

	Specification	Nuclear Engineering
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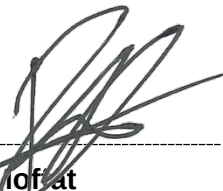
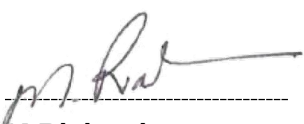
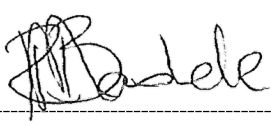
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1. Introduction

The National Nuclear Regulator (NNR) has legislated [29] and established [16], [20] and [15] the need for the establishment of a decommissioning plan for nuclear power stations, and requires compliance through the design, siting, construction, operating and decommissioning phases of a nuclear facilities life.

This user requirement specification (URS) has been compiled to assist Eskom in complying with the conditions set out in its nuclear installation license, applicable during the operating phase of the facility. This URS describes the requirements for the procurement of the following items related to the decommissioning of Koeberg Nuclear Power Station (KNPS), as well as the Original Steam Generator Interim Storage Facility (OSGISF):

- Work breakdown structures and resource breakdown structures and supporting documentation.
- Project schedules and supporting documentation.
- Estimates of anticipated radioactive, non-radioactive and mixed waste inventories to be generated during decommissioning activities.
- Decommissioning cost estimate reports.

According to the IAEA [6], the cost estimate for decommissioning needs to be updated on the basis of the periodic update of the initial decommissioning plan or on the basis of the final decommissioning plan. The mechanism used to provide financial assurance for decommissioning shall be consistent with the cost estimate for the facility and shall be changed if necessary. This is applicable for commercial power generating facilities, such as KNPS, and interim waste storage facilities, such as the OSGISF.

This URS does not suggest or imply that Eskom is planning on decommissioning the KNPS once its current operational nuclear installation license expires.

2. Supporting Clauses

2.1 Scope

The scope of this document covers the user requirements for the procurement of

- a work breakdown structure,
- a project schedule,
- estimation of waste inventories and,
- cost estimates

associated with the decommissioning of KNPS and the OSGISF.

2.1.1 Purpose

The purpose of this document is to capture the user requirements for the procurement of

- a work breakdown structure,
- a project schedule,

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- estimation of waste inventories and,
- cost estimates

associated with the decommissioning of KNPS and the OSGISF.

2.1.2 Applicability

This URS is applicable for all parties interested in tendering as well as the successful tender submission for the defined scope of work in this URS.

This URS does not suggest or imply that Eskom is planning on decommissioning the KNPS once its current operational nuclear installation license expires.

2.1.3 Effective date

This document is effective from the date of authorisation thereof.

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

- [1] 240-123880544, Decommissioning Strategy for Koeberg Nuclear Power Station
- [2] 240-149139316 Decommissioning Plan for Koeberg Nuclear Power Station
- [3] 240-165111647, Decommissioning Plan for the Original Steam Generator Storage Facility
- [4] Costs of Decommissioning Nuclear Power Plants, Published by the OECD's Nuclear Energy Association, NEA No. 7201, 2016
- [5] Classification of Radioactive Waste, IAEA General Safety Guide No. GSG-1
- [6] Decommissioning of Facilities, IAEA General Safety Requirements, GSR Part 6
- [7] Decommissioning of Nuclear Facilities, National Nuclear Regulator Requirements, RD-0026
- [8] Decommissioning of Nuclear Power Plants, Research Reactors and Other Nuclear Fuel Cycle Facilities, IAEA SSG-47
- [9] Decommissioning of Medical, Industrial and Research Facilities, IAEA SSG-49
- [10] DSG-318-087: Quality Requirements for the Procurement of Assets, Goods, and Services.
- [11] Ensuring the Adequacy of Funding Arrangements for Decommissioning and Radioactive Waste Management, Published by the OECD's Nuclear Energy Association, 2021
- [12] International Structure for Decommissioning Costing of Nuclear Installations, Nuclear Energy Association, NEA No. 7088, 2012.
- [13] ISO 9001 Quality Management Systems
- [14] KSA-119: Management and Control of Supplemental Workers Koeberg Operating Unit.
- [15] NNR Regulations on Safety Standards and Regulatory Practices, No. R. 388

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- [16] Nuclear Installation Licence No. NIL-01, Variation 19, 13 March 2019
- [17] Project Management Body of Knowledge
- [18] Regulations for the Safe Transport of Radioactive Material, IAEA Specific Safety Requirements No. SSR-6
- [19] The Practice of Cost Estimation for Decommissioning of Nuclear Facilities, Published by the OECD's Nuclear Energy Association, NEA No. 7237, 2015.

2.2.2 Informative

- [20] Decommissioning of Nuclear Facilities: Training and Human Resource Considerations, IAEA No. NG-T-2.3
- [21] Handling and Processing of Radioactive Waste from Nuclear Applications, IAEA Technical Report Series, TRS No. 402
- [22] Hazardous Substances Act, Act No. 15 of 1973
- [23] Hazardous Substances Amendment Act, Act No. 53 of 1992
- [24] IAEA Radioactive Waste Management Glossary Radioactive Waste Management Glossary, 2003
- [25] Management of Problematic Waste and Material Generated During the Decommissioning of Nuclear Facilities, IAEA, Technical Report Series, TRS No. 441
- [26] Methods for the Minimization of Radioactive Waste from Decontamination and Decommissioning of Nuclear Facilities, IAEA Technical Reports Series No. 401
- [27] National Environmental Management: Waste Act, NEM:WA, Act No. 59 of 2008
- [28] National Environmental Management: Waste Amendment Act, Act No. 26 of 2014
- [29] National Nuclear Regulator Act, Act No. 47 of 1999
- [30] National Radioactive Waste Disposal Institute Act, Act No. 53 of 2008
- [31] Occupational Health and Safety Act, Act No.85 of 1993 and Regulations
- [32] Predisposal Management of Organic Radioactive Waste, IAEA Technical Reports Series No. 427
- [33] Predisposal Management of Radioactive Waste, IAEA General Safety Requirements GSR Part 5
- [34] Preparing for Decommissioning During Operation and after Final Shutdown , Organization for Economic Co-Operation and Development, OECD
- [35] Radiation Dose Limitation at Koeberg Nuclear Power Station, National Nuclear Regulator Requirements, RD-0022
- [36] Radioactive Waste Management Policy and Strategy for the Republic of South Africa, Department of Minerals and Energy
- [37] Redevelopment and Reuse of Nuclear Facilities and Sites: Case Histories and Lessons Learned, IAEA NW-T-2.2
- [38] Site Decommissioning for Planned Exposures and Remediation of Existing Exposures for Release of Land from Regulatory Control, Interim Regulatory Guide, RG-0026

