| Eskom | WORKING PROCEDURE | Allocation Centre 38A | Reference Number KWH-S-033 | Rev 21 |
|---|---|---|---|---|
| NNR: NO<br>No.: | PROCESSING AND ADMINISTRATION OF SOLID RADWASTE | | | PAGE 1 |

| KORC | ACCESS | IMPORTANCE CATEGORY | NEXT REVIEW DATE | DATE AUTHORISED |
|---|---|---|---|---|
| NO | Nuclear Restricted | SR | 2026-05-29 | 2021-05-29 |

| COMPILED / REVISED | REVIEWED | AUTHORISED |
|---|---|---|
| (Sgd) R TRIMM | (Sgd) M MINNAAR | (Sgd) T KARSTEN |
| R TRIMM | M MINNAAR | T KARSTEN |
| RADIATION PROTECTION OPERATIONS MANAGER | SENIOR ADVISOR RADIATION PROTECTION | RADIATION PROTECTION MANAGER |
| **DATE** 2021-05-28 | **DATE** 2021-05-28 | **DATE** 2021-05-29 |

**THIS PROCEDURE HAS BEEN SEEN AND ACCEPTED BY:**

| | |
|---|---|
| D de Villiers | Document Custodian |
| E Ellis | ALARA Co-ordinator (Acting) |
| N Mokoto | Senior Licensing Physicist RP |
| C Le Roux | Radwaste Supervisor |
| G Visser | Chemistry |
| G Hemy | Senior Radiation Protection Assistant |
| A Christian | Senior Supervisor RP (Acting) |

**CATEGORY 3 – PROCEDURE FOR REFERENCE**

| FCA | ALARA REVIEW | SUPERSEDES |
|---|---|---|
| PROTECTION | YES<br>2021-05-19 | KWH-S-033, Rev 20<br>2020-02-24<br>FULL REVIEW |

# PAGE STATUS INDEX

| | REVISION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Page | 20 | 21 | | | | | | |
| 1 | x | x | | | | | | |
| 2 | x | x | | | | | | |
| 3 | x | x | | | | | | |
| 4 | x | x | | | | | | |
| 5 | x | x | | | | | | |
| 6 | x | x | | | | | | |
| 7 | x | x | | | | | | |
| 8 | x | x | | | | | | |
| 9 | x | x | | | | | | |
| 10 | x | x | | | | | | |
| 11 | x | x | | | | | | |
| 12 | x | x | | | | | | |
| 13 | x | x | | | | | | |
| 14 | x | x | | | | | | |
| 15 | x | x | | | | | | |
| 16 | x | x | | | | | | |
| 17 | x | x | | | | | | |
| 18 | x | x | | | | | | |
| 19 | x | x | | | | | | |
| 20 | x | x | | | | | | |
| 21 | x | x | | | | | | |
| 22 | x | x | | | | | | |
| 23 | x | x | | | | | | |
| 24 | x | x | | | | | | |
| 25 | x | x | | | | | | |
| 26 | x | x | | | | | | |
| 27 | x | x | | | | | | |
| 28 | x | x | | | | | | |
| END | | | | | | | | |
| | | | | | | | | |

| | REVISION | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Page | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

**CONTENTS** **PAGE**



 

## 1.0 PURPOSE

1.1 To provide Radiation Protection personnel with requirements for checking that all solid radioactive waste packages leaving site meet the requirements of:

1.1.1 The International Atomic Energy Agency (IAEA) Transport Regulations.

1.1.2 Vaalputs waste acceptance criteria.

1.1.3 All other applicable standards and procedures.

1.2 To describe the Radiation Protection responsibilities for the processing of solid low and intermediate level radioactive waste.

## 2.0 SCOPE

2.1 Applicable to solid radioactive waste generated at Koeberg and transported from Koeberg to Vaalputs.

## 3.0 DEFINITIONS AND ABBREVIATIONS

### 3.1 Definitions

3.1.1 **$A_1$ and $A_2$** – $A_1$ shall mean the activity value of special form radioactive material which is listed in the IAEA transport regulations and is used to determine the activity limits for the requirements of the transport regulations. $A_2$ shall mean the activity value of radioactive material, other than special form radioactive material, which is listed in the IAEA transport regulations and is used to determine the activity limits for the requirements of the transport regulations.

3.1.2 **Activity** – The quantity A for an amount of radionuclide in a given energy state at a given time, defined as:

$A(t) = dN/dt$

where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt.

3.1.3 **Centreline Dose Rate** – Is a contact doserate taken on the side of the drum in the centre.

3.1.4 **Compacting** – Compressing trash in steel drums by mechanical means.

3.1.5 **Date of Shipment** – Is the date the shipment is loaded at Koeberg.

3.1.6 **Drum Type** – Either C1, C2, C3, C4, C2F, or steel.

3.1.7 **Exclusive Use** – Exclusive use shall mean the sole use, by a single consignor, of a conveyance or of a large freight container, in respect of which all initial, intermediate and final loading and unloading is carried out in accordance with the directions of the consignor or consignee.

