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| WASTE STREAM | 5B336 | Analytical Laboratories ILW |
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SITE Dounreay
SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Dounreay Site Restoration Limited

WASTE TYPE ILW

Is the waste subject to Scottish Policy: Yes

WASTE VOLUMES

| | | Reported |
|------------------------|---------------------------|---------------------|
| Stocks: | At 1.4.2022..... | 24.4 m ³ |
| Future arisings - | 1.4.2022 - 31.3.2023..... | 6.8 m ³ |
| | 1.4.2023 - 31.3.2024..... | 6.8 m ³ |
| | 1.4.2024 - 31.3.2025..... | 6.8 m ³ |
| | 1.4.2025 - 31.3.2026..... | 6.8 m ³ |
| | 1.4.2026 - 31.3.2027..... | 6.8 m ³ |
| | 1.4.2030 - 31.3.2031..... | 0.5 m ³ |
| | 1.4.2031 - 31.3.2032..... | 1.0 m ³ |
| Total future arisings: | | 35.5 m ³ |
| Total waste volume: | | 59.9 m ³ |

Comment on volumes: Includes both low active and high active facilities. It should be noted that the DSRL site is using a provisional LifeTime Plan (LTP). This is currently under review and future arisings dates are subject to change. Decommissioning techniques to be confirmed.

Uncertainty factors on volumes: Stock (upper): x 1.02 Arisings (upper) x 1.2
Stock (lower): x 0.98 Arisings (lower) x 0.8

WASTE SOURCE Experimental laboratories including gloveboxes and cells together with wastes produced from general plant decommissioning.

PHYSICAL CHARACTERISTICS

General description: Contaminated equipment, debris, gloves, swabs, etc. Large items will be size reduced during decommissioning.

Physical components (%vol): Glass (11.12%), Lead (4.01%), Mild Steel (69.39%), Other organics (0.17%), Paper (0.16%), Plastic (9.74%), Rubber (0.21%), Sources (0.02%), Stainless steel (1.81%), Paper / Cardboard (3.36%),

Sealed sources: The waste contains sealed sources. Solid and Liquid sources identified as waste arisings

Bulk density (t/m³): 0.23

Comment on density: Bulk Density is based on Consignor's estimates

CHEMICAL COMPOSITION

General description and components (%wt): Glass (4.33%), Lead (7.06%), Mild Steel (84.88%), Other organics (0.03%), Paper (0.02%), Plastic (1.39%), Rubber (0.05%), Sources (0.02%), Stainless steel (2.22%),

Chemical state: Neutral

Chemical form of radionuclides: H-3: May be present at low concentrations.
C-14: May be present at low concentrations.
Cl-36: Not likely to be present.
Se-79: May be present at low concentrations.
Tc-99: May be present at low concentrations.
I-129: May be present at low concentrations.
Ra: May be present at low concentrations.
Th: May be present at low concentrations.
U: Likely to be present as oxide.
Np: May be present at low concentrations.
Pu: Likely to be present as oxide.

Metals and alloys (%wt): Ferrous metals include stainless steel, though the proportions are unknown. Both sheet and bulk metals will be present, proportions not specified.