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[39] Use of the Nuclear Decommissioning Trust Fund, NEI 15-06, Revision 0, October 2016

2.3 Definitions

- 2.3.1 Controlled Disclosure:** Controlled disclosure refers to disclosure of information to external parties (either enforced by law or discretionary).
- 2.3.2 Critical path:** The critical path is the sequence of activities that represents the longest path through a project, which determines the shortest possible project duration.
- 2.3.3 Critical path method:** The critical path method is used to estimate the minimum project duration and determine the amount of schedule flexibility on the logical network paths within the schedule model.
- 2.3.4 Decommissioning:** The process by which nuclear power stations / installations are retired from service. This process takes place when nuclear facilities have reached the end of their useful life, no longer economically viable to operate, or when the operating license has been irrevocably withdrawn.
- 2.3.5 Decommissioning End-Point / End-State:** The final state of completing the decommissioning plan. "On the completion of decommissioning actions, the licensee shall demonstrate that the end-state/end-point criteria, as specified in the final decommissioning plan and any additional regulatory requirements have been met. The regulatory body shall verify the compliance with the end state criteria and shall decide on termination of the authorization for decommissioning" (Reference [6] Section 9, Page 19).
- 2.3.6 Decommissioning Phase:** A well-defined and discrete set of activities within the decommissioning process.
- 2.3.7 Decommissioning Strategy:** The documentation containing information on the description of the options, overall timescales for the decommissioning of the facility and the end-state after completion of all decommissioning activities and justification for the preferred decommissioning option.
- 2.3.8 DECON:** See 'Immediate dismantling'.
- 2.3.9 Disposal:** Emplacement of waste in an appropriate facility without the intention of future retrieval.
- 2.3.10 Expert:** A professional, registered with a professional or industry body, who has acquired a great deal of knowledge and special skills through study, practice and experience, in a particular field or subject matter, to the extent that their opinion is critical or essential in fact finding, problem solving, or understanding of a situation. This typically includes someone with more than 15 years' experience, at the level of chief or principal engineer, etc.

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- 2.3.11 Greenfields:** Greenfields [37] refers to a site that has been granted unrestricted release from regulatory control (as defined by the limits in Reference [15] as it relates to radiological contamination), and which can be released for unrestricted reuse. This may include situations where limited but acceptable radiological exposure exist or where further protective measures are required to limit radiological exposure. This may also include structures and equipment inside and outside of ACP2 which remain after decontamination.
- 2.3.12 Immediate Dismantling:** Immediate dismantling (also known as DECON) is the overall method of decommissioning by which, shortly after permanent termination of operations, the equipment, structures and parts of a nuclear facility containing radioactive contaminants are removed or decontaminated to a level that permits the facility to be released for unrestricted use or with restrictions imposed by the regulatory body. It implies prompt and complete decommissioning and involves the removal and processing of all radioactive material from the facility.
- 2.3.13 Intermediate:** A professional, not yet registered with a professional or industry body, who has acquired basic knowledge and skills through study and practice, in a particular field or subject matter, to the extent that their opinion is helpful in fact finding, problem solving, or understanding of a situation. This typically includes someone with more than 5 years' experience, at the level of trainee engineer, etc. The person reports to a senior or lead engineer, etc.
- 2.3.14 Junior:** A graduate level or articles clerk, who has acquired basic knowledge and skills through study, in a particular field, to the extent that their opinion may be helpful in fact finding. This typically includes someone with less than 5 years' experience, at the level of graduate, or articles Clerk, etc.
- 2.3.15 Primary Waste:** Waste which is unchanged from the form and quantity in which it was generated, i.e. waste that has not been processed or treated [24].
- 2.3.16 Project schedule:** The schedule includes at least the list of work activities, their durations, resources, and planned start and finish dates.
- 2.3.17 Project schedule Level 1:** Level 1 is the Project Master Schedule (PMS). This is a major milestone type of schedule as it highlights major project activities, milestones, and key deliverables for the whole project
- 2.3.18 Project schedule Level 2:** Level 2 is the Project Summary Schedule (PSS) and is maintained as a summary of the Level 3 Project Coordination Schedule(s). It depicts the overall project broken down into its major components by area and is used for higher-level management reporting.
- 2.3.19 Project schedule Level 3:** Level 3 is the Project Control Schedule (PCS). Initially developed as an integrated CPM overview of the project, the Level 3 schedule is then maintained as an integrated rollup or summary of the Level 4 schedule activities for reporting status to senior management and to report monthly status to major clients, etc.
- 2.3.20 Project schedule Level 4:** Level 4 is the Detailed Network Schedule or Works Order. This is the key working level CPM schedule displaying the activities to be accomplished by the project workforce and is required for every project.

