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| WASTE STREAM | 2D25 | MSSS - Compartment 15 |
|---------------------|-------------|------------------------------|

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..... | 389.0 m ³ |
| Total future arisings: | | 0 m ³ |
| Total waste volume: | | 389.0 m ³ |

Comment on volumes: There are no future arisings. Bulk and absolute volumes of tipped MBGW uncertain. Bulk volume expected to be modified as more information becomes available during retrieval operations.

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

WASTE SOURCE MBGW waste from general site operations and other off-site establishments.

PHYSICAL CHARACTERISTICS

General description: The waste is a very wide variety of items; loose, containerised, whole, broken and compacted. It includes a wide variety of materials; metals, graphite, organics and inorganics. It also includes a small amount of Magnox items, and a very small amount of fissile material. The sources of the waste include redundant and broken, contaminated equipment from reprocessing and other site operations, and contaminated and activated reactor parts from various sites. The waste stream is stored under water, and includes some corrosion products, including a small amount of Magnox and sludge. A small amount of limestone aggregate is present at the bottom of the compartment. Items are of a very wide size range, but generally less than 2 metres long. MBGW waste and packaging expected to degrade in storage.

Physical components (%vol): Magnox swarf (0%), Magnox sludge (0%), Al/Al(OH)3 (2.05%), U/UO2/U3O8 (0%), MBGW (scrap, filters, cans, etc.) (72.83%), aggregate (limestone) (1.44%), water (23.68%), others (0%). Includes interstitial liquor and cover liquor, total waste volume including cover liquor is 426 m³.

Sealed sources: Not yet determined.

Bulk density (t/m³): 1.72

Comment on density: Bulk density is solids only - includes water content based on assumptions of draining characteristics. Bulk density including interstitial liquor = 2.15t/m³, bulk density with cover liquor and interstitial liquor = 2.04t/m³. Average decanning debris is ~1.6t/m³ and average MBGW is ~3.2t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Magnox swarf (0%), Magnox sludge (0%), Al/Al(OH)3 (2.05%), U/UO2/U3O8 (0%), MBGW (scrap, filters, cans, etc.) (72.83%), aggregate (limestone) (1.44%), water (23.68%), others (0%). Includes interstitial liquor and cover liquor, total waste volume including cover liquor is 426 m³.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Present in elemental and reacted forms.
C-14: Present in elemental and reacted forms.
Cl-36: Present in elemental and reacted forms.
Se-79: Present in elemental and reacted forms.
Tc-99: Present in elemental and reacted forms.
I-129: Present in elemental and reacted forms.
Ra: Present in elemental forms.
Th: Present in elemental and reacted forms.
U: Present in metallic and reacted forms (oxides and possibly hydride).
Np: Present in elemental and reacted forms.
Pu: Present in metallic and mixed oxide forms.

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Metals and alloys (%wt): Sheet metal (incl. uncrushed tins) 35%v/v; average thickness 4mm. Bulky metal items 23% v/v; average size 160mm dia x 400mm, average volume 20 l. Small items of metal (unknown dimensions) 42%v/v.

| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---------------------------|-------|-------------------------------------|-------------------------|
| Stainless steel..... | ~27.2 | Mainly SS316 and SS304. | |
| Other ferrous metals..... | ~24.8 | Carbon steels. | |
| Iron..... | P | | |
| Aluminium..... | ~2.1 | | |
| Beryllium..... | NE | | |
| Cobalt..... | P | | |
| Copper..... | P | | |
| Lead..... | P | | |
| Magnox/Magnesium..... | ~0.02 | | |
| Nickel..... | NE | | |
| Titanium..... | NE | | |
| Uranium..... | ~0.02 | | |
| Zinc..... | NE | | |
| Zircaloy/Zirconium..... | 0 | | |
| Other metals..... | 0 | | |

Organics (%wt): -

| | (%wt) | Type(s) and comment | % of total C14 activity |
|-------------------------------------|-------|---------------------|-------------------------|
| Total cellulosics..... | ~1.5 | | |
| Paper, cotton..... | | | |
| Wood..... | | | |
| Halogenated plastics | ~1.5 | | |
| Total non-halogenated plastics..... | ~0.47 | | |
| Condensation polymers..... | | | |
| Others..... | | | |
| Organic ion exchange materials.... | NE | | |
| Total rubber..... | NE | | |
| Halogenated rubber | | | |
| Non-halogenated rubber..... | | | |
| Hydrocarbons..... | | | |
| Oil or grease | ~0.05 | | |
| Fuel..... | NE | | |
| Asphalt/Tarmac (cont.coal tar)... | NE | | |
| Asphalt/Tarmac (no coal tar).... | NE | | |
| Bitumen..... | NE | | |
| Others..... | NE | | |
| Other organics..... | ~0.18 | | |

