## WASTE STREAM 5B16 Bulk Operational LLW

| | |
|---|---|
| **SITE** | Dounreay |
| **SITE OWNER** | Nuclear Decommissioning Authority |
| **WASTE CUSTODIAN** | Dounreay Site Restoration Limited |
| **WASTE TYPE** | LLW |
| Is the waste subject to Scottish Policy: | No |

**WASTE VOLUMES**

| | | Reported |
|---|---|---|
| Stocks: | At 1.4.2022..... | 3104.2 $m^3$ |
| Total future arisings: | | 0 $m^3$ |
| Total waste volume: | | 3104.2 $m^3$ |

Comment on volumes: This waste stream captures all Bulk LLW which is packaged and then loaded into containers for storage awaiting disposal. Future arisings are not reported to avoid double counting, as future arisings are captured within the waste streams from which the waste originates. These waste streams are: 5B301, 5B303, 5B305, 5B307, 5B309, 5B311, 5B313, 5B315, 5B329, 5B331, 5B333, 5B335, 5B337, 5B339, 5B341, 5B343, 5B345, 5B348, 5B349, 5B351, 5B352, and 5B358. The increase in stock in this waste stream since 2019 relates to the generation and consignment of bulk waste which have been packaged into containers for storage pending encapsulation and disposal of consignment to an alternative offsite waste route. Previous estimates have been based on container numbers and internal /external container volumes. This estimate is based on individual package data. Some uncertainty will arise as this waste stream contains historical waste packages with outdated / incomplete waste records.

| Uncertainty factors on volumes: | | | | |
|---|---|---|---|---|
| | Stock (upper): | x 1.02 | Arisings (upper) | x |
| | Stock (lower): | x 0.98 | Arisings (lower) | x |

**WASTE SOURCE** Large items of waste from reactor and reprocessing operations and support facilities.

### PHYSICAL CHARACTERISTICS

| | |
|---|---|
| General description: | Gloveboxes, ducting and other redundant bulk wastes that cannot be size reduced into 200 l drums. The waste has been packaged into disposal containers. |
| Physical components (%wt): | Large plant items such as: tanks, pipework, shield blocks, roof plates, concrete structures, ventilation ducting, etc not able to be size reduced into a 200L drum. Includes cemented sludge drums from effluent treatment plant. |
| Sealed sources: | Not yet determined. |
| Bulk density (t/$m^3$): | 1.2 |
| Comment on density: | Based on consignor's records |

### CHEMICAL COMPOSITION

| | |
|---|---|
| General description and components (%wt): | Steel (66.8%), Lead (6.98%), Aluminium (0.04%), Copper (0.19%), Glass (0.11%), Rubber (0.15%), Wood (2.16%), Paper (0.18%), Unhalogenated plastic (0.79%), halogenated plastic (0.4%), Ceramics (0.01%), Rubble (3.53%), Concrete(14.71%), Soil (0.2%), Cemented Sludge (1.15%), and other materials (2.6%). |
| Chemical state: | Neutral |
| Chemical form of radionuclides: | H-3: Tritiated steel is present.<br>C-14: May be present at low concentrations.<br>Cl-36: May be present at low concentrations.<br>Tc-99: May be present at low concentrations.<br>I-129: May be present at low concentrations.<br>Ra: May be present at low concentrations.<br>Th: May be present at low concentrations.<br>U: Likely to be present as oxide, nitrate or metal.<br>Np: May be present at low concentrations.<br>Pu: Likely to be present as oxide, nitrate or metal. |
| Metals and alloys (%wt): | Both bulk and sheet metals are likely to be present, proportions not specified. |

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| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---|---|---|---|
| Stainless steel | 0 | | |
| Other ferrous metals | 66.8 | | |
| Iron | | | |
| Aluminium | 0.04 | | |
| Beryllium | | | |
| Cobalt | 0 | | |
| Copper | 0.19 | | |
| Lead | 7.0 | | |
| Magnox/Magnesium | 0 | | |
| Nickel | | | |
| Titanium | | | |
| Uranium | | | |
| Zinc | TR | | |
| Zircaloy/Zirconium | 0 | | |
| Other metals | 2.6 | Trace quantities of other, unspecified, metals may be present. | |

Organics (%wt): The waste is wrapped in polythene. PVC may be present.