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- 2.3.21 Project schedule Level 5:** Level 5 is the Detailed Report Schedule or Works Order at task level. It is a short term schedule used to map out the detailed tasks needed to coordinate day to day work in a specific area. Level 5 schedules are developed by workforce supervisors to plan and coordinate their work at the detail level, and used to determine the scope for work packages.
- 2.3.22 Simple facility:** A simple facility is a facility: (a) that has sealed radioactive sources that can be removed with relative ease; (b) that may have a relatively small localized area or areas of contamination that can be addressed through simple decontamination methods and techniques; and (c) for which the risk to the public and the environment due to decommissioning activities is relatively low [9].
- 2.3.23 Senior:** A professional, registered with a professional or industry body, who has acquired knowledge and special skills through study, practice and experience, in a particular field or subject matter, to the extent that their opinion is necessary in fact finding, problem solving, or understanding of a situation. This typically includes someone with more than 10 years' experience, with the title Senior or Lead Engineer, etc. The person reports to a Chief or Principle Engineer, etc.
- 2.3.24 Secondary Waste:** A form and quality of waste created as a by-product of processing of primary waste [24].
- 2.3.25 Spent Nuclear Fuel (SNF):** Spent Nuclear Fuel (SNF) is fuel that is removed from a reactor following irradiation, which is no longer usable in its present form because of the depletion of fissile material, build-up of poison or radiation damage. Spent fuel is not classified as waste unless it is declared as such.
- 2.3.26 Unit 0:** Systems, structures and components designated as general to the KNPS site.
- 2.3.27 Unit 1:** Systems, structures and components dedicated to the safe operation, production and accident mitigation of Unit 1 at KNPS.
- 2.3.28 Unit 2:** Systems, structures and components dedicated to the safe operation, production and accident mitigation of Unit 2 at KNPS.
- 2.3.29 Unit 6:** Systems, structures and components designated as civil, or security related.
- 2.3.30 Unit 9:** Systems, structures and components designated as common to the safe operation, production and accident mitigation of Unit 1 and Unit 2 at KNPS.
- 2.3.31 WBS:** The WBS is a hierarchical decomposition of the total scope of work to be carried out by the project team to accomplish the project objectives and create the required deliverables. The WBS organizes and defines the total scope of the project and represents the work specified in the current project scope statement as defined in Reference [1] as it relates to the decommissioning option and decommissioning end-point.
- 2.3.32 WBS levels:** At the top level (level 1) is the project ultimate goal, the second level (level 2) contains the project outcomes, the third level (level 3) has the project outputs, and the fourth level (level 4) with activities. The WBS may contain a fifth level (level 5) that describes the tasks. Beyond task level is work package/work instruction level.

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2.4 Abbreviations

Abbreviation	Explanation
BATNEEC	Best Available Technology not Entailing Excessive Cost
CPM	Critical Path Method
DCMA	Defence Contract Management Agency
D&D	Decontamination and Dismantling (IAEA)
GSR (IAEA)	General Safety Requirements (IAEA)
IAEA	International Atomic Energy Agency
IPD-K	Integrated Plant Design – Koeberg
ISDC	International Structure for Decommissioning Costing
KNPS	Koeberg Nuclear Power Station
OE	Operating Experience
OECD	Organization for Economic Co-Operation and Development
Radwaste	Radioactive Waste
RD	Requirements Document (NNR)
SRS (IAEA)	Safety Report Series
SSG (IAEA)	Specific Safety Guide (IAEA)
SSRP (NNR)	Safety Standards and Regulatory Practices (NNR)
WBS	Work Breakdown Structure

2.5 Roles and Responsibilities

The Employer shall fulfil the roles and responsibilities as described in the Contract.

- Providing the Contractor with any requested financial information required for the decommissioning cost estimates, for example, salaries of staff at various task levels, or the existing costs of radioactive waste shipments and disposal.

The Contractor is responsible for meeting the requirements of this URS.

2.6 Process for Monitoring

Not applicable

2.7 Related/Supporting Documents

- 240-123880544, Decommissioning Strategy for Koeberg Nuclear Power Station
- 240-165111647, Decommissioning Plan for the OSGISF

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3. User Requirements Specification

(i) KNPS (NIL-01 Variation 19)

Koeberg Nuclear Power Station is a commercial nuclear power station, located on the Duynefontein site; approximately 30 km north of Cape Town in the Western Cape. KNPS is solely owned and operated by the South African state-owned electricity utility, Eskom SOC Ltd. (Eskom).

The two units at KNPS each consist of three-loop pressurised water reactor (PWR) systems designed to produce 2 775 MWt (megawatt thermal) each. Each unit was designed for a net output of 921.5 MWe (megawatt electrical) and following the uprating of the low pressure turbines in 2010, was rated for a net output of 975 MWe (megawatt electrical). KNPS is similar to the units of the French CP1 fleet. The reference plant for the nuclear island is Tricastin Unit 1, located in France.

The two reactors, based on the Westinghouse design and constructed by Framatome, are each located in a containment building, with shared nuclear auxiliary and electrical buildings. Directly in front of the reactor building (seawards) is the cooling water pump house, which abstracts sea water to cool the condenser. Both turbo-generator sets are in the common turbine hall, which is situated alongside the electrical building on the landward side of the 56 m high (above terrace level) reactor buildings.

Units 1 and 2 were commissioned in 1984 and 1985 respectively, with an original design and operational life of 40 years (current end-of-life in 2024). Presently, an economic life of 60 years is being pursued, which could lead to a shutdown of the units in 2044.

Eskom is required to periodically update its decommissioning strategy and decommissioning plan documents for Koeberg Nuclear Power Station (KNPS). Both documents are currently pending approval by the NNR. Eskom is also required to report the financial liability of decommissioning KNPS in its annual financial statements.

In line with the Decommissioning Strategy for Koeberg Nuclear Power Station, 240-123880544, the current strategy for decommissioning will be the "DECON" (Immediate Decontamination and Dismantling (D&D)) decommissioning option, with "Greenfields" decommissioning end-point being the most preferred. The spent fuel pool will be operated separately for a further 10 years after cessation of operation, before spent nuclear fuel (SNF) will be removed to dry storage.