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| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|-------------------------------------|-------|-------------------------------------|-------------------------|
| Stainless steel..... | 2.2 | M316 | |
| Other ferrous metals..... | 84.9 | | |
| Iron..... | | | |
| Aluminium..... | 0 | | |
| Beryllium..... | NE | | |
| Cobalt..... | 0 | | |
| Copper..... | 0 | | |
| Lead..... | 7.1 | | |
| Magnox/Magnesium..... | 0 | | |
| Nickel..... | | | |
| Titanium..... | | | |
| Uranium..... | P | | |
| Zinc..... | 0 | | |
| Zircaloy/Zirconium..... | 0 | | |
| Other metals..... | 0.02 | sources | |
| Organics (%wt): | - | | |
| | (%wt) | Type(s) and comment | % of total C14 activity |
| Total cellulose..... | 0.02 | | |
| Paper, cotton..... | 0.02 | | |
| Wood..... | 0 | | |
| Halogenated plastics | 0 | | |
| Total non-halogenated plastics..... | 1.4 | | |
| Condensation polymers..... | NE | | |
| Others..... | 1.4 | | |
| Organic ion exchange materials.... | 0 | | |
| Total rubber..... | 0.05 | | |
| Halogenated rubber | NE | | |
| Non-halogenated rubber..... | 0.05 | | |
| Hydrocarbons..... | | | |
| Oil or grease | | | |
| Fuel..... | | | |
| Asphalt/Tarmac (cont.coal tar)... | | | |
| Asphalt/Tarmac (no coal tar).... | | | |
| Bitumen..... | | | |
| Others..... | | | |
| Other organics..... | 0.03 | Filters | |
| 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 | | | |
| Brick/Stone/Rubble..... | 0 | | | |
| Cementitious material..... | 0 | | | |
| Sand..... | 0 | | | |
| Glass/Ceramics..... | 4.3 | | | |
| Graphite..... | 0 | | | |
| Desiccants/Catalysts..... | 0 | | | |
| Asbestos..... | 0 | | | |
| Non/low friable..... | | | | |
| Moderately friable..... | | | | |
| Highly friable..... | | | | |
| Free aqueous liquids..... | 0 | | | |
| Free non-aqueous liquids..... | 0 | | | |
| Powder/Ash..... | 0 | | | |

Inorganic anions (%wt): Inorganic anions may be present in trace quantities.

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

Materials of interest for waste acceptance criteria: Nitric acid swabs may be present in trace quantities, having been used for spillages.

| | (%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 | |

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

Hazardous substances / non hazardous pollutants: Mercury may be present at trace levels.

| | (%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..... | P | |
| 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 engineered steel structures & contaminated tools. Potential for grouted containers within external package.

PACKAGING AND CONDITIONING

Conditioning method: RHILW will be packaged into 500l drums for long term storage. CHILW will be supercompacted with the pucks being encapsulated into 500L drums.

Plant Name: RHILW and CHILW Repackaging Facilities

Location: Dounreay

Plant startup date: 2026 & 2028

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: 2026

Throughput for this stream (m³/y incoming waste): 7.0

Other information: CHILW and RHILW Repacking plant are in design phase. Assume throughputs unconstrained.

| Likely container type: | Container | Waste packaged (%vol) | Waste loading (m ³) | Payload (m ³) | Number of packages |
|------------------------|------------|-----------------------|---------------------------------|---------------------------|--------------------|
| | 500 l drum | 100.0 | 0.488 | 0.5 | 123 |

Likely container type comment: The conditioning factor for RHILW will be about 1.7 while that for CHILW is about 0.5.

Range in container waste volume: It is estimated that between 2 and 8 CHILW pucks will be placed into each 500l drum with the average being 5 drums per 500L drum. A small percentage of drums may not be suitable for supercompaction and will be directly immobilised into the 500l drum. Assume 3:2 Z6033 to 500L drum ratio.

Other information on containers: Waste Loading is a calculated value as stocks use primary container's Payload volume as their loading volume whereas arisings use a packing fraction to reduce the loading volume.

Likely conditioning matrix: Cement

Other information: -

Conditioned density (t/m³): ~2.5

Conditioned density comment: The density is likely to be around 2-3 te/m³

Other information on conditioning: -

Opportunities for alternative disposal routing: No

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| Baseline Management Route | Opportunity Management Route | Stream volume (%) | Estimated Date that Opportunity will be realised | Opportunity Confidence | Comment |
|---------------------------|------------------------------|-------------------|--|------------------------|---------|
| - | - | - | - | - | - |

RADIOACTIVITY

| | |
|---|---|
| Source: | The main sources of activity are contaminated equipment/structures. |
| Uncertainty: | Stocks Specific Activities is based on LoC data for all ILW in stocks. This will be an amalgamation of several facilities. Arisings data is an extrapolation of a specific activity based on consignors data. There is a reasonable dataset for consignors records. |
| 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: | Stocks is based on LoC data for ILW in stocks. Arisings is based on consignors data for labs. |
| Other information: | Specific activities are from 2019 UKRWI decayed to 2022 |

