## WASTE STREAM 2D09.1 MSSS Compartment 7

| | |
|---|---|
| **SITE** | Sellafield |
| **SITE OWNER** | Nuclear Decommissioning Authority |
| **WASTE CUSTODIAN** | Sellafield Limited |
| **WASTE TYPE** | ILW |
| Is the waste subject to Scottish Policy: | No |

**WASTE VOLUMES**

| | | Reported |
|---|---|---|
| Stocks: | At 1.4.2022..... | ~598.0 m³ |
| Total future arisings: | | 0 m³ |
| Total waste volume: | | 598.0 m³ |

Comment on volumes: There are no future arisings to this stream. Waste volume includes swarf/sludge, miscellaneous beta/gamma waste, aggregate and associated water.

| Uncertainty factors on volumes: | | | | |
|---|---|---|---|---|
| | Stock (upper): | x 1.5 | Arisings (upper) | x |
| | Stock (lower): | x 0.66 | Arisings (lower) | x |

**WASTE SOURCE** Swarf from Magnox decanning; some miscellaneous beta/gamma, mainly from Windscale, some from other sites.

### PHYSICAL CHARACTERISTICS

| | |
|---|---|
| General description: | Magnox cladding, much of which has been converted to a magnesium hydroxide sludge. Some miscellaneous beta/gamma wastes (MBGW) are also present: these include tins/cans, filters, tools, pipework, pumps, valves, plastic items. The waste also includes some uranium most of which has corroded to oxides of uranium. A small volume of limestone aggregate is present at the bottom of the compartment. Swarf from Magnox decanning has reacted with the storage cover water to form corrosion products. Some degradation of miscellaneous components waste will have occurred. |
| Physical components (%wt): | Magnox swarf (8.89%), Magnox sludge (38.89%), Al/Al(OH)3 (0.49%), U/UO2/U3O8 (5.10%), MBGW (scrap, filters, cans, etc.) (5.54%), aggregate (limestone) (1.37%), water (39.2%), others (0.55%). Includes interstitial liquor and cover liquor. |
| Sealed sources: | Not yet determined. |
| Bulk density (t/m³): | ~1.48 |
| Comment on density: | Bulk density is solids only - includes water content based on assumptions of draining characteristics. Bulk density including interstitial liquor = 1.53t/m³, bulk density with cover liquor and interstitial liquor = 1.52t/m³. Average decanning debris is ~1.6t/m³ and average MBGW is ~3.2t/m³. |

### CHEMICAL COMPOSITION

| | |
|---|---|
| General description and components (%wt): | Magnox swarf (8.89%), Magnox sludge (38.89%), Al/Al(OH)3 (0.49%), U/UO2/U3O8 (5.10%), MBGW (scrap, filters, cans, etc.) (5.54%), aggregate (limestone) (1.37%), water (39.2%), others (0.55%). Includes interstitial liquor and cover liquor. |
| Chemical state: | Neutral |
| Chemical form of radionuclides: | H-3: Present in elemental and reacted forms.<br>C-14: Present in elemental and reacted forms.<br>Cl-36: Present in elemental and reacted forms.<br>Se-79: Present in elemental and reacted forms.<br>Tc-99: Present in elemental and reacted forms.<br>I-129: Present in elemental and reacted forms.<br>Ra: Ra isotopes are present in less than trace amounts in fuel.<br>Th: Present in elemental and reacted forms.<br>U: Present in metallic and reacted forms (oxides and possibly hydride).<br>Np: Present in elemental and reacted forms.<br>Pu: Present in metallic and mixed oxide forms. |
| Metals and alloys (%wt): | No significant quantities of sheet metal, although small quantities of fabricated items are present, e.g. paint tins, HEPA filters. Small pieces of Magnox metal present. |

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| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---|---|---|---|
| Stainless steel | ~1.2 | | |
| Other ferrous metals | ~5.2 | | |
| Iron | P | | |
| Aluminium | ~0.49 | | |
| Beryllium | NE | | |
| Cobalt | P | | |
| Copper | TR | | |
| Lead | TR | | |
| Magnox/Magnesium | ~9.0 | Predominantly Magnox. | |
| Nickel | TR | | |
| Titanium | NE | | |
| Uranium | ~2.1 | | |
| Zinc | TR | | |
| Zircaloy/Zirconium | ~0.04 | | |
| Other metals | ~0.06 | | |