The deliverables listed below, related to KNPS, shall be performed holistically for decommissioning at KNPS, and for each of the six phases of decommissioning as described in the document, Decommissioning Strategy for Koeberg Nuclear Power Station, 240-123880544.

Information must be relevant as of 2020, i.e. include international experience from current nuclear decommissioning projects and lessons learnt in nuclear decommissioning since the 2011 Fukushima nuclear disaster. References used by the Contractor must be the latest revisions.

(ii) OGSISF (NIL-44 Variation 0)

The Original Steam Generator Interim Storage Facility (OGSISF) is an additional waste storage facility which is to be constructed for the interim storage of the OSGs, before shipment and final disposal. The OGSISF is to be located on the site earmarked for the Transient Interim Storage Facility (TISF), and situated on the site of Cape Farm No. 1552, also known as

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Duynefontein, in the magisterial district of Malmesbury in the Western Cape. The concept for the OSGISF facility is a rectangular reinforced concrete building, designed to house three OSGs per building.

The OSGISF will form part of, and fall under the existing management and control of the existing Koeberg Nuclear Power Station (KNPS) site as approved in the Duynefontein Site Safety Report.

The primary objective of decommissioning is to place the OSGISF into such a condition that it poses no unacceptable risk (with the focus on radiological hazards) to the public, the workers or the environment, [21], [22], [23], [75]. All the contaminated systems, structures, components, and locations must be decontaminated to reduce residual radioactivity, to levels that allow them to be reused (either with or without restrictions), or in the case of components, transported [73] and disposed of in an identified radioactive waste disposal site. This excludes the transportation, off-site storage and disposal of the OSGs, as per Condition 17.3 of NIL-044 Variation 0 which requires that the OSGs must be disposed of in accordance with the approved disposal plan, no later than 10 years after the operational licence activities commence at the OSGISF.

As described in Reference [3], the OSGISF is classified as a simple facility, thus requiring little to no decontamination during decommissioning.

The deliverables listed below, related to the OSGISF, shall be performed holistically for decommissioning at KNPS, and for each of the four phases of decommissioning as described in the document, 240-165111647, Decommissioning Plan for the OSGISF.

A graded approach to the decommissioning the OSGISF will be applied. Consideration shall be taken to account for the different levels of hazard and risk, by the D&D activities, as well as the degree of complexity, and the fact that the OSGs will have already been removed prior to decommissioning of the OSGISF. It is anticipated that the decommissioning of the OSGISF will not be complex from a radiologically point of view.

3.1 Work breakdown structures

3.1.1 Work breakdown structure for KNPS (NIL-01 Variation 19)

The Contractor shall develop appropriate decommissioning work-breakdown structure for the KNPS (NIL-01 Variation 19). The WBS shall:

- (i) Contain a detailed description of the basis, methodology, limitations, considerations and assumptions made in developing the decommissioning work-breakdown structure.
- (ii) Be based on international experience from past and current nuclear decommissioning projects, and be appropriate for the South African context and applicable to KNPS (NIL-01 Variation 19) as described in Section 3(i).
- (iii) Be reported at level 3 and include all major milestone, major elements of design, engineering, procurement, construction, testing, commissioning and/ or start-up, etc.
- (iv) Include a resource breakdown structure; including equipment and human resources but not on a material and/or consumables level, by resource category and type.
- (v) Be reported as an organogram chart-like diagram, as depicted in Figure 1.
- (vi) Be reported adjacent to the project schedule, as is possible using Primavera.

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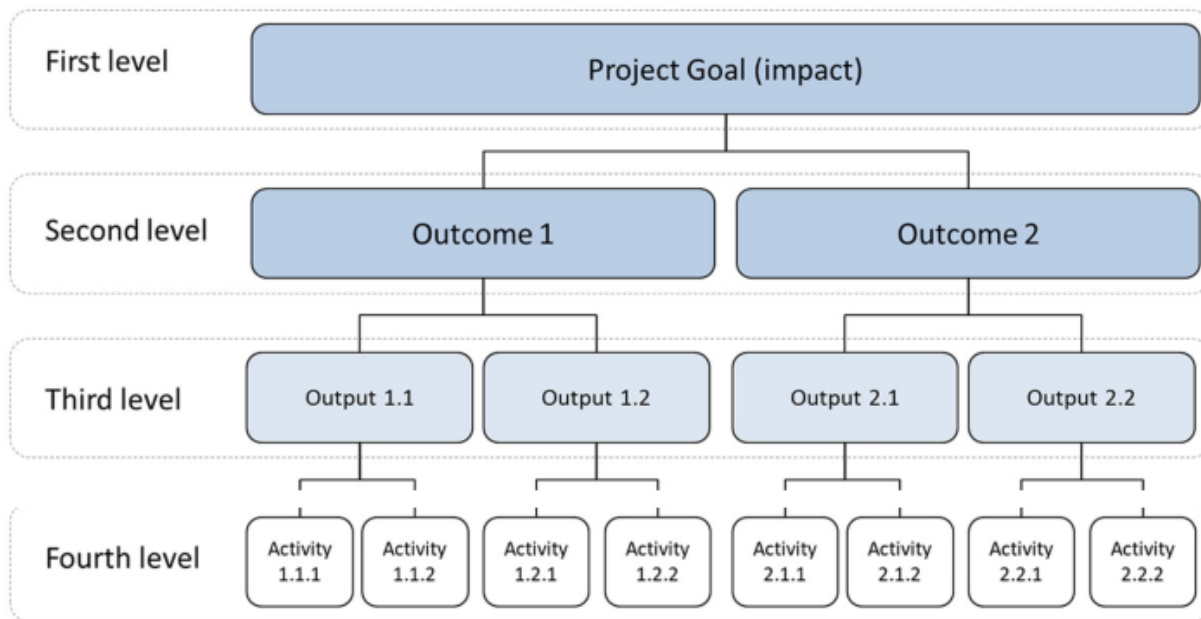