3.1.8 **Freight Container** – Freight container shall mean an article of transport equipment that is of a permanent character and is strong enough to be suitable for repeated use, specially designed to facilitate the transport of goods by one or other modes of transport without intermediate reloading, designed to be secured and/or readily handled, and having fittings for these purposes. The term freight container does not include the vehicle.

3.1.9 **Koeberg Number** – A number assigned in consecutive order to each drum. A concrete and steel drum can have the same Koeberg number, but it is unique for steel drums and unique for concrete drums.

3.1.10 **Low Specific Activity (LSA) Material** – Low specific activity (LSA) material shall mean radioactive material which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply. External shielding materials surrounding the LSA material shall not be considered in determining the estimated average specific activity.

3.1.11 **Manufacturer's Number** – The number assigned by the manufacturer to each concrete drum and stencilled onto the drum.

3.1.12 **Non-Compactable Waste (NCW)** – Is either non-compacted waste in steel drums and concrete drums or high active trash directly encapsulated in a concrete drum.

3.1.13 **Package** – Package shall mean the packaging with its radioactive contents as presented for transport.

3.1.14 **Radwaste Tracking Program** – A program used to enter all relevant drum data and calculate shipping activities.

3.1.15 **Shipment Data Pack** – The collection of documents that is presented with a waste package in Vaalputs and is retained as records at Koeberg.

3.1.16 **Shipment Number** – A number assigned to each shipment of radwaste to Vaalputs in the format V-YYYY-NNNN, with YYYY denoting the year and NNNN a sequential number.

3.1.17 **Shipped Radwaste** – Refers to radwaste that is contained within concrete/steel drums and has been sent to Vaalputs for disposal.

3.1.18 **Special Form Radioactive Material** – Special form radioactive material shall mean either an indispensable solid radioactive material or a sealed capsule containing radioactive material.

3.1.19 **Specific Activity** – Specific activity of a radionuclide shall mean the activity per unit mass of that nuclide. The specific activity of a material shall mean the activity per unit mass of the material in which the radionuclides are essentially uniformly distributed.

3.1.20 **Surface Contaminated Object (SCO)** – Surface contaminated object (SCO) shall mean a solid object which is not itself radioactive but which has radioactive material distributed on its surfaces.

3.1.21 **Task Performance Assessment** – Assessment performed on RP workers to determine competency for radwaste functions.

3.1.22 **Trailer** – Means a vehicle which is not self-propelled and which is designed or adapted to be drawn by a motor vehicle.

3.1.23 **Transport Index (TI)** – Refer to the IAEA transport regulations.

3.1.24 **Trash** – Is regarded as compacted low level waste which is drummed in steel drums of which the contact dose rate cannot exceed 2 000 µSv/h. Trash consists of plastics, paper, swipes, etc.

3.1.25 **Vehicle** – Vehicle shall mean a road vehicle (including an articulated vehicle, i.e. a tractor and semi-trailer combination), railroad car or railway wagon. Each trailer shall be considered as a separate vehicle.

**3.2 Abbreviations**

3.2.1 **APG** – Steam Generator Blowdown System

3.2.2 **DWS** – Decontamination Workshop

3.2.3 **IAEA** – International Atomic Energy Agency

3.2.4 **ISOCS** – In-Situ Object Counting System

3.2.5 **LAN** – Local Area Network

3.2.6 **LLBG** – Long Lived Beta Gamma

3.2.7 **LLW** – Low Level Waste

3.2.8 **LSA** – Low Specific Activity

3.2.8.1 **LSA-I** – Refer to the IAEA Transport Regulations

3.2.8.2 **LSA-II** – Refer to the IAEA Transport Regulations

3.2.8.3 **LSA-III** – Refer to the IAEA Transport Regulations

3.2.9 **NAB** – Nuclear Auxiliary Building

3.2.10 **NCW** – Non-Compactable Waste

3.2.11 **ND** – Non detectable

3.2.12 **NECSA** – South African Nuclear Energy Corporation

3.2.13 **NNR** – National Nuclear Regulator

3.2.14 **PC** – Personal Computer

3.2.15 **PCA** – Primary Circuit Activity

3.2.16 **QA** – Quality Assurance

3.2.17 **RCP** – Reactor Coolant System

3.2.18 **RPM** – Radiation Protection Monitor

3.2.19 **RTP** – Radwaste Tracking Program

3.2.20 **SAP(RP)** – Senior Authorised Person (Radiation Protection)

3.2.21 **SCO** – Surface Contaminated Object

3.2.21.1 **SCO-I** – Refer to the IAEA Transport Regulations

3.2.21.2 **SCO-II** – Refer to the IAEA Transport Regulations

3.2.22 **SOP** – Step-off Pad

3.2.23 **SRPA** – Senior Radiation Protection Assistant

3.2.24 **TES** – Solid Waste Treatment System

3.2.25 **TI** – Transport Index

3.2.26 **TRU** – Transuranics

3.2.27 **UN** – United Nations Number

3.2.28 **WAC** – Waste Acceptance Criteria

# 4.0 REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs unless a specific revision is stipulated by Nuclear Installation License NIL-01 Variation 19.

