring frequent maintenance are equipped with flanged connections for easy removal.	☐	☐	☒
4.7	Canned pumps or mechanical seals are employed instead of standard packing glands.	☐	☐	☒
4.8	Tanks and sumps are designed with sloping bottoms.	☐	☐	☒
4.9	Tanks and sumps are provided with a mechanism for flushing and decontamination.	☐	☐	☒
4.10	Vents and relief valve tail pipes are routed to drains.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
5.	**Liquid Systems - Valves**	**YES**	**NO**	**N/A**
5.1	Valves are located away from tanks, filters, demineralizers, etc., where possible.	☐	☐	☒
5.2	Process valves are remotely operated (reach rods are acceptable).	☐	☐	☒
5.3	Valves are mounted with the stem facing up where possible.	☐	☐	☒
5.4	Platforms are provided for valve maintenance.	☐	☐	☒
5.5	There is sufficient space around the valve for efficient maintenance.	☐	☐	☒

5.6	Valve designs minimize cavities and crevices.	☐	☐	☒
5.	**Liquid Systems - Valves**	**YES**	**NO**	**N/A**
5.7	The design eliminates the use of cobalt containing materials for parts or components (e.g., valve trim, seats, pins, etc.) that could be in a flow path leading to the reactor core.	☐	☐	☒
5.8	The design maximizes the removal of cobalt particulates from systems which can interface with the reactor coolant system.	☐	☐	☒
5.9	Valves can be installed or removed without cutting or welding.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
6.	**Piping**	**YES**	**NO**	**N/A**
6.1	Crud traps are minimized and stagnant legs avoided.	☐	☐	☒
6.2	Socket welds are avoided.	☐	☐	☒
6.3	All sections of piping can be adequately drained.	☐	☐	☒
6.4	Vents are provided and piping can be flushed.	☐	☐	☒
6.5	Piping run is in a shielded pipe chase where possible.	☐	☐	☒
6.6	Piping run lengths and horizontal runs are minimized.	☐	☐	☒
6.7	Field joints are minimized.	☐	☐	☒
6.8	Piping is pretreated prior to installation (e.g., electropolish, prefilm).	☐	☐	☒
6.9	Piping which potentially contains radioactive contaminants is physically separated from non-radioactive piping.	☐	☐	☒
6.10	Use of field-run piping is avoided	☐	☐	☒

6.	**Piping**	**YES**	**NO**	**N/A**
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
7.	**Sludge and Slurry Systems**	**YES**	**NO**	**N/A**
	In addition to considerations for liquid systems, systems containing slurries shall also meet the statements below.	☐	☐	☒
7.1	Sharp bends in pipes are avoided. (Five diameter or greater bends are acceptable.)	☐	☐	☒
7.2	Check valves or strainers are provided at interfaces with liquid systems.	☐	☐	☒
7.3	Backflush connections are provided.	☐	☐	☒
7.4	Ball valves are used whenever possible.	☐	☐	☒
	Justifications: (All "No" responses)			
	(if necessary use continuation sheet at end of checklists.)			
8.	**Instrumentation**	**YES**	**NO**	**N/A**
8.1	Instrument readouts are located in the lowest radiation area feasible.	☒	☐	☐
8.2	Instrument taps on liquid systems are located above the piping midplane.	☐	☐	☒
8.3	Existing radiation monitors are appropriate in terms of types and locations. (If No, indicate how existing radiation monitoring systems should be modified or what new systems will be required.)	☐	☐	☒
8.4	Instruments and controls are grouped functionally to minimize time spend in the area.	☐	☐	☒

8.5	Instruments are selected and specified for long service life and low maintenance requirements.	☐	☐	☒
8.	**Instrumentation**	**YES**	**NO**	**N/A**
8.6	There are provisions for remote calibration.	☐	☐	☒
8.7	Instruments can be flushed to reduce crud accumulation.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
9.	**Ventilation**	**YES**	**NO**	**N/A**
9.1	There are provisions for ventilating the area.	☒	☐	☐
9.2	The flow of air is from areas of lesser contamination to areas of greater contamination.	☐	☐	☒
9.3	Filter banks are readily accessible for maintenance.	☐	☐	☒
9.4	Filter banks are separated or shielded from each other to permit working on one with the other operating.	☐	☐	☒
9.5	The ventilation system (exclusive of filters) is designed to minimize activity buildup.	☐	☐	☒
9.6	Ventilation ducts have cleanout ports for decontamination.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			