Figure 1: Typical organogram chart-like WBS diagram

3.1.2 Work breakdown structure for OSGISF (NIL-44 Variation 0)

The Contractor shall develop appropriate decommissioning work-breakdown structure for the OSGISF (NIL-44 Variation 0). The WBS shall:

- (i) Contain a detailed description of the basis, methodology, limitations, considerations and assumptions made in developing the decommissioning work-breakdown structure.
- (ii) Be based on international experience from past and current nuclear decommissioning projects, and be appropriate for the South African context and applicable to the OSGISF (NIL-44 Variation 0), an interim low-level waste storage facility located within the KNPS site, as described in Section 3(ii).
- (iii) Be reported at level 3 and include all major milestone, major elements of design, engineering, procurement, construction, testing, commissioning and/ or start-up, etc.
- (iv) Include a resource breakdown structure; including equipment and human resources but not on a material and/or consumables level, by resource category and type.
- (v) Be reported as an organogram chart-like diagram, as depicted in Figure 1.
- (vi) Be reported adjacent to the project schedule, as is possible using Primavera.

3.2 Project schedules

3.2.1 Project schedule for KNPS (NIL-01 Variation 19)

The Contractor shall develop an appropriate decommissioning project schedule for KNPS (NIL-01 Variation 19). After both parties have accepted the initial schedule, that schedule becomes the baseline for measuring performance and it shall be included in every submission of any revised schedule.

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The project schedule shall:

- (i) Describe in detail the basis, limitations, considerations and assumptions made in developing the project schedule.
- (ii) Be based on international experience from past and current nuclear decommissioning projects, and be appropriate for the South African context and applicable to KNPS (NIL-01 Variation 19) as described in Section 3(i).
- (iii) Be reported at level 3 and include all major milestone, major elements of design, engineering, procurement, construction, testing, commissioning and/ or start-up, etc.
- (iv) Define activities, sequence activities, and estimate activity durations
- (v) Be developed for two end-of-life scenarios, i.e., an end of life of 40 years (2024) and 60 years (2044) as two separate schedules.
- (vi) Include separate and combined decommissioning schedules for each of the plant units (Units 1 and 2) and including Units 0, 6 and 9.
- (vii) Be aligned with the six phases of decommissioning as described in 240-123880544, Decommissioning Strategy for Koeberg Nuclear Power Station, i.e.
 - o Phase 1: Preparation and planning
 - o Phase 2: Plant shutdown and defueling: Transition from operations to decommissioning
 - o Phase 3: Implementation of the SFP separation plan, and SNF storage strategy
 - o Phase 4: Decommissioning operations
 - o Phase 5: Spent nuclear fuel removal and electro-mechanical dismantling of the fuel building and auxiliaries
 - o Phase 6: Demolition of remaining structures, site remediation and rehabilitation, and licence termination
- (viii) Be aligned with the Spent Nuclear Fuel (SNF) wet storage plan after the final shutdown of the unit, i.e., the spent fuel pool the spent fuel pool conservatively remains operational for an additional 10 years after cessation of operation (based on the design information for the CASTOR X28/F casks).
- (ix) Must assume that the earliest date at which SNF casks could be shipped off-site to the NRWDI operated CISF is 2030.
- (x) Include streamlined/optimised workflow between Unit 1 and 2 decommissioning and evaluate the best scenarios for the actual D & D phases.
- (xi) Include time and schedule constraints, arising from external factors, e.g., interdependencies on other governmental organizations, such as the NNR, NRWDI, NCRWM, etc.
- (xii) Include activities related to waste, rubble and chemical removal where necessary.
- (xiii) Include regulatory administrative/licensing processes and steps, e.g. submission of the decommissioning radwaste plan to the NCRWM.
- (xiv) Be provided in a Gantt chart format and Microsoft Excel spreadsheet.

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- (xv) Show dependencies, as well as and critical path activities, between the tasks (e.g. parent/child and predecessor/successor activities).
- (xvi) Include activities known to have cost implications in the activity sheet.
- (xvii) Include a summary as a high level decommissioning project timeline.
- (xviii) Take into account international and local OE and BATNEEC considerations.
- (xix) Make it possible to assign a cost to an activity.
- (xx) Be complete, in that "parent and child" relationships between activities must be complete in terms of time duration, etc.
- (xxi) Make provision for activities related to radioactive components and radwaste to be clearly delineated in terms of where the activity falls in the radwaste lifecycle, i.e. decontamination, processing/treatment, removal treatment, packaging, transport and disposal.
- (xxii) Include an assumptions log.
- (xxiii) Account for and include a list of delays commensurate with nuclear decommissioning projects for commercial PWRs.
- (xxiv) Be checked using the 14-point DCMA assessment to ensure the schedule is of high quality, complete and to improve the probability of a successful outcome, i.e. check Logic, Leads, Lags, FS Relationship, Hard Constraints, High Float, Negative Float, High Duration Task, Invalid Date, Resources, Missed Tasks, Critical Path test, Critical Path Length index, Baseline Execution Index.

The Contractor shall estimate human and equipment resource requirements to carry out the activities in the proposed schedule.

The Contractor shall report the workforce/human resource requirements for the activities, to include the number of people by labour category as professional, skilled, semi-skilled, unskilled labour. Professional labour must be identified as Junior, Intermediate, Senior or Expert as defined in Section 2.3. This is to be reported for foreign and local workforce/human resource requirements.

The Contractor shall, as far as possible, utilise Eskom personnel, given that the majority of KNPS staff would be available to complete many of the decommissioning activities.