## 4.1 Referenced Documents

4.1.1 238-51, Rev 0b: Radiation Protection: Radioactive Waste Management

4.1.2 240-127949130, Rev 1: Qualification Testing of TES Concrete Waste Disposal Drums

4.1.3 335-2, Rev 5: Koeberg Nuclear Power Station Management Manual

4.1.4 Activity Assessment of Non-Gamma Emitting Isotopes in Solid Radwaste (Comp Ref. 544877R)

4.1.5 DSG-314-283, Rev 11: Radwaste Open Head Metal Drum

4.1.6 DSG-318-002, Rev 4: Design and Qualification Testing of TES Metallic Waste Disposal Drums

4.1.7 DSG-318-003, Rev 7: Manufacture of TES Concrete Waste Disposal Drums

4.1.8 KAA-500, Rev 13: The Process for Controlled Documents

4.1.9 KBA 0022 E03 002: 900 MWe Nuclear Reactor Radiation Source Term Data at Power and Reactor Shutdown

4.1.10 KEP-086, Rev 6: Emergency Plan for Radwaste Transport to Vaalputs

4.1.11 KFH-HP-161, Rev 3: Resin Transfer Job Cover Checklist

4.1.12 KSA-011, Rev 14: The Requirements for Controlled Documents

4.1.13 KSA-048, Rev 3a: Management of the Solid Radioactive Waste Programme

4.1.14 KWC-RC-ADM-001, Rev 4: Calculating the Ratio of Gamma Emitting Radionuclides in the Primary Coolant

4.1.15 KWH-I-074, Rev 3: Gamma Spectrometry with Genie 2000 and ISOCS

4.1.16 KWH-I-094, Rev 3a: Operation and Use of Radiation Protection Portable Radiation Instruments

4.1.17 KWH-I-095, Rev 4: The Operation and Use of Portable and Installed Contamination Monitors

4.1.18 KWH-S-001, Rev 20: Radiation and Surface Contamination Surveys

4.1.19 KWH-S-037, Rev 14: Classification of Solid Radioactive Materials and the Acceptable On- and Off-site Packaging Requirements for such Materials

4.1.20 NNR Fax 973: Proportionality Constants for Resins

4.1.21 NNR Letter Ref. K-11272E: Approval for KWH-S-033

4.1.22 NNR Letter Ref. K13022N: Scaling Factors for Solid Radioactive Waste

4.1.23 NNR Letter Ref. K-18626-E: Activity Assessment of Sludge in Concrete Drums

4.1.24 NNR Letter Ref K-7394-E: Quantitative Assessment of Radionuclides in Resins and Filters

4.1.25 NNR Letter Ref k5900: Koeberg Nuclear Power Station Proportionality Constants for Resin and Filter Drums

4.1.26 NNR Letter Ref. K-8178: Proposed Proportionality Factors for Compactable Waste in Concrete Drums

4.1.27 NNR Letter Ref. K-8226: Approval for KWH-S-033, Rev 7

4.1.28 TAR 003/2016: Justification for the Classification of Trash Shipped in Steel Drums as SCO-11

4.1.29 TAR 035/97: Assessment of the Radwaste Tracking Program

4.1.30 TR-57/01: Proportionality Factors for Resin in Steel Drums

4.1.31 TS-G-1.2: Planning and Preparing for Emergency Response to Transport Accidents Involving Radioactive Material

4.1.32 TR 001/2018: Concrete Drums LSA-II and LILW-SL Requirements

**4.2 Applicable Documents**

4.2.1 IAEA Regulations for the Safe Transport of Radioactive Material

4.2.2 KAA-634: Responsibilities for the Radioactive Material and Radioactive Waste Control Programme

4.2.3 KFH-HP-151: Shipment Check-Off List (LLW 18)

4.2.4 KSH-008: Radiation Protection Records, Data and Information Management

4.2.5 Measurements of the Long-lived Isotopes Contained in the Waste Produced by EDF PWR Power Stations (Computer Ref. R754972)

4.2.6 Waste Acceptance Criteria for Vaalputs: VLP-WAC-01

4.2.7 SANS 10187-1: 2009: South African National Standards

## 5.0 PREREQUISITES

5.1 Radiation dosimetry must be worn by all personnel when performing work in the LLW store or transporting radwaste.

5.2 Personnel handling radioactive materials must comply with applicable radiological protection procedures.

5.3 Personnel surveying radwaste must be suitably trained and/or qualified for specified activities.

5.4 Appendix 1 to be used to control the drumming process i.e. to ensure that the correct drum is used. Surveillance of drums from the decontamination workshop shall be performed in the area with the lowest background.

5.5 The following instruments must be used for the surveillance of radwaste drums:

5.5.1 For radiation: A Teletector must be used to measure for contact reading and an ion chamber used to measure for the 1 m reading.

5.5.2 For contamination: A L-177 must be used to measure for external beta gamma; and an approved instrument is to be used to measure for alphas.

5.6 Radiological data (contact and 1 metre doserate for drumming, capping and transfer taken from the highest doserate value on top, side and base) must be updated on the Radwaste Tracking Program.

5.7 The Radiation Protection Shipment check-off list (LLW18) (KFH-HP-151) must be completed in conjunction with this procedure.