Organics (%wt): The organic content of the waste is low.

| | (%wt) | Type(s) and comment | % of total C14 activity |
|---|---|---|---|
| Total cellulosics | ~0.18 | | |
| Paper, cotton | | | |
| Wood | | | |
| Halogenated plastics | ~0.08 | | |
| Total non-halogenated plastics | ~0.05 | | |
| Condensation polymers | | | |
| Others | | | |
| Organic ion exchange materials | NE | | |
| Total rubber | NE | | |
| Halogenated rubber | | | |
| Non-halogenated rubber | | | |
| Hydrocarbons | | | |
| Oil or grease | <0.01 | | |
| Fuel | NE | | |
| Asphalt/Tarmac (cont.coal tar) | NE | | |
| Asphalt/Tarmac (no coal tar) | NE | | |
| Bitumen | NE | | |
| Others | NE | | |
| Other organics | <0.01 | | |

Other materials (%wt): -

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| | (%wt) | Type(s) and comment | % of total C14 activity |
|---|---|---|---|
| Inorganic ion exchange materials.. | NE | | |
| Inorganic sludges and flocs..... | ~40.1 | | |
| Soil..... | NE | | |
| Brick/Stone/Rubble..... | ~1.3 | | |
| Cementitious material..... | NE | | |
| Sand..... | NE | | |
| Glass/Ceramics..... | ~0.39 | | |
| Graphite..... | ~0.85 | | |
| Desiccants/Catalysts..... | NE | | |
| Asbestos..... | NE | | |
| Non/low friable..... | | | |
| Moderately friable..... | | | |
| Highly friable..... | | | |
| Free aqueous liquids..... | ~37.6 | Includes interstitial liquor and cover liquor. Total waste volume 603 m3 with cover liquor. | |
| Free non-aqueous liquids..... | NE | | |
| Powder/Ash..... | NE | | |

Inorganic anions (%wt): Hydroxides and carbonates are present.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Fluoride..... | TR | |
| Chloride..... | TR | Alkali metal and alkaline earth chlorides. |
| Iodide..... | TR | |
| Cyanide..... | NE | |
| Carbonate..... | ~0.04 | |
| Nitrate..... | TR | |
| Nitrite..... | TR | |
| Phosphate..... | TR | |
| Sulphate..... | TR | |
| Sulphide..... | TR | |

Materials of interest for waste acceptance criteria: Waste contains uranium, Magnox and traces of uranium hydride. Cellulosics are present as putrescible waste.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Combustible metals..... | P | |
| Low flash point liquids..... | 0 | |
| Explosive materials..... | 0 | |
| Phosphorus..... | 0 | |
| Hydrides..... | P | Trace, passivated. |
| Biological etc. materials..... | 0 | |
| Biodegradable materials..... | P | |
| Putrescible wastes..... | P | Celluosics. |

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| | | |
|---|---|---|
| Non-putrescible wastes..... | P | Organics - plastics and rubbers. |
| Corrosive materials..... | 0 | |
| Pyrophoric materials..... | 0 | |
| Generating toxic gases..... | 0 | |
| Reacting with water..... | P | <5%. |
| Higher activity particles..... | P | Radioactive sludges and solids. |
| Soluble solids as bulk chemical compounds..... | P | Elemental and hydroxides, oxides and carbonates. |

Hazardous substances / non hazardous pollutants: -

| | (%wt) | Type(s) and comment |
|---|---|---|
| Acrylamide..... | | |
| Benzene..... | 0 | |
| Chlorinated solvents..... | | |
| Formaldehyde..... | | |
| Organometallics..... | | |
| Phenol..... | 0 | |
| Styrene..... | | |
| Tri-butyl phosphate..... | 0 | |
| Other organophosphates..... | | |
| Vinyl chloride..... | 0 | |
| Arsenic..... | 0 | |
| Barium..... | | |
| Boron..... | NE | Traces - elemental and borates. |
| Boron (in Boral)..... | | |
| Boron (non-Boral)..... | | |
| Cadmium..... | 0 | |
| Caesium..... | | |
| Selenium..... | 0 | |
| Chromium..... | P | In steels. |
| Molybdenum..... | P | In steels. |
| Thallium..... | | |
| Tin..... | P | Traces. |
| Vanadium..... | P | In steels. |
| 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): Not yet determined

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

Potential for the waste to contain discrete items: Not yet determined.