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| Nuclide | Mean radioactivity, TBq/m ³ | | | | Nuclide | Mean radioactivity, TBq/m ³ | | | |
|---------|--|----------------|-----------------|----------------|------------------|--|----------------|-----------------|----------------|
| | Waste at 1.4.2022 | Bands and Code | Future arisings | Bands and Code | | Waste at 1.4.2022 | Bands and Code | Future arisings | Bands and Code |
| H 3 | | CC 2 | | | Gd 153 | | | | |
| Be 10 | 1.28E-07 | CC 2 | | | Ho 163 | | | | |
| C 14 | 2.39E-03 | CC 2 | | | Ho 166m | | | | |
| Na 22 | | | | | Tm 170 | | | | |
| Al 26 | | | | | Tm 171 | | | | |
| Cl 36 | | | | | Lu 174 | | | | |
| Ar 39 | | | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | | | | | Hf 182 | | | | |
| Ca 41 | 3.35E-06 | CC 2 | | | Pt 193 | | | | |
| Mn 53 | 2.04E-03 | CC 2 | | | Tl 204 | | | | |
| Mn 54 | 1.77E-08 | CC 2 | | | Pb 205 | | | | |
| Fe 55 | 4.44E-02 | CC 2 | | | Pb 210 | 1.94E-11 | CC 2 | 2.74E-10 | CC 2 |
| Co 60 | 2.79E+00 | CC 2 | 3.71E-07 | CC 2 | Bi 208 | | | | |
| Ni 59 | 7.95E-03 | CC 2 | | | Bi 210m | | | | |
| Ni 63 | 2.15E+00 | CC 2 | 1.88E-07 | CC 2 | Po 210 | 1.79E-11 | CC 2 | 2.29E-10 | CC 2 |
| Zn 65 | 3.45E-13 | CC 2 | | | Ra 223 | 8.91E-10 | CC 2 | 1.1E-16 | CC 2 |
| Se 79 | 4.30E-06 | CC 2 | | | Ra 225 | 7.21E-10 | CC 2 | 1.35E-18 | CC 2 |
| Kr 81 | | | | | Ra 226 | 1.08E-10 | CC 2 | 3.07E-09 | CC 2 |
| Kr 85 | | | | | Ra 228 | 7.54E-10 | CC 2 | 2.64E-20 | CC 2 |
| Rb 87 | | | | | Ac 227 | 8.99E-10 | CC 2 | 1.24E-16 | CC 2 |
| Sr 90 | 2.74E-01 | CC 2 | 3.03E-04 | | Th 227 | 8.82E-10 | CC 2 | 1.14E-16 | CC 2 |
| Zr 93 | 3.93E-05 | CC 2 | | | Th 228 | 1.37E-07 | CC 2 | 5.94E-21 | CC 2 |
| Nb 91 | | | | | Th 229 | 7.24E-10 | CC 2 | 1.43E-18 | CC 2 |
| Nb 92 | | | | | Th 230 | 2.75E-08 | CC 2 | 1.83E-12 | CC 2 |
| Nb 93m | 1.02E-02 | CC 2 | 1.45E-05 | CC 2 | Th 232 | 9.25E-10 | CC 2 | 2.39E-19 | CC 2 |
| Nb 94 | 7.40E-04 | CC 2 | | | Th 234 | 5.85E-06 | CC 2 | 8.79E-15 | CC 2 |
| Mo 93 | 4.42E-03 | CC 2 | 1.47E-05 | CC 2 | Pa 231 | 3.17E-09 | CC 2 | 3.99E-15 | CC 2 |
| Tc 97 | | | | | Pa 233 | 1.51E-06 | CC 2 | 2.33E-09 | CC 2 |