5.8 An NNR approved safety submission is required for each waste stream (concrete and steel) prior to shipment of such waste.

## 6.0 PRECAUTIONS AND LIMITATIONS

6.1 Only solid or solidified radioactive waste may be shipped.

6.2 No explosive or pyrophoric material shall be shipped.

6.3 No radwaste packages shall be opened without written authorisation from Radiation Protection.

6.4 No radioactive material shall be shipped in a container constructed from cardboard.

6.5 The mass of any individual package of radioactive waste must be limited to ensure that the allowable trailer loading of 29000 kgs (concrete drums) or 24000 kgs (steel drums) is not compromised.

***NOTE:*** *A maximum mass of 6,3 tons for any individual package of radioactive waste is allowed and must not be exceeded unless approval has been given by the repository site. The maximum allowable trailer loading must never be compromised.*

6.6 Shipping of radwaste packages that exceed the requirements for LILW-SL is **NOT** permitted. All packages found to exceed this limit must be reported to the NNR. Refer to Section 7.8 for calculations.

6.7 The NNR approved methodology is provided in (Appendix 2) for references purposes. Drum volumes of active material (Appendix 3) is also provided for reference purposes.

6.8 Pressurised containers, which may also have contained gases or other substances, particularly hazardous or toxic materials, must be emptied and their valves left open, i.e. such containers shall not be sent to Vaalputs while still pressurised (Radwaste to ensure that this is complied with).

6.9 The total TI for a shipment is not to exceed 50.

## 7.0 PROCEDURE

7.1 The different kinds of radwaste are processed according to the applicable Operating Radwaste procedures.

### 7.2 Drum Information

7.2.1 When drumming of radwaste is required, a Koeberg number is assigned to each drum. This number will be generated by the RTP automatically.

7.2.2 After drumming, the survey details must be recorded on the Radwaste Tracking Program using the Surveys Data Icon. The manufacturer's number and Koeberg number, as well as the drum type, should have been entered by Radwaste personnel and will automatically be linked.

7.2.3 The following must be surveyed for steel and concrete drums for shipment purposes:

(1) Highest contact dose rate (Top, side and base) must be referenced on the survey.

(2) Dose rate at 1 m from the highest point.

 

(3) Highest centreline contact dose rate (for filters, resins and NCW).

(4) Contamination swipe of entire drum outer surface.

***NOTE:*** *If the steel drum is drummed and transferred to LLW within seven working days; the radiation results from the drumming survey can be used for the transfer survey. The contamination survey must be performed when the drum is transferred to LLW.*

### 7.3 Recording of Survey Results on Radwaste Tracking Program

7.3.1 Refer to operational training with regards to the Radwaste tracking program by logging onto the Link on the G:\Koeberg\Nuclear Services\Radiation Protection\SharePoint Migration\RP Operations\Radwaste\Training Videos\Radwaste User Guide.

### 7.4 Package Survey Requirements

7.4.1 When a shipment is due to occur, the relevant drums are selected from the LLW building by Radwaste Operations and surveyed by Radiation Protection.

7.4.2 Surveys must be conducted in accordance with this procedure and recorded in Radwaste Tracking Program. The highest contact and 1 metre dose rate from the highest value over the entire surface of the package is to be ascertained and recorded. The shipment of any radwaste package must not proceed if the contact doserate exceeds 2000 µSv/h or the 1 metre dose rate exceeds 100 µSv/h unless a waiver is approved by the NNR.

***NOTE 1:*** *For drums (steel and concrete) that contain NCW, if the doserate is ≥ 80% (1600 µSv/h) of the shipping limit at transfer, the SAP need to be informed before shipment of that drum to make a decision if the drum can be shipped or not.*

***NOTE 2:*** *When surveying drums for shipment; all drums to be independently surveyed if the contact dose rate is ≥ 1600 µSv/h.*

***NOTE 3:*** *All drums surveyed for pre-shipment that have a contact dose rate ≥ 1600 µSv/hr is to be verified by a different RPM.*

### 7.5 Marking and Labelling of Packages

7.5.1 Make sure that each package is marked with a permanent identification number.

7.5.2 For packages weighing in excess of 50 kg, the maximum permissible mass must be marked on the outside.

7.5.3 The correct package category is ascertained from the Radwaste Tracking Program and the appropriate label (refer to the IAEA transport regulations) is completed as follows:

7.5.3.1 Contents – Enter the most restrictive nuclides followed by LSA-I or LSA-II or LSA-III or SCO-1 or SCO-II.

7.5.3.2 Activity – Enter the maximum activity of the radioactive contents in units of Giga Becquerels (Gbq).

7.5.3.3 Transport Index – Enter the numeric value of the 1 metre dose rate measurement made in µSv/h ÷ 10, rounded up to the first decimal place.

7.5.4 The label is affixed to two opposite sides of each package.

7.5.5 One IAEA information label with the package type, United Nations number and proper shipping name must be affixed to the drum (refer to Appendix 6).

**7.6 Vehicle Requirements**

7.6.1 The drums should be loaded onto the trailer in such a way that the dose rate in the driver's cabin is at all times less than 20 µSv/h, less than 2000 µSv/h on the outside surface of the trailer, and less than 100 µSv/h at 2 m from the trailer.