| | (%wt) | Type(s) and comment | % of total C14 activity |
|---|---|---|---|
| Total cellulosics | 2.3 | | |
| Paper, cotton | 0.18 | | |
| Wood | 2.2 | | |
| Halogenated plastics | 0.40 | | |
| Total non-halogenated plastics | 0.79 | | |
| Condensation polymers | NE | | |
| Others | | | |
| Organic ion exchange materials | 0 | | |
| Total rubber | 0.15 | | |
| Halogenated rubber | TR | | |
| Non-halogenated rubber | TR | | |
| Hydrocarbons | | | |
| Oil or grease | | | |
| Fuel | | | |
| Asphalt/Tarmac (cont.coal tar) | | | |
| Asphalt/Tarmac (no coal tar) | | | |
| Bitumen | | | |
| Others | | | |
| Other organics | 0 | | |

Other materials (%wt): -

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| | (%wt) | Type(s) and comment | % of total C14 activity |
|---|---|---|---|
| Inorganic ion exchange materials.. | 0 | | |
| Inorganic sludges and flocs..... | 0 | | |
| Soil..... | 0.20 | | |
| Brick/Stone/Rubble..... | 3.5 | | |
| Cementitious material..... | 15.9 | Concrete + Cemented sludge | |
| Sand..... | 0 | | |
| Glass/Ceramics..... | 0.12 | | |
| Graphite..... | 0 | | |
| Desiccants/Catalysts..... | | | |
| Asbestos..... | TR | | |
| Non/low friable..... | TR | | |
| Moderately friable..... | TR | | |
| Highly friable..... | TR | | |
| Free aqueous liquids..... | 0 | | |
| Free non-aqueous liquids..... | 0 | | |
| Powder/Ash..... | 0 | | |

Inorganic anions (%wt): Trace quantities only.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Fluoride..... | TR | |
| Chloride..... | TR | |
| Iodide..... | 0 | |
| Cyanide..... | TR | |
| Carbonate..... | TR | |
| Nitrate..... | TR | |
| Nitrite..... | TR | |
| Phosphate..... | TR | |
| Sulphate..... | TR | |
| Sulphide..... | TR | |

Materials of interest for waste acceptance criteria: Items are treated before consignment and/or potential future disposal to ensure that no fire or non-radiological hazard is present.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Combustible metals..... | 0 | |
| Low flash point liquids..... | 0 | |
| Explosive materials..... | 0 | |
| Phosphorus..... | 0 | |
| Hydrides..... | 0 | |
| Biological etc. materials..... | 0 | |
| Biodegradable materials..... | 0 | |
| Putrescible wastes..... | 0 | |
| Non-putrescible wastes..... | 0 | |

**WASTE STREAM 5B16 Bulk Operational LLW**

| | |
|---|---|
| Corrosive materials..... | 0 |
| Pyrophoric materials..... | 0 |
| Generating toxic gases..... | 0 |
| Reacting with water..... | 0 |
| Higher activity particles..... | |
| Soluble solids as bulk chemical compounds..... | |

Hazardous substances / non hazardous pollutants: Lead will be present, mostly in the form of bricks.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Acrylamide..... | | |
| Benzene..... | NE | |
| Chlorinated solvents..... | | |
| Formaldehyde..... | | |
| Organometallics..... | | |
| Phenol..... | NE | |
| Styrene..... | | |
| Tri-butyl phosphate..... | NE | |
| Other organophosphates..... | | |
| Vinyl chloride..... | NE | |
| Arsenic..... | NE | |
| Barium..... | | |
| Boron..... | NE | |
| Boron (in Boral)..... | | |
| Boron (non-Boral)..... | | |
| Cadmium..... | NE | |
| Caesium..... | | |
| Selenium..... | NE | |
| Chromium..... | NE | |
| Molybdenum..... | NE | |
| Thallium..... | | |
| Tin..... | NE | |
| Vanadium..... | NE | |
| Mercury compounds..... | | |
| Others..... | NE | |
| Electronic Electrical Equipment (EEE) | | |
| EEE Type 1..... | | |
| EEE Type 2..... | | |
| EEE Type 3..... | | |
| EEE Type 4..... | | |
| EEE Type 5..... | | |

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Complexing agents (%wt): No

| | (%wt) | Type(s) and comment |
|---|---|---|
| EDTA..... | | |
| DPTA..... | | |
| NTA..... | | |
| Polycarboxylic acids……. | | |
| Other organic complexants..... | | |
| Total complexing agents..... | 0 | |

Potential for the waste to contain discrete items: Yes. Durable Steel engineered structures, hand tools

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):

| Treatment | On-site / Off site | Stream volume % |
|---|---|---|
| Low force compaction | | |
| Supercompaction (HFC) | | |
| Incineration | | |
| Solidification | On-site | 76.5 |
| Decontamination | | |
| Metal treatment | Off-site | 23.5 |
| Size reduction | | |
| Decay storage | | |
| Recyling / reuse | | |
| Other / various | | |
| None | | |

Comment on planned treatments: Bulk wastes in HHISO containers will be encapsulated at the grout plant prior to emplacement within the LLW Vault. HHISOs containing tritiated steel and other items of suitable bulk waste may undergo treatment and disposal offsite.