### PACKAGING AND CONDITIONING

Conditioning method: The waste will be retrieved from MSSS and stored in an unconditioned state for a period of 70 years. Following the period of storage it will be retrieved (from storage) and conditioned for ultimate disposal to the GDF.

Plant Name: TBD

Location: Sellafield

Plant startup date: 2070-2090

Total capacity ($m^3$/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream ($m^3$/y incoming waste): -

Other information: The plant has not yet been designed. Hence, throughputs & capacities cannot be quoted at this time.

Likely container type:

| Container | Waste packaged (%vol) | Waste loading ($m^3$) | Payload ($m^3$) | Number of packages |
|---|---|---|---|---|
| Sellafield enhanced 3$m^3$ box | 100.0 | 0.699 | 2.15 | 855 |

Likely container type comment: 1 skip of retrieved waste (max 1,400 litres) in = 1 package out.

Range in container waste volume: There will be considerable variability in unconditioned waste volume per package due to variations in skip loading and content. The actual number of packages produced is identified in the Sellafield Decommissioning Product and Secondary Waste Plan.855 Boxes = 815 Boxes plus 40 from residuals.

Other information on containers: Stainless Steel.

Likely conditioning matrix: BFS/OPC;PFA/OPC

Other information: -

Conditioned density ($t/m^3$): ~2.0

Conditioned density comment: Density of conditioned waste will be fairly uniform.

Other information on conditioning: Waste matrix (as retrieved) will be in-filled with grout. A second pour of capping grout will be added. Void spaces between Skip wall and Box wall will be filled with grout.

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: | Irradiated fuel, fuel components, reactor components and miscellaneous items contaminated with fuel residues. |
| Uncertainty: | Accuracy is generally good for fuel based residues, based on decanning records arisings and fuel carry over evaluations. For miscellaneous waste items, where records are incomplete, the accuracy is worse. |
| Definition of total alpha and total beta/gamma: | FISPIN generates data for approximately 2500 radionuclides. Only a proportion of these are considered in the UK inventory for this waste stream. |
| Measurement of radioactivities: | Isotopic specific activity (TBq/m$^3$) is derived by dividing the estimated total activity of the isotope by the total volume of the waste. |
| Other information: | Short-lived daughters are included in the "other" beta/gamma activity. |