7.6.2 The appropriate placards (refer to the IAEA transport regulations) must be affixed to two lateral sides, rear side, the front of the trailer and on the front of the vehicle.

7.6.3 The applicable UN number must be displayed on all four sides of the vehicle for an exclusive use shipment having only one UN number.

7.6.4 The radwaste trailer must be loaded under the supervision of Radiation Protection to ensure that the drums are loaded according to activity. The highest drums to be loaded in the middle of the trailer and the lowest to be loaded in front.

**7.7 Shipping Data Requirements**

7.7.1 Shipment data (drum data and Vaalputs checklist) must be faxed to Vaalputs for review and approval.

7.7.2 Before the shipment may leave site, approval must be obtained from Vaalputs by Radwaste.

7.7.3 The shipment data pack is to accompany the shipment to Vaalputs and must be given to the driver of the vehicle. **The shipment data pack shall consist of:**

(1) List of unique drum numbers of waste packages and type of package.

(2) Chemical analysis report, including pH or waiver. (Refer to WAC)

(3) Surveys of drums and vehicle.

(4) Calibration certificates of survey instruments.

(5) Completed forms VLP-CHL-03/1001 and LLW 18 (KFH-HP-151).

(6) Copies of data books and work packs for each drum.

(7) The Final Shipment Form (LLW 3).

(8) Applicable Chemistry reports.

(9) Waste transfer forms for each drum. (LLW 13)

(10) Inspection report of drums.

(11) Completed radioactive labels of ALL drums.

(12) List off all reportable radionuclides.

(13) Calculations demonstrating compliance to LSA-II criteria.

(14) Calculations demonstrating compliance to LILW-SL criteria.

## 7.8 LSA-II and LILW-SL Concrete Drum Calculations

7.8.1 Refer to TR 001/2018 for background information. The calculations below are required to confirm that the LSA-II and LILW-SL requirements are met.

***NOTE:*** The LSA-II and TRU calculations in the Koeberg SAR only describe one waste stream. The calculations therefore have to be performed for all other waste streams. The LLBG calculations were not required prior to VLP-WAC-001 Rev 8.

7.8.2 Calculate the active mass of the concrete drum, using the mass of the encapsulated drum from RTP, the measured masses of the empty drum and steel liner as provided by Radwaste section or calculated masses of the empty drum and steel liner as per Table 1 below:

**Table 1: Calculation of the Active Mass of Concrete Drums**

| Drum Type | Active Mass(kg) |
|---|---|
| C1 Concentrates | $= m_{full} - 0.05 * m_{empty} - 2981.44 - m_{msl}$ OR $= m_{full} - 3312.55$ |
| C1 Resins | $= m_{full} - 0.05 * m_{empty} - 2981.44 - m_{msl}$ OR $= m_{full} - 3312.55$ |
| C1 NCW | $m_{full} - 0.05 * m_{empty} - 2981.44$ OR $= m_{full} - 3177.55$ |
| C1 Sludge | $= m_{full} - 0.05 * m_{empty} - 2981.44 - m_{msl}$ OR $= m_{full} - 3312.55$ |
| C2 Concentrates | $= m_{full} - 0.05 * m_{empty} - 4075.28 - m_{msl}$ OR $= m_{full} - 4464.75$ |
| C2 Resins | $= m_{full} - 0.05 * m_{empty} - 4075.28 - m_{msl}$ OR $= m_{full} - 4464.75$ |
| C2 NCW | $= m_{full} - 0.05 * m_{empty} - 4075.28$ OR $= m_{full} - 4384.75$ |
| C2F | $= m_{full} - 0.05 * m_{empty} - 3910.72$ OR $= m_{full} - 4204$ |
| C4 | $= m_{full} - 0.05 * m_{empty} - 1805.32$ OR $= m_{full} - 1947.46$ |

7.8.3 Calculate the active mass of the steel drum using the mass of the packaged drum from RTP together with the empty mass as per Table 2:

**Table 2: Calculation of Active Mass of Steel Drums**

| Drum Type | Active Mass (kg) |
|---|---|
| Steel Drum containing Resin | = $m_{full} - 19$ |
| Steel Drum containing NCW | = $m_{full} - 19$ |

7.8.4 Confirm, using the $A_2$ value and the active mass as calculated in Tables 1 and 2 that:

- The drum number of $A_2$'s < 1.

AND

- The active mass of the drum > 50 kg

AND

- The shipment number of $A_2$'s < 100

7.8.5 Confirm, using the $A_2$ value from RTP, the TRU activity from RTP and the active mass as calculated in Tables 1 and 2 that:

- $\sum Individual\ Drums\ TRU\ Activity \Big/ \sum Individual\ Drums\ Active\ Mass \leq 400\ Bq/g$

- $Drum\ TRU\ Activity \Big/ Drum\ Active\ Mass \leq 4\,000\ Bq/g$

7.8.6 Confirm, using the drum total activity and the individual LLBG activity from RTP and the active mass as calculated in Tables 1 and 2 that:

- $\sum Individual\ Drums\ Total\ Activity \Big/ \sum Individual\ Drums\ Active\ Mass \leq 4\,000 Bq/g$

OR

- $\sum Individual\ Drums\ LLBG\ Activity \Big/ \sum Individual\ Drums\ Active\ Mass \leq 4\,000 Bq/g$

AND

- $Drum\ Total\ Activity \Big/ Drum\ Active\ Mass \leq 40\,000 Bq/g$

OR

- $Drum\ LLBG\ Activity \Big/ Drum\ Active\ Mass \leq 40\,000 Bq/g$

### 7.9 Trash SCO-II Total Activity Limit

7.9.1 The conveyance activity limit for SCO material as per the IAEA transport regulations is 100 $A_2$. This equates to a total activity limit of 40 000 GBq for trash in steel drums.