3.2.2 Project schedule for OSGISF (NIL-44 Variation 0)

The Contractor shall develop an appropriate decommissioning project schedule for the OSGISF (NIL-44 Variation 0). It is anticipated that due to the low level of complexity of the OSGISF, that the decommissioning of the facility will be simple, and not complicated by contaminated material [3]. After both parties have accepted the initial schedule, that schedule becomes the baseline for measuring performance and it shall be included in every submission of any revised schedule. The project schedule shall:

- (i) Describe in detail the basis, limitations, considerations and assumptions made in developing the project schedule.
- (ii) Be based on international experience from past and current nuclear decommissioning projects, and be appropriate for the South African context and applicable to the OSGISF (NIL-44 Variation 0), an interim low-level waste storage facility located within the KNPS site, as described in Section 3(ii), and which is defined as a simple facility [3].

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- (iii) Be reported at level 3 and include all major milestone, major elements of design, engineering, procurement, construction, testing, commissioning and/ or start-up, etc.
- (iv) Define activities, sequence activities, and estimate activity durations.
- (v) Be developed for an end of life after 10 years of operation.
- (vi) Include separate and combined decommissioning schedules for each of the OSGISF buildings.
- (vii) Be aligned with the four phases of decommissioning as described in 240-165111647, Decommissioning Plan for the OSGISF, i.e.
 - o Phase 1: Preparation and planning.
 - o Phase 2: Decommissioning license application and radiological characterisation.
 - o Phase 3: Decontamination and dismantling activities.
 - o Phase 4: Site remediation, rehabilitation and licence termination.
- (viii) Be aligned with the TISF project timelines.
- (ix) Include time and schedule constraints, such as the availability of waste processing facilities and disposal facilities, interdependencies on other governmental organizations, etc.
- (x) Include activities related to waste, rubble and chemical removal where necessary.
- (xi) Include regulatory administrative/licensing processes and steps.
- (xii) Be provided in a Gantt chart format and Microsoft Excel spreadsheet.
- (xiii) Show dependencies between the tasks (e.g. parent/child and predecessor/successor activities).
- (xiv) Include activities known to have cost implications in the activity sheet,
- (xv) Include a summary as a high level decommissioning project timeline,
- (xvi) Take into account international and local OE and BATNEEC considerations.
- (xvii) Make it possible to assign a cost to an activity.
- (xviii) Be complete, in that "parent and child" relationships between activities must be complete in terms of time duration, etc.
- (xix) Make provision for activities related to radioactive components and radwaste to be clearly delineated in terms of where the activity falls in the radwaste lifecycle, i.e. decontamination, processing/treatment, removal treatment, packaging, transport and disposal.
- (xx) Include an assumptions log.
- (xxi) Account for and include a list of delays commensurate with nuclear decommissioning projects for interim radwaste storage facilities according to the IAEA's graded approach methodology.

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- (xxii) Be checked using the 14-point DCMA assessment to ensure the schedule is of high quality, complete and to improve the probability of a successful outcome, i.e. check Logic, Leads, Lags, FS Relationship, Hard Constraints, High Float, Negative Float, High Duration Task, Invalid Date, Resources, Missed Tasks, Critical Path test, Critical Path Length index, Baseline Execution Index.

The Contractor shall estimate human and equipment resource requirements to carry out the activities in the proposed schedule.

The Contractor shall report the workforce/human resource requirements for the activities, to include the number of people by labour category as professional, skilled, semi-skilled, unskilled labour. Professional labour must be identified as Junior, Intermediate, Senior or Expert as defined in Section 2.3. This is to be reported for foreign and local workforce/human resource requirements.

The Contractor shall, as far as possible, utilise Eskom personnel, given that KNPS staff could be available to complete many of the decommissioning activities.

3.3 Estimation of waste generated

3.3.1 Estimation of waste generated for KNPS (NIL-01 Variation 19)

The Contractor shall provide the following for KNPS (NIL-01 Variation 19):

- (i) An estimation of anticipated radioactive, non-radioactive and mixed waste inventories to be generated during decommissioning activities.

Note: At this stage it is not necessary to develop a detailed decommissioning waste inventory based on the specific KNPS plant as-built. The use of engineering heuristics, international experience and industry expertise for decommissioning a plant similar to KNPS may be used, with sufficient substantiation that the information consulted is comparable with the KNPS plant.

- (ii) References for all estimates, volumes and quantities,
- (iii) A detailed description of the basis, limitations, considerations and assumptions made in developing the estimation.
- (iv) Radwaste inventories shall be grouped as primary or secondary waste, and be classified as defined by the IAEA [5], [24].
- (v) Conventional waste shall be classified according to Reference [22], [23], [27] and [28].
- (vi) Waste inventory estimation for all waste types shall be reported by volume, weight, and radioactivity.
- (vii) Expected radwaste stream types, their composition, packaging and disposal volumes must be determined and quantified. The proposed framework must comply with the definition and requirements as defined by the IAEA [5], [24].
- (viii) Identification of special equipment (demolition / cutting robots etc.) based on Best Available Technology Not Entailing Excessive Cost (BATNEEC). Current international operating experience in the world shall be included.

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- (ix) A high level synopsis of treatment and disposal options, as well as the technical basis and assumptions for selection need to be advised for each type of waste. Briefly summarise the different treatment pathways for re-use or disposal of each type of material or waste produced by decommissioning activities, in accordance with BATNEEC.

3.3.2 Estimation of waste generated for OSGISF (NIL-44 Variation 0)

The Contractor shall provide the following for the OSGISF (NIL-44 Variation 0):

- (i) An estimation of anticipated radioactive, non-radioactive and mixed waste inventories to be generated during decommissioning activities.

Note: It is possible to use the existing OSGISF design information to determine the detailed decommissioning waste inventory based on the specific OSGISF buildings as built.