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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 | 2.03E-01 | A B 2 | | | Gd 153 | 4.32E-22 | A A 2 | | |
| Be 10 | 3.47E-07 | A A 2 | | | Ho 163 | 2.33E-11 | A A 2 | | |
| C 14 | 3.01E-02 | A B 2 | | | Ho 166m | 1.72E-07 | A A 2 | | |
| Na 22 | | | | | Tm 170 | 1.43E-40 | A A 2 | | |
| Al 26 | | | | | Tm 171 | 3.09E-11 | A A 2 | | |
| Cl 36 | 2.43E-07 | A B 2 | | | Lu 174 | | | | |
| Ar 39 | 1.27E-05 | A B 2 | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | 1.37E-08 | A B 2 | | | Hf 182 | 4.50E-16 | A A 2 | | |
| Ca 41 | 1.52E-04 | A B 2 | | | Pt 193 | | | | |
| Mn 53 | 3.66E-11 | A B 2 | | | Tl 204 | 2.26E-06 | A A 2 | | |
| Mn 54 | | | | | Pb 205 | | | | |
| Fe 55 | 6.03E-04 | A A 2 | | | Pb 210 | 1.28E-09 | A A 2 | | |
| Co 60 | 1.34E-01 | A A 2 | | | Bi 208 | | | | |
| Ni 59 | 4.77E-02 | A A 2 | | | Bi 210m | 4.03E-23 | A A 2 | | |
| Ni 63 | 4.42E+00 | A A 2 | | | Po 210 | 1.25E-09 | A A 2 | | |
| Zn 65 | | | | | Ra 223 | 3.84E-08 | A A 2 | | |
| Se 79 | 2.11E-05 | A A 2 | | | Ra 225 | 3.70E-11 | A A 2 | | |
| Kr 81 | | | | | Ra 226 | 3.61E-09 | A A 2 | | |
| Kr 85 | 2.11E-01 | A A 2 | | | Ra 228 | | | | |
| Rb 87 | 3.10E-11 | A A 2 | | | Ac 227 | 1.51E-08 | A A 2 | | |
| Sr 90 | 9.41E+00 | A A 2 | | | Th 227 | 1.49E-08 | A A 2 | | |
| Zr 93 | 6.58E-04 | A A 2 | | | Th 228 | 6.29E-07 | A A 2 | | |
| Nb 91 | | | | | Th 229 | 3.72E-11 | A A 2 | | |
| Nb 92 | 2.69E-15 | A A 2 | | | Th 230 | 3.51E-07 | A A 2 | | |
| Nb 93m | 6.27E-04 | A A 2 | | | Th 232 | 1.11E-12 | A A 2 | | |
| Nb 94 | 9.39E-05 | A A 2 | | | Th 234 | 9.08E-04 | A A 2 | | |
| Mo 93 | 8.08E-05 | A A 2 | | | Pa 231 | 2.85E-08 | A A 2 | | |
| Tc 97 | | | | | Pa 233 | 4.12E-05 | A A 2 | | |
| Tc 99 | 5.31E-03 | A B 2 | | | U 232 | 6.11E-07 | A A 2 | | |
| Ru 106 | 5.97E-11 | A A 2 | | | U 233 | 1.09E-08 | A A 2 | | |
| Pd 107 | 3.75E-05 | A A 2 | | | U 234 | 8.12E-04 | A A 2 | | |
| Ag 108m | 5.76E-09 | A A 2 | | | U 235 | 2.36E-05 | A A 2 | | |
| Ag 110m | 2.35E-19 | A A 2 | | | U 236 | 8.70E-05 | A A 2 | | |
| Cd 109 | 2.97E-16 | A A 2 | | | U 238 | 9.08E-04 | A A 2 | | |
| Cd 113m | 5.18E-05 | A A 2 | | | Np 237 | 4.12E-05 | A A 2 | | |
| Sn 119m | | | | | Pu 236 | 2.98E-10 | A A 2 | | |
| Sn 121m | 4.77E-07 | A A 2 | | | Pu 238 | 1.01E-01 | A A 2 | | |
| Sn 123 | | | | | Pu 239 | 3.83E-01 | A A 2 | | |
| Sn 126 | 2.79E-04 | A A 2 | | | Pu 240 | 3.86E-01 | A A 2 | | |
| Sb 125 | 9.10E-05 | A A 2 | | | Pu 241 | 4.58E+00 | A A 2 | | |
| Sb 126 | 3.89E-05 | A A 2 | | | Pu 242 | 1.99E-04 | A A 2 | | |
| Te 125m | 2.22E-05 | A A 2 | | | Am 241 | 1.08E+00 | A A 2 | | |
| Te 127m | | | | | Am 242m | 1.43E-03 | A A 2 | | |
| I 129 | 1.16E-05 | A B 2 | | | Am 243 | 3.81E-04 | A A 2 | | |
| Cs 134 | 7.64E-06 | A A 2 | | | Cm 242 | 1.18E-03 | A A 2 | | |
| Cs 135 | 2.92E-04 | A A 2 | | | Cm 243 | 1.51E-04 | A A 2 | | |
| Cs 137 | 1.38E+01 | A B 2 | | | Cm 244 | 1.74E-03 | A A 2 | | |
| Ba 133 | 3.22E-07 | A A 2 | | | Cm 245 | 2.24E-07 | A A 2 | | |
| La 137 | | | | | Cm 246 | 1.91E-08 | A A 2 | | |
| La 138 | 3.31E-14 | A A 2 | | | Cm 248 | | | | |
| Ce 144 | 3.86E-14 | A A 2 | | | Cf 249 | 8.23E-14 | A A 2 | | |
| Pm 145 | | | | | Cf 250 | 4.66E-14 | A A 2 | | |
| Pm 147 | 1.16E-03 | A A 2 | | | Cf 251 | 1.97E-15 | A A 2 | | |
| Sm 147 | | | | | Cf 252 | 2.39E-18 | A A 2 | | |
| Sm 151 | 1.33E-01 | A A 2 | | | Other a | 3.85E-01 | | | |
| Eu 152 | 5.76E-04 | A A 2 | | | Other b/g | 2.25E+01 | | | |
| Eu 154 | 2.63E-02 | A A 2 | | | **Total a** | **2.34E+00** | **A B 2** | **0** | |
| Eu 155 | 2.01E-03 | A A 2 | | | **Total b/g** | **5.55E+01** | **A 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