## 8.0 ACCEPTANCE CRITERIA

8.1 Before shipment departure, the SAP (RP) must review the shipment data pack for:

8.1.1 Completeness in terms of the documentation listed in paragraph 7.7.3.

8.2 The SAP (RP) must then sign and date any form that requires the signature of the SAP (RP).

8.3 The SRPA must co-sign with the SAP (RP) where it is required.

## 9.0 RECORDS

9.1 Radwaste Section must forward a copy of the full shipment data pack including form KFH-HP-151 to Records Section as these are permanent records that must be retained at Koeberg in accordance with KSH-008.

## 10.0 ATTACHMENTS

Appendix 1 – Drumming Control

Appendix 2 – NNR Approved Methodology for Activity Calculations

Appendix 3 – Drum Volumes of Active Material

Appendix 4 – Proportionality Constants for Resin Filled Drums

Appendix 5 – Proportionality Constants for Filters and NCW Drums

Appendix 6 – Example of IAEA Information Labels

Appendix 7 – Process for Compacting/Drumming Steel 210L Drums

Appendix 8 – Justification

## APPENDIX 1

## DRUMMING CONTROL

Advise Radwaste Management on the correct drum to be used in accordance with the guidelines below:

| FILTER | CONTACT DOSE RATE | | | DRUM TYPE |
|---|---|---|---|---|
| | | < 2 | mSv/h | 210 litre metal drum |
| | > 2 | < 15 | mSv/h | C1 drum |
| | > 15 | < 500 | mSv/h | C4 drum |
| | | > 500 | mSv/h | C2F drum |
| * RESINS | CONTACT DOSE RATE | | | DRUM TYPE |
| | | < 2 | mSv/h | 210 litre metal drum (APG) |
| | | < 200 | mSv/h | C1 drum |
| | > 200 | < 3500 | mSv/h | C2 drum |
| | | > 3500 | mSv/h | C3 drum |
| CONCENTRATES | ACTIVITY | | | DRUM TYPE |
| | < 92,5 MBq/litre | | | C1 drum |
| | > 92,5 MBq/litre | | | C2 drum |

**** NOTE:*** *When drumming resins commence using a C1 drum and a mixture of resin "shots" of 1 high to 6 low from the appropriate resin holding tanks. In conjunction with Radiation Protection, monitor the result as long as the ratio of the mix allows the contact doserate at the outside of the drum to remain below 2000 µSv/h. Increase the mix accordingly, i.e. 2 to 5; 3 to 4 etc. Should the mix indicate that the contact doserate might be exceeded by the next increase in ratio, continue drumming at the present mix being used. Should the low resins holding tank expire and the high level holding tank still requires emptying, increase the drum type as required to C2 or C3 accordingly.*

## APPENDIX 2

## NNR APPROVED METHODOLOGY FOR ACTIVITY CALCULATIONS

1. For concentrates and sludge, the shipping activity for each nuclide is calculated using the following formula:

$$A = CV \times 10^{-9} e^{-\lambda t}$$

Where A = Activity in GBq
C = Concentration from chemistry sample in Bq/$m^3$
V = Volume of active waste (in accordance with Appendix 3) in $m^3$
$\lambda$ = Decay constant in day-$^1$ (per day)
t = Decay time in days (sampling date to shipment date)

2. For resins, filters and NCW, the total shipping activity is calculated, based on the highest 1 cm centreline doserate on the drum. The fraction of each nuclide listed in Appendices 4 and 5 is calculated as follows:

$$Fraction = \frac{decayed\ nuclide\ activity\ at\ time\ of\ shipment}{\sum individual\ decayed\ nuclide\ activity\ at\ time\ of\ shipment}$$

The activities are obtained from the mean activity given in the Chemistry report. Activities are decayed from the sampling / reference date to the shipment date.

$$Total\ Activity\ (GBq) = \frac{doserate\ (\mu Sv/h)}{\sum \frac{fraction\ for\ each\ nuclide}{proportinality\ factor\ for\ each\ nuclide}}$$

3. The activity of compacted trash in steel drums is calculated as follows:

$$A\ (GBq) = 6{,}4 \times 10^{-4} \times highest\ 1\ cm\ doserate\ (\mu Sv/h)$$

The main isotope quoted for shipment purposes is Co-60.

4. For transport containers with ventilation filters, the specific activity is determined using the method as determined in reference 4.1.21 (ISOCS). The total activity is determined through multiplication by the mass of the waste inside the container. The activity of TRU is determined as indicated in 5 (b), and for other difficult to measure nuclides, in accordance with 5(c). Tritium will not be reported, due to the nature of the waste.