- (ii) References for all estimates, volumes and quantities,
- (iii) A detailed description of the basis, limitations, considerations and assumptions made in developing the estimation.
- (iv) Radwaste inventories shall be grouped as primary or secondary waste, and be classified as defined by the IAEA [5], [24].
- (v) Conventional waste shall be classified according to Reference [22], [23], [27] and [28].
- (vi) Waste inventory estimation for all waste types shall be reported by volume, weight, and radioactivity.
- (vii) Expected radwaste stream types, their composition, packaging and disposal volumes must be determined and quantified. The proposed framework must comply with the definition and requirements as defined by the IAEA [5], [24].
- (viii) Identification of special equipment (demolition etc.) based on Best Available Technology Not Entailing Excessive Cost (BATNEEC). Current international operating experience in the world shall be included.
- (ix) A high level synopsis of treatment and disposal options, as well as the technical basis and assumptions for selection need to be advised for each type of waste. Briefly summarise the different treatment pathways for re-use or disposal of each type of material or waste produced by decommissioning activities, in accordance with BATNEEC.

3.4 Cost Estimate

3.4.1 Cost Estimate for KNPS (NIL-01 Variation 19)

The Contractor shall develop an appropriate decommissioning cost estimate for KNPS (NIL-01 Variation 19). The decommissioning cost estimate for KNPS shall meet the following requirements:

- (i) It shall contain a detailed description of the basis, methodology, limitations, considerations and assumptions made in developing the decommissioning cost estimate.

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- (ii) It shall incorporate the human and financial resource considerations for project management.
- (iii) It shall be reported in such a way to allow for provision for the decommissioning of KNPS to be made in the Eskom annual financial report, as follows:
 - o It shall include total costs for each unit, for both end-of-life scenario schedules as described in Section 3.2.1 (v).
 - o It shall include sub-totals, for each phase, task and activity, per schedule, reported as a pivot table.
 - o It shall be presented in a tabular format indicating expenditure for each of the six phases Section 3.2.1 (vii) and reported for each financial year in which the expenditure is anticipated.
 - o It shall include breakdowns of sub-costs comprised of risk factors, contingencies, etc. in line with the International Structure for Decommissioning Costing (ISDC) [12].
 - o Cost categories shall be grouped as per the ISDC [12].
 - o For each activity it shall make distinction between the labour costs and equipment costs.
 - o All costs shall be reflected in the currency in which the cash flow will be incurred, i.e. local and foreign cost shall be disclosed separately to ensure the correct financial parameters are used.
- (iv) It shall include an overview of internationally accepted dismantling and disposal options assessment of various large components'.
- (v) It shall consider the cost implication of spent fuel pool operation for 10 years after the final shutdown of the units.
- (vi) It shall include any economies of scale for simultaneous decommissioning of the two co-located reactor units.
- (vii) It shall include the basis and assumptions for the selection or derivation of all unit cost factors, and also list all the unit cost factors and their units, e.g. R/m³, R/hour, US \$/hour, etc.
- (viii) The use of special equipment, e.g. demolition / cutting robots, etc. shall be based on Best Available Technology Not Entailing Excessive Cost (BATNEEC).
- (ix) It shall include any applicable work difficulty adjustment factors (WDFs) to account for the inefficiencies in working in a power plant environment, such as
 - o Access Factor
 - o Respiratory Protection Factor
 - o Radiation/ALARA Factor
 - o Protective Clothing Factor
 - o Work Break Factor
 - o Productivity adjustable
- (x) Application of specific principles contained in NEI 15-06 [39], must be verified with the Employer.

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- (xi) International best practices related to the development of decommissioning cost estimates shall be utilised, as described in References [3], [11], [12] and [19].
- (xii) Cost of disposal to Vaalputs shall be included, but not include any storage related costs at the Vaalputs facility.
- (xiii) Where cost of waste transportation and disposal for radioactive waste types and waste packages which are currently outside the Vaalputs waste acceptance criteria (WAC), this shall be documented and international data used to estimate such costs.
- (xiv) Costs for the workforce/human resource requirements for the activities, shall include the number of people by labour category as professional, skilled, semi-skilled, unskilled labour. Professional labour must be identified as Junior, Intermediate, Senior or Expert as defined in Section 2.3. This is to be reported for foreign and local workforce/human resource requirements.
- (xv) Any exchange rate shall be clearly indicated in South African Rand/foreign currency unit.
- (xvi) Exchange rate values shall be set at a date as agreed, at contract signature, between Eskom and the Contractor, to ensure a total cost can be calculated.
- (xvii) VAT for any items shall be at 15%.
- (xviii) The costs shall be reported in line with the International Structure for Decommissioning Costing (ISDC) disaggregated decommissioning cost items, according to the Principal Activities for cost structure hierarchy [11], [12] and [19]. Any cost estimation derived from the project schedule WBS shall be mapped onto the ISDC by the Contractor, as described in Reference [12]
- (xix) Where costing information has been obtained from a PNNL-type cost breakdown methodology it must be reconciled to the ISDC format by the Contractor and indicated as such.

3.4.2 Cost Estimate for OSGISF (NIL-44 Variation 0)

The Contractor shall develop an appropriate decommissioning cost estimate for the OSGISF (NIL-44 Variation 0). The decommissioning cost estimate for the OSGISF shall meet the following requirements:

- (i) It shall contain a detailed description of the basis, methodology, limitations, considerations and assumptions made in developing the decommissioning cost estimate.
- (ii) It shall incorporate the human and financial resource considerations for project management.
- (iii) It shall be reported in such a way to allow for the financial provision for the decommissioning of OSGISF to be made in the Eskom annual financial report, as follows:
 - o It shall include total costs for the OSGISF, for the end-of-life scenario schedule as described in Section 3.2.2 (v).
 - o It shall include sub-totals, for each phase, task and activity, per schedule, reported as a pivot table.