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..... | 0 | | |
| Soil..... | NE | | |
| Brick/Stone/Rubble..... | ~1.4 | | |
| Cementitious material..... | TR | | |
| Sand..... | NE | | |
| Glass/Ceramics..... | 0 | | |
| Graphite..... | ~6.8 | | |
| Desiccants/Catalysts..... | NE | | |
| Asbestos..... | NE | | |
| Non/low friable..... | | | |
| Moderately friable..... | | | |
| Highly friable..... | | | |
| Free aqueous liquids..... | ~23.7 | Includes interstitial liquor and cover liquor. Total waste volume including cover liquor is 426 m3. | |
| Free non-aqueous liquids..... | NE | | |
| Powder/Ash..... | NE | | |

Inorganic anions (%wt): The inorganic anion content is low; traces may be present.

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

Materials of interest for waste acceptance criteria: The waste includes a small proportion of magnesium and uranium. Putrescible wastes include paper filter and cleaning media, including fissile material.

| | (%wt) | Type(s) and comment |
|--------------------------------|-------|-----------------------|
| Combustible metals..... | 0 | |
| Low flash point liquids..... | 0 | |
| Explosive materials..... | 0 | |
| Phosphorus..... | 0 | |
| Hydrides..... | 0 | Trace UH3 passivated. |
| Biological etc. materials..... | 0 | |
| Biodegradable materials..... | P | <4%. |
| Putrescible wastes..... | P | <2%. |

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| Non-putrescible wastes..... | P | <2%. |
| Corrosive materials..... | 0 | |
| Pyrophoric materials..... | 0 | |
| Generating toxic gases..... | 0 | |
| Reacting with water..... | P | <2%. |
| Higher activity particles..... | P | |
| Soluble solids as bulk chemical compounds..... | P | Hydroxides, chlorides and carbonates. |

Hazardous substances /
non hazardous pollutants:

Uranium, a small number of lead cylinders, sheets, boxes and bricks are present. Cleaning materials', and mechanical devices which may contain oil / grease are also present. A few records contain references to substances such as acidified uranyl nitrate solution absorbed in Vermiculite, oil absorbent material, and 'soluble' bags.

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

(%wt) Type(s) and comment

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids.....

Other organic complexants.....

Total complexing agents..... NE

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 (m³/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m³/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 3m ³ box | 100.0 | 0.5 | 2.15 | 778 |

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. 778 Boxes = 675 Boxes plus 103 from residuals.

Other information on containers: Stainless Steel.

Likely conditioning matrix: BFS/OPC;PFA/OPC

Other information: -

Conditioned density (t/m³): ~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: | The activity mainly arises from activation products of irradiated metals (i.e. Co-60) and partly from contamination with fission products etc. from other processes. |
| Uncertainty: | Best available data have been used. However, accuracy is not good for this waste type. |
| 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: | Calculation, based on available data. |
| Other information: | Short-lived daughters are included in the "other" beta/gamma activity. |