10.	**Filters/Demineralisers**	**YES**	**NO**	**N/A**
10.1	Vents and relief valve tail pipes are routed to drains.	☐	☐	☒
10.2	Filters and demineralisers have been assessed as radiation sources. (If yes, give calculation number.)	☐	☐	☒
10.3	Multiple filters or demineralisers are housed in separate cubicles to permit maintenance with the system operating.	☐	☐	☒
10.4	Filter cartridge sizes are common to other filters already in use at the plant.	☐	☐	☒
10.5	Filters are designed to minimize servicing frequency.	☐	☐	☒
10.6	Filters are designed for efficient removal.	☐	☐	☒
10.7	Filters are located in low occupancy and low traffic areas.	☐	☐	☒
10.8	There are features for remote or shielded methods of filter removal.	☐	☐	☒
10.9	Submicron filters are employed as applicable.	☐	☐	☒
	Justifications: (All "No" responses) (if necessary use continuation sheet at end of checklists.)			
11.	**Implementation Requirements (REQ) / Recommendations (REC)**	**YES**	**NO**	**N/A**
11.1	Radiation Work Permit	☒	☐	☐
11.2	Temporary Shielding	☐	☒	☐
11.3	RADCON Instructions or Precautions	☐	☐	☒
11.4	Additional or Temporary Ventilation	☐	☒	☐
11.5	Temporary Containments	☐	☒	☐
11.6	Decontamination of System/Components/Work Areas	☐	☒	☐
11.7	System Flushing	☐	☒	☐

11.8	Tool List	☐	☒	☐
11.	**Implementation Requirements (REQ) / Recommendations (REC)**	**YES**	**NO**	**N/A**
11.9	Special Installation	☒	☐	☐
11.10	QA/QC Inspection/Hold Points	☒	☐	☐
11.11	Support Work (Scaffolding, etc.)	☒	☐	☐
11.12	Special Training (Mock-up, Classroom)	☐	☒	☐
11.13	Plant Mode	☐	☒	☐
11.14	Safety	☒	☐	☐
11.15	Special Cautions and ALARA design features identified and annotated as such in the DCN package affecting modification activities when high radiation exposures could occur during installation.	☐	☒	☐
	COMMENTS:			

Appendix D3 – PROJECT TEAM CONCURRENCE

Each member of the project identified in the table below are required to complete and sign the Project Team Review Report, 240-119523820 (KFU-027). Each completed form is then added to the Detailed Design Review Report (331-433).

Group	Name	Review Form Received (Y/N)
System Engineer	Tshetlwane Moila	
Operations Support	Andre Holthauzen	
Maintenance	Leon Singh/ Amanda Ludidi	
Component Engineering	Tshetlwane Moila	
Process Computing	N/A (Alan Lawrence)	
Project Engineering	Alan Lawrence	
OTS	Cate Pretorius	
SAR	Cate Pretorius	
OPG	Nkani Mahlangu	
Civil Engineer	Emuel Venter	
Mechanical Engineer	Alan Lawrence	
Electrical Engineer	Andrias Mgulwa	
C&I Engineer	Andrias Mgulwa	
KSA custodian	Nkani Mahlangu	
Hazloc - Committee Chairman or Representative	Liyaaqat Khan	
Fire Risk Management (FRM)	Genevieve Fick	
ALARA	Peon Ellis	
SAMG	Guy Dongmo	
MRG (Equipment Qualification and other Programmes (Incl. ISI, IST, FAC, Ageing Matrix and MIC)	Magrieta Koopman	
MRG (Ageing Management Database Custodian)	Mahir Matthews	
PSA	Guy Dongmo	

7. REVISIONS

Date	Rev	Remarks
22nd April 2024	00	Initial version.
29th April 2024	01	• Registration details of the Design Engineer in Cover Page. • Re-title in S2.2.1 and S.2.2.2. Correction in conversion from gallons to litres (S3.1.3) • Clarification about ASM design in S3.7
16th July 2024	02	• Correction of editorial errors as per Appendix B to NAPP11B012. Clarifications S3.16.6.3 and S3.16.6.4.
14th November 2024	03	• Corrected editorial errors in general. • Corrected editorial errors in accordance with the NNR letter NAPP11B114 as follows: – Page 39, Section 3.3.4 - The first paragraph was corrected to read as "Investigations about the software used in calculations and analyses included in this detailed design are included in Section 5.2, Benchmarking and Testing of the Review Reports of Appendix A2.7, Appendix A2.8 and Appendix A2.9:" – Reference to HI-STORM was corrected to HI-STAR 100 in the applicable sections. • Tables 8a - 8c show calculations of HI-STAR 100 components based on extreme ambient temperatures referenced in the DSSR.

8. DEVELOPMENT TEAM

KCC EngineeringTeam

9. ACKNOWLEDGEMENTS

Not applicable.