**APPENDIX 2 (continued)**

**NNR APPROVED METHODOLOGY FOR ACTIVITY CALCULATIONS**

5. The activity of non-gamma emitting nuclides are calculated as follows:

   a) Tritium concentration in the waste is equivalent to that of the primary circuit. The highest value for either unit for the month of drumming is used. Half this value is used for resins, filters and NCW.

   b) TRU activity is taken as $2{,}0 \times 10^{-5} \times$ Cs-137 activity at time of drumming. For filters, the factor is $2{,}0 \times 10^{-4}$. If > 400 Bq/g, approval for shipment is required from the NNR.

   c) Difficult to measure nuclides listed in (i) and (ii): Use the decay corrected activity (to time of drumming) of either Co-60 or Cs-137, and multiply by the applicable scaling factor for each difficult to measure nuclide.

## APPENDIX 2 (continued)

## NNR APPROVED METHODOLOGY FOR ACTIVITY CALCULATIONS

### i) Resin Scaling Factor

- Be-10 activity is take
- C-14 activity is taken
- Cl-36 activity is take
- Ca-41 activity is take
- Fe-55 activity is take
- Ni-59 activity is take
- Ni-63 activity is take
- Se-79 activity is take
- Sr-90 activity is take
- Zr-93 activity is take
- Mo-93 activity is tak
- Nb-94 activity is take
- Tc-99 activity is take
- Pd-107 activity is tak
- Ag-108m activity is t
- Sn-121 m activity is
- Sn-126 activity is tak
- I-129 activity is take
- Cs-135 activity is tak
- Sm-151 activity is ta

PAIA section 36(b).Redacted scaling values, this is proprietery information

### ii) Filters, Concentrates, Sludge and Non-compactable Waste Scaling Factors

- Be-10 activity is take
- C-14 activity is taken
- Cl-36 activity is taken
- Ca-41 activity is take
- Fe-55 activity is take
- Ni-59 activity is taken
- Ni-63 activity is taken
- Se-79 activity is take
- Sr-90 activity is taken
- Zr-93 activity is taken
- Mo-93 activity is take
- Nb-94 activity is take
- Tc-99 activity is take
- Pd-107 activity is tak
- Ag-108m activity is ta
- Sn-121 m activity is t
- Sn-126 activity is tak
- I-129 activity is taken
- Cs-135 activity is tak
- Sm-151 activity is tak

PAIA section 36(b).Redacted scaling values, this is proprietery information

## APPENDIX 3

## DRUM VOLUMES OF ACTIVE MATERIAL

| CONCENTRATES | | |
|---|---|---|
| DRUM TYPE | VOLUME (cu. m.) | VOLUME (litres) |
| C1 | 0,342 | 342 |
| RESINS AND FILTERS | | |
| DRUM TYPE | VOLUME (cu. m.) | VOLUME (litres) |
| C1 | 0,298 | 298 |
| C2 | 0,128 | 128 |
| C3 | 0,043 | 43 |
| C2F | 0,042 | 42 |
| C4 | 0,123 | 123 |
| NCW | | |
| DRUM TYPE | VOLUME (cu. m.) | VOLUME (litres) |
| C1 | 0,510 | 510 |
| STEEL DRUMS | | |
| DRUM TYPE | VOLUME (cu. m.) | VOLUME (litres) |
| Trash | 0,140 | 140 |
| Resins | 0,210 | 210 |
| NCW | 0,210 | 210 |
| SLUDGE | | |
| DRUM TYPE | VOLUME (cu. m.) | VOLUME (litres) |
| C1 | 0,360 | 360 |

## APPENDIX 4

## PROPORTIONALITY CONSTANTS FOR RESIN FILLED DRUMS

| ISOTOPE | 210L STEEL | C1 DRUM | C2 DRUM | C3 DRUM |
|---|---|---|---|---|
| Mn-54 | 1,70E-3 | 1,08E-1 | 6,49E-1 | 1,55E00 |
| Fe-59 | 1,19E-3 | 5,67E-2 | 2,70E-1 | 5,48E-1 |
| Zn-65 | 2,43E-3 | 1,27E-1 | 6,13E-1 | 1,29E00 |
| Co-58 | 1,50E-3 | 1,00E-1 | 6,41E-1 | 1,55E00 |
| Co-60 | 5,62E-4 | 2,66E-2 | 1,16E-1 | 2,30E-1 |
| Ag-110m | 5,21E-4 | 3,09E-2 | 1,63E-1 | 3,49E-1 |
| Sb-124 | 7,69E-4 | 3,63E-2 | 1,45E-1 | 2,70E-1 |
| Cs-134 | 9,43E-4 | 6,66E-2 | 4,48E-1 | 1,12E00 |
| Cs-137 | 2,44E-3 | 1,85E-1 | 1,39E00 | 3,74E00 |
| Ce-144 | 1,26E-1 | 9,26E+3 | 2,40E+6 | 4,20E+7 |