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- o It shall be presented in a tabular format indicating expenditure for each of the four phases, as described in Section 3.2.2 (vii) and reported for each financial year in which the expenditure is anticipated.
 - o It shall include breakdowns of sub-costs comprised of risk factors, contingencies, etc. in line with the International Structure for Decommissioning Costing (ISDC) [12].
 - o For each activity it shall make distinction between the labour costs and equipment costs.
 - o All costs shall be reflected in the currency in which the cash flow will be incurred, i.e. local and foreign cost shall be disclosed separately to ensure the correct financial parameters are used.
- (iv) It shall include the basis and assumptions for the selection or derivation of all unit cost factors, and also list all the unit cost factors and their units, e.g. R/m³, R/hour, US \$/hour, etc.
- (v) The use of special equipment, e.g. decontamination and demolition machines, etc. shall be based on Best Available Technology Not Entailing Excessive Cost (BATNEEC).
- (vi) It shall include any applicable work difficulty adjustment factors (WDFs) to account for the inefficiencies in working in a power plant environment, such as
 - o Access Factor
 - o Respiratory Protection Factor
 - o Radiation/ALARA Factor
 - o Protective Clothing Factor
 - o Work Break Factor
 - o Productivity adjustable
- (vii) Application of specific principles contained in NEI 15-06 [39] shall be verified with the Employer.
- (viii) International best practices related to the development of decommissioning cost estimates shall be utilised, as described in References [3], [11], [12] and [19].
- (ix) Cost of disposal to Vaalputs shall be included, but not include any storage related costs at the Vaalputs facility.
- (x) Where cost of waste transportation disposal for radioactive for waste types and packages which are currently outside the Vaalputs waste acceptance criteria (WAC), international data may be used to estimate such costs. This shall be documented.
- (xi) Costs for the workforce/human resource requirements for the activities, shall include the number of people by labour category as: professional, skilled, semi-skilled, unskilled labour. Professional labour must be identified as Junior, Intermediate, Senior or Expert as defined in Section 2.3. This is to be reported for foreign and local workforce/human resources.
- (xii) Any exchange rate shall be clearly indicated in South African Rand/foreign currency unit.
- (xiii) Exchange rate values shall be set at a date as agreed, at contract signature, between Eskom and the Contractor, to ensure a total cost can be calculated.

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- (xiv) VAT for any items shall be at 15%.
- (xv) The costs shall be reported in line with the International Structure for Decommissioning Costing (ISDC) disaggregated decommissioning cost items, according to the Principal Activities for cost structure hierarchy [11], [12] and [19], unless agreed upon by Eskom and the Contractor.
- (xvi) Where costing information has been obtained from a PNNL-type cost breakdown methodology it must be reconciled to the ISDC format by the Contractor and indicated as such.

3.5 Deliverables

All data and technical documents updated and supplied to the Employer by the Contractor shall be in the English language with SI System of measurements.

System trigrams and all other specific terminology relevant to KNPS shall be applied by the Contractor and provided in the detailed technical and cost estimates decommissioning plan.

Any electronic media which forms part of the deliverables shall be in a format fully compatible with the following software (latest version in use by Employer at the time of delivery):

- Word Processing: Microsoft Word
- Database: SAP or SQL
- Spreadsheets: Microsoft Excel (and include all formulas and cell references where applicable)
- Photogrammetry 3D drawings: Electronic files compatible with Microstation
- Process flow diagrams and P&ID's: Electronic files compatible with Microstation
- Digital photographs: JPEG format
- Schedules and timelines: Primavera
- Assumptions need to be verified for validity by KNPS decommissioning team prior to inclusion in the final report.
- All backup data used for generation of the reported figures is submitted to the *Employer*.
- Draft report must be submitted.

3.6 Review and Approval of deliverables

The Contractor shall adhere to the following:

- (i) Final form documents for review and approval shall be provided in searchable Portable Document Format (PDF/A) and Microsoft Word formats.
- (ii) All documentation produced by the Contractor in terms of this contract shall become the property of the Employer.
- (iii) Finalization of any documentation will be subject to technical review by the Employer.

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- (iv) Work performed shall be subject to two Employer review iterations on all submissions. Employer review comments not adequately addressed by the Contractor shall not constitute a second review iteration.

3.7 Qualification of personnel and skills/competencies required

It is anticipated the works will be developed by a professional person/s at a senior level, and reviewed by a professional person, with suitable qualification, at an expert level as defined in Section 2.3.

3.8 Quality

- (i) The Contractor shall comply with the quality requirements stipulated in the Contract.
- (ii) The Contractor shall ensure that all work is performed under a quality process requiring technical reviews and approval.
- (iii) The Contractor's quality process shall be submitted to the Employer for approval prior to the commencement of work.
- (iv) The Contractor shall notify the Employer of any discrepancies between referenced documents or drawings and the plant. No work shall proceed until the Employer and the Contractor have come to an agreement in writing about the resolution of the discrepancy.
- (v) In order to be authorised to work at Koeberg Nuclear Power Station, all Contractors shall comply with Fitness for Duty requirements (KSA-119).

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Michael Richardson	Senior Manager Finance Business
Ditsietsi Malale	Integration Engineering Manager
Mosebetsi Leotlela	Senior Physicist: Nuclear Licensing
Mervin Theron	Manager Nuclear Regulatory and Licensing
Bravance Mashele	Koeberg Engineering Manager
Minette Minnaar	Radiation Protection Senior Advisor
Phina Thauge	Nuclear Back-end
Marc Maree	Corporate Specialist RP/EP
Cyril Hendriks	Project planner
Allister Speelman	Planner
Renee Ovis	Manager Project Accounting
Huibré van der Merwe	Engineer – SGR
Tommy Booysen	Project Engineering Manager – SGR

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5. Revisions

Date	Rev.	Compiler	Remarks
December 2021	1	RA Moffat	New document compiled to capture the requirements to support the commercial process.

6. Development Team

- N/A

7. Acknowledgements

- N/A.

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