WASTE STREAM

2D25

MSSS - Compartment 15

| 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 | 3.77E+00 | BB 2 | | | Gd 153 | 5.09E-21 | BB 2 | | |
| Be 10 | 1.70E-07 | BB 2 | | | Ho 163 | 2.25E-13 | BB 2 | | |
| C 14 | 3.48E-01 | BB 2 | | | Ho 166m | 6.84E-09 | BB 2 | | |
| Na 22 | | | | | Tm 170 | 8.98E-38 | BB 2 | | |
| Al 26 | | | | | Tm 171 | 6.01E-12 | BB 2 | | |
| Cl 36 | 5.76E-06 | BB 2 | | | Lu 174 | | | | |
| Ar 39 | 9.01E-04 | BB 2 | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | 5.08E-09 | BB 2 | | | Hf 182 | 6.85E-18 | BB 2 | | |
| Ca 41 | 7.30E-05 | BB 2 | | | Pt 193 | | | | |
| Mn 53 | 2.78E-09 | BB 2 | | | Tl 204 | 3.77E-04 | BB 2 | | |
| Mn 54 | | | | | Pb 205 | 1.86E-10 | BB 2 | | |
| Fe 55 | 2.34E-01 | BB 2 | | | Pb 210 | 3.13E-12 | BB 2 | | |
| Co 60 | 7.75E+00 | BB 2 | | | Bi 208 | | | | |
| Ni 59 | 1.46E+00 | BB 2 | | | Bi 210m | 1.28E-14 | BB 2 | | |
| Ni 63 | 1.46E+02 | BB 2 | | | Po 210 | 3.02E-12 | BB 2 | | |
| Zn 65 | | | | | Ra 223 | 2.10E-10 | BB 2 | | |
| Se 79 | 2.56E-07 | BB 2 | | | Ra 225 | 8.23E-12 | BB 2 | | |
| Kr 81 | | | | | Ra 226 | 1.00E-11 | BB 2 | | |
| Kr 85 | 4.42E-03 | BB 2 | | | Ra 228 | | | | |
| Rb 87 | 1.23E-09 | BB 2 | | | Ac 227 | 8.27E-11 | BB 2 | | |
| Sr 90 | 1.46E-01 | BB 2 | | | Th 227 | 8.14E-11 | BB 2 | | |
| Zr 93 | 8.73E-06 | BB 2 | | | Th 228 | 1.69E-08 | BB 2 | | |
| Nb 91 | | | | | Th 229 | 8.24E-12 | BB 2 | | |
| Nb 92 | 2.56E-17 | BB 2 | | | Th 230 | 1.17E-09 | BB 2 | | |
| Nb 93m | 8.51E-03 | BB 2 | | | Th 232 | 1.05E-12 | BB 2 | | |
| Nb 94 | 6.09E-03 | BB 2 | | | Th 234 | 4.89E-06 | BB 2 | | |
| Mo 93 | 1.12E-02 | BB 2 | | | Pa 231 | 1.70E-10 | BB 2 | | |
| Tc 97 | | | | | Pa 233 | 5.56E-07 | BB 2 | | |
| Tc 99 | 2.78E-04 | BB 2 | | | U 232 | 1.64E-08 | BB 2 | | |
| Ru 106 | 4.88E-11 | BB 2 | | | U 233 | 2.38E-09 | BB 2 | | |
| Pd 107 | 3.89E-07 | BB 2 | | | U 234 | 1.64E-01 | BB 2 | | |
| Ag 108m | 5.59E-11 | BB 2 | | | U 235 | 1.60E-07 | BB 2 | | |
| Ag 110m | 1.94E-18 | BB 2 | | | U 236 | 1.18E-06 | BB 2 | | |
| Cd 109 | 7.59E-13 | BB 2 | | | U 238 | 4.99E-06 | BB 2 | | |
| Cd 113m | 2.02E-03 | BB 2 | | | Np 237 | 3.13E-04 | BB 2 | | |
| Sn 119m | | | | | Pu 236 | 6.29E-11 | BB 2 | | |
| Sn 121m | 3.77E-05 | BB 2 | | | Pu 238 | 5.16E-01 | BB 2 | | |
| Sn 123 | | | | | Pu 239 | 2.33E-03 | BB 2 | | |
| Sn 126 | 3.03E-06 | BB 2 | | | Pu 240 | 3.25E-03 | BB 2 | | |
| Sb 125 | 1.52E-05 | BB 2 | | | Pu 241 | 6.63E-02 | BB 2 | | |
| Sb 126 | 4.24E-07 | BB 2 | | | Pu 242 | 4.35E-06 | BB 2 | | |
| Te 125m | 3.72E-06 | BB 2 | | | Am 241 | 9.96E-03 | BB 2 | | |
| Te 127m | | | | | Am 242m | 1.59E-05 | BB 2 | | |
| I 129 | 1.33E-07 | BB 2 | | | Am 243 | 2.06E-05 | BB 2 | | |
| Cs 134 | 2.04E-06 | BB 2 | | | Cm 242 | 1.31E-05 | BB 2 | | |
| Cs 135 | 2.78E-06 | BB 2 | | | Cm 243 | 8.72E-06 | BB 2 | | |
| Cs 137 | 2.01E-01 | BB 2 | | | Cm 244 | 3.57E-04 | BB 2 | | |
| Ba 133 | 6.83E-06 | BB 2 | | | Cm 245 | 7.12E-08 | BB 2 | | |
| La 137 | | | | | Cm 246 | 1.02E-08 | BB 2 | | |
| La 138 | 5.85E-16 | BB 2 | | | Cm 248 | | | | |
| Ce 144 | 1.01E-13 | BB 2 | | | Cf 249 | 9.05E-14 | BB 2 | | |
| Pm 145 | | | | | Cf 250 | 8.74E-14 | BB 2 | | |
| Pm 147 | 8.31E-05 | BB 2 | | | Cf 251 | 2.23E-15 | BB 2 | | |
| Sm 147 | | | | | Cf 252 | 3.70E-17 | BB 2 | | |
| Sm 151 | 1.15E-03 | BB 2 | | | Other a | 2.06E-03 | | | |
| Eu 152 | 6.38E-06 | BB 2 | | | Other b/g | 3.34E-01 | | | |
| Eu 154 | 1.25E-03 | BB 2 | | | Total a | 6.98E-01 | BB 2 | 0 | |
| Eu 155 | 5.76E-05 | BB 2 | | | Total b/g | 1.60E+02 | BB 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