Units are Giga Bequerels per microSievert per hour

## APPENDIX 5

## PROPORTIONALITY CONSTANTS FOR FILTERS AND NCW DRUMS

| ISOTOPE | C1 - “NCW” | C2F DRUM | C4 DRUM |
|---|---|---|---|
| Mn-54 | 4,769E-1 | 9,01E-1 | 7,30E-2 |
| Fe-59 | 1,794E-1 | 3,33E-1 | 3,70E-2 |
| Zn-65 | 4,143E-1 | 7,75E-1 | 8,06E-2 |
| Co-58 | 4,824E-1 | 9,01E-1 | 6,94E-2 |
| Co-60 | 7,639E-2 | 1,41E-1 | 1,64E-2 |
| Ag-110m | 1,145E-1 | 2,10E-1 | 2,03E-2 |
| Sb-124 | 9,718E-2 | 1,71E-1 | 2,27E-2 |
| Cs-134 | 3,481E-1 | 6,45E-1 | 4,74E-2 |
| Cs-137 | 1,142E00 | 2,11E00 | 1,35E-1 |
| Ce-144 | 5,325E+5 | 1,97E+7 | 4,09E+4 |

Units are Giga Bequerels per microSievert per hour

## APPENDIX 6

## EXAMPLE OF IAEA INFORMATION LABEL

**Label used for Trash in Steel Drums**

Type IP II
UN 2913
RADIOACTIVE
MATERIAL,

**Label used for all other Waste**

Type IP II
UN 3321
RADIOACTIVE
MATERIAL,

## APPENDIX 7

## PROCESS FOR COMPACTING/DRUMMING STEEL 210L DRUMS

1. A Hi-Q to be placed at the door to the compactor and a particulate air sample to be taken during the compacting process.
2. General area dose rate must be taken and compare to the area radiation monitor reading at the entrance to N034. Perform random dose rate surveys when bags are removed from the pile.
3. RPM must identify a low dose area with in N034.
4. Bags with radioactive waste must be survey with a Teletector before drumming commence and all bags found higher or equal to 2000 µSv/h to be removed and placed in N030.

   ***NOTE:*** *Special care needs to be taken with compacting of hot particles bags:*

   - *Bags marked as hot particles needs to be surveyed individually before placing the bag in the drum.*
   - *Hot particles bags must not be cut but opened at the neck and placed in the bottom of the drum.*

5. Survey steel drum with Teletector for all contact readings on top, side and base before storing the drum in the drum storage area.

   ***NOTE 1:*** *Drums that exceed the shipping dose rate limits as per 7.6.2 must be returned to the compactor and the high dose rate bag or bags to be removed from the drum.*

   ***NOTE 2:*** *The Barrier of the Drum storage area must be surveyed and sign posted if drums are being stored in this area.*

6. A contamination survey must be performed on the compactor and thereafter as deemed necessary.

   ***NOTE:*** *When compactor is found to be contaminated the job must be stopped and compactor needs to be decontaminated before proceeding with compacting.*

7. Survey of 210L steel drums.
8. Perform a pre job contamination survey of the floor area including the area behind the SOP into the drum storage area.

   ***NOTE:*** *Accessible floor area behind SOP must be free of contamination:*

   - *Request RPDC to decontaminate the floor if contamination is detected.*
   - *Both drum and trolley must be free of loose contamination before it they may be moved over the SOP.*
   - *Frequent contamination survey's to be performed of the floor during the transfer of drums over the SOP.*

**APPENDIX 7 (continued)**

**PROCESS FOR COMPACTING/DRUMMING STEEL 210L DRUMS**

9. Perform contact dose rates with teletector on top, side and base of each 210L steel.

10. Indicate with a small dot no bigger than a 10cent piece the highest contact dose rate point on the drum if drum.

11. Perform a 1 meter dose rate survey with ion chamber e.g. L 9-4 from the highest contact dose rate survey point.

12. Complete drum label with date, drum number and content.

13. Temporary barrier to be placed around drums if drums are not transferred immediately.

14. **Transfer of 210L Steel drums**

15. All drums with labels completed for drumming may be transfer to LLW.

16. Perform a pre job contamination survey of the floor area of the entire route to the loading bay in N265 including the loading bay and barrier wall before Victor 3 can be opened.

17. Perform post job contamination survey of the route when drums are transferred.

    ***NOTE:*** *All drums surveyed within 7 days may be transferred without re-surveying them for radiation.*

18. Complete drum label with date of transfer, highest CT and 1 m.

    ***NOTE 1:*** *No transfer certificate required as the drum label replace the function of the transfer tag. (KAA-634)*

    ***NOTE 2:*** *Complete drum label with the date of transfer, highest contact and 1m dose rates.*

## APPENDIX 8

## JUSTIFICATION

**Revision 20**

1. Page 8: Referenced Documents updated.

2. Page 17, para 8.3: Removed “shipping” from sentence.

**Revision 21**

1. Removal of Survey Template for Radwaste Form (KFH-HP-171). This is not a form, rather a template used by the RPM as an aid for capturing info during a survey and the info is updated on the radwaste tracking program as a survey.

2. GA 39683: Update to reflect Nuclear Installation License NIL-01 variation 19 and to include trailer.