**Disposal Routes:**

| Disposal Route | Stream volume % | Disposal density t/m3 |
|---|---|---|
| Expected to be consigned to the LLW Repository | | |
| Expected to be consigned to a Landfill Facility | | |
| Expected to be consigned to an On-Site Disposal Facility | 76.5 | 2.0 |
| Expected to be consigned to an Incineration Facility | | |
| Expected to be consigned to a Metal Treatment Facility | 23.5 | ~1.2 |
| Expected to be consigned as Out of Scope | | |
| Expected to be recycled / reused | | |
| Disposal route not known | | |

Classification codes for waste expected to be consigned to a landfill facility: -

**Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):**

| Disposal Route | Stream volume % | | |
|---|---|---|---|
| | 2022/23 | 2023/24 | 2024/25 |
| Expected to be consigned to the LLW Repository | | | |
| Expected to be consigned to a Landfill Facility | | | |
| Expected to be consigned to an On-Site Disposal Facility | | | |
| Expected to be consigned to an Incineration Facility | | | |
| Expected to be consigned to a Metal Treatment Facility | | | |
| Expected to be consigned as Out of Scope | | | |
| Expected to be recycled / reused | | | |
| Disposal route not known | | | |

## WASTE STREAM 5B16 Bulk Operational LLW

**Opportunities for alternative disposal routing:** Yes

| Baseline Management Route | Opportunity Management Route | Stream volume (%) | Estimated Date that Opportunity will be realised | Opportunity Confidence | Comment |
|---|---|---|---|---|---|
| Metal treatment | Metal treatment | >23.53 | TBC | High | Opportunity for further identification of LLW in stores to be treated offsite instead of going for disposal. |

**Waste Packaging for Disposal:**

| Container | Stream volume % | Waste loading m³ | Number of packages |
|---|---|---|---|
| 1/3 Height IP-1 ISO<br>2/3 Height IP-2 ISO<br>1/2 Height WAMAC IP-2 ISO<br>1/2 Height IP-2 Disposal/Re-usable ISO<br>2m box (no shielding)<br>4m box (no shielding)<br>Other | 76.5 | ~10 | 238 |

Other information: This waste consists of large items of non-compactable waste. DSRL have developed a non-IP2 HHISO for use specifically at Dounreay. A small % of waste is non-containerised and may go for direct disposal in vaults pending further characterisation.

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

Container voidage: -

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

### RADIOACTIVITY

Source: This waste originates from a wide variety of activities on site including reactor operations, fuel reprocessing and general site activities. It will therefore contain a mixture of fission products and activation products.

Uncertainty: Within a factor of three.

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: The specific activities have been derived from using the summation of consignor's declarations divided by the total declared volume. Stocks decayed based on the period starting on the average date when waste was consigned.

Other information: There are no unlisted radionuclides present at significant concentrations.