| Tc 99 | 2.12E-04 | CC 2 | 1.44E-07 | CC 2 | U 232 | 1.32E-07 | CC 2 | | |
| Ru 106 | 2.03E-06 | CC 2 | | | U 233 | 4.25E-07 | CC 2 | 1.53E-14 | CC 2 |
| Pd 107 | | | | | U 234 | 1.76E-04 | CC 2 | 1.32E-07 | CC 2 |
| Ag 108m | 3.44E-05 | CC 2 | | | U 235 | 7.75E-06 | CC 2 | 1.26E-10 | CC 2 |
| Ag 110m | 1.17E-12 | CC 2 | | | U 236 | 8.94E-06 | CC 2 | 3.23E-09 | CC 2 |
| Cd 109 | | | | | U 238 | 5.85E-06 | CC 2 | 9.08E-15 | CC 2 |
| Cd 113m | 3.55E-04 | CC 2 | | | Np 237 | 1.51E-06 | CC 2 | 2.42E-09 | CC 2 |
| Sn 119m | | | | | Pu 236 | | | | |
| Sn 121m | | | 1.39E-07 | CC 2 | Pu 238 | 3.12E-02 | CC 2 | 1.54E-02 | CC 2 |
| Sn 123 | | | | | Pu 239 | 1.10E-01 | CC 2 | 4.26E-02 | CC 2 |
| Sn 126 | 7.74E-06 | CC 2 | | | Pu 240 | 1.10E-01 | CC 2 | 3.68E-02 | CC 2 |
| Sb 125 | 3.80E-04 | CC 2 | | | Pu 241 | 1.94E+00 | CC 2 | 7.41E-02 | CC 2 |
| Sb 126 | 1.08E-06 | CC 2 | | | Pu 242 | 9.59E-05 | CC 2 | 1.95E-05 | CC 2 |
| Te 125m | 9.51E-05 | CC 2 | | | Am 241 | 1.75E-01 | CC 2 | 2.55E-03 | CC 2 |
| Te 127m | | | | | Am 242m | 1.38E-02 | CC 2 | | |
| I 129 | 3.63E-07 | CC 2 | | | Am 243 | 1.33E-04 | CC 2 | 4.39E-10 | CC 2 |
| Cs 134 | 2.04E-04 | CC 2 | | | Cm 242 | 1.14E-02 | CC 2 | 1.03E-08 | CC 2 |
| Cs 135 | 6.77E-06 | CC 2 | | | Cm 243 | 7.21E-04 | CC 2 | 6.82E-10 | CC 2 |
| Cs 137 | 7.93E-01 | CC 2 | 8.20E-04 | CC 2 | Cm 244 | 5.92E-02 | CC 2 | 4.79E-05 | CC 2 |
| Ba 133 | | | | | Cm 245 | 1.85E-06 | CC 2 | | |
| La 137 | | | | | Cm 246 | 1.85E-07 | CC 2 | | |
| La 138 | | | | | Cm 248 | | | | |
| Ce 144 | 1.17E-09 | CC 2 | | | Cf 249 | | | | |
| Pm 145 | | | | | Cf 250 | | | | |
| Pm 147 | 2.94E-03 | CC 2 | 2.17E-08 | CC 2 | Cf 251 | | | | |
| Sm 147 | 3.79E-12 | CC 2 | 6.50E-19 | CC 2 | Cf 252 | | | | |
| Sm 151 | 2.94E-02 | CC 2 | 2.38E-06 | CC 2 | Other a | | | 9.20E-09 | CC 2 |
| Eu 152 | 2.22E-02 | CC 2 | | | Other b/g | 8.15E-07 | CC 2 | 2.21E-02 | CC 2 |
| Eu 154 | 1.10E-02 | CC 2 | 7.52E-08 | CC 2 | Total a | 4.98E-01 | CC 2 | 9.74E-02 | CC 2 |
| Eu 155 | 5.7E-03 | CC 2 | 3.10E-08 | CC 2 | Total b/g | 8.13E+00 | CC 2 | 9.74E-02 | CC 2 |

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