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| Nuclide | Mean radioactivity, TBq/m³ Waste at 1.4.2022 | Bands and Code | Future arisings | Bands and Code | Nuclide | Mean radioactivity, TBq/m³ Waste at 1.4.2022 | Bands and Code | Future arisings | Bands and Code |
|---|---|---|---|---|---|---|---|---|---|
| H 3 | 3.62E-04 | B B 2 | | | Gd 153 | | | | |
| Be 10 | | | | | Ho 163 | | | | |
| C 14 | 1.11E-06 | B B 2 | | | Ho 166m | | | | |
| Na 22 | 8.78E-09 | B B 2 | | | Tm 170 | | | | |
| Al 26 | | | | | Tm 171 | | | | |
| Cl 36 | | | | | Lu 174 | | | | |
| Ar 39 | | | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | | | | | Hf 182 | | | | |
| Ca 41 | | | | | Pt 193 | | | | |
| Mn 53 | | | | | Tl 204 | | | | |
| Mn 54 | 2.90E-12 | B B 2 | | | Pb 205 | | | | |
| Fe 55 | 7.19E-10 | B B 2 | | | Pb 210 | | | | |
| Co 60 | 5.65E-07 | B B 2 | | | Bi 208 | | | | |
| Ni 59 | | | | | Bi 210m | | | | |
| Ni 63 | 1.08E-08 | B B 2 | | | Po 210 | 2.50E-13 | B B 2 | | |
| Zn 65 | | | | | Ra 223 | | | | |
| Se 79 | | | | | Ra 225 | | | | |
| Kr 81 | | | | | Ra 226 | 4.21E-12 | B B 2 | | |
| Kr 85 | | | | | Ra 228 | 4.99E-10 | B B 2 | | |
| Rb 87 | | | | | Ac 227 | | | | |
| Sr 90 | 1.05E-05 | B B 2 | | | Th 227 | | | | |
| Zr 93 | | | | | Th 228 | 3.67E-09 | B B 2 | | |
| Nb 91 | | | | | Th 229 | | | | |
| Nb 92 | | | | | Th 230 | 1.16E-09 | B B 2 | | |
| Nb 93m | 6.85E-09 | B B 2 | | | Th 232 | 5.77E-10 | B B 2 | | |
| Nb 94 | 3.27E-09 | B B 2 | | | Th 234 | 8.31E-08 | B B 2 | | |
| Mo 93 | 6.97E-09 | B B 2 | | | Pa 231 | | | | |
| Tc 97 | | | | | Pa 233 | | | | |
| Tc 99 | 5.97E-11 | B B 2 | | | U 232 | 3.18E-09 | B B 2 | | |
| Ru 106 | 2.61E-11 | B B 2 | | | U 233 | 8.51E-15 | B B 2 | | |
| Pd 107 | | | | | U 234 | 1.15E-05 | B B 2 | | |
| Ag 108m | | | | | U 235 | 3.35E-07 | B B 2 | | |
| Ag 110m | | | | | U 236 | 8.06E-07 | B B 2 | | |
| Cd 109 | 1.78E-12 | B B 2 | | | U 238 | 8.31E-08 | B B 2 | | |
| Cd 113m | | | | | Np 237 | 5.37E-12 | B B 2 | | |
| Sn 119m | | | | | Pu 236 | | | | |
| Sn 121m | 4.93E-11 | B B 2 | | | Pu 238 | 5.98E-07 | B B 2 | | |
| Sn 123 | | | | | Pu 239 | 9.97E-07 | B B 2 | | |
| Sn 126 | | | | | Pu 240 | 8.01E-07 | B B 2 | | |
| Sb 125 | 6.71E-09 | B B 2 | | | Pu 241 | 1.59E-05 | B B 2 | | |
| Sb 126 | | | | | Pu 242 | 6.12E-10 | B B 2 | | |
| Te 125m | | | | | Am 241 | 1.65E-06 | B B 2 | | |
| Te 127m | | | | | Am 242m | 2.33E-08 | B B 2 | | |
| I 129 | | | | | Am 243 | 2.66E-13 | B B 2 | | |
| Cs 134 | 5.59E-09 | B B 2 | | | Cm 242 | 1.92E-08 | B B 2 | | |
| Cs 135 | | | | | Cm 243 | 4.03E-09 | B B 2 | | |
| Cs 137 | 3.88E-05 | B B 2 | | | Cm 244 | 5.55E-08 | B B 2 | | |
| Ba 133 | 1E-09 | B B 2 | | | Cm 245 | | | | |
| La 137 | | | | | Cm 246 | | | | |
| La 138 | | | | | Cm 248 | | | | |
| Ce 144 | 8.67E-16 | B B 2 | | | Cf 249 | | | | |
| Pm 145 | | | | | Cf 250 | | | | |
| Pm 147 | 1.46E-07 | B B 2 | | | Cf 251 | | | | |
| Sm 147 | | | | | Cf 252 | | | | |
| Sm 151 | 3.87E-07 | B B 2 | | | Other a | | | | |
| Eu 152 | 5.60E-07 | B B 2 | | | Other b/g | 8.40E-11 | B B 2 | | |
| Eu 154 | 4.32E-07 | B B 2 | | | **Total a** | **1.68E-05** | **B B 2** | **0** | |
| Eu 155 | 4.64E-08 | B B 2 | | | **Total b/g** | **4.31E-04** | **B B 2** | **0** | |

**Bands (Upper and Lower)**

A a factor of 1.5
B a factor of 3
C a factor of 10
D a factor of 100
E a factor of 1000

Note: Bands quantify uncertainty in mean radioactivity.

**Code**

1 Measured activity
2 Derived activity (best estimate)
3 Derived activity (upper limit)
4 Not present
5 Present but not significant
6 Likely to be present but not assessed
7 Present in significant quantities but not determined
8 Not expected to be present in significant quantity