## WASTE STREAM 2D31 Magnox Fuel Transport Flasks

| | |
|---|---|
| **SITE** | Sellafield |
| **SITE OWNER** | Nuclear Decommissioning Authority |
| **WASTE CUSTODIAN** | Sellafield Limited |
| **WASTE TYPE** | LLW; SPD1 |
| Is the waste subject to Scottish Policy: | No |

**WASTE VOLUMES**

| | | Reported |
|---|---|---|
| Stocks: | At 1.4.2022...................... | 461.8 m³ |
| Total future arisings: | | 0 m³ |
| Total waste volume: | | 461.8 m³ |

Comment on volumes: Assumes a medium term strategy for decommissioning the Magnox flasks. The total number of Magnox flasks identified is 42 which includes 9 that were already at Sellafield in 2019 and a further 33 flasks transferred from Magnox Ltd (from waste stream 9Z201). The volume declared for disposal is the volume of the flasks without any size reduction. A study is currently being carried out to consider options for decommissioning the PNTL (Japanese owned flasks on the Sellafield site) which may influence the overall decommissioning strategy for the Magnox flasks.

Uncertainty factors on volumes:

| | | | |
|---|---|---|---|
| Stock (upper): | x 1.5 | Arisings (upper) | x |
| Stock (lower): | x 0.5 | Arisings (lower) | x |

**WASTE SOURCE** Transport flasks that have been used for irradiated Magnox fuel transport.

**PHYSICAL CHARACTERISTICS**

General description: These are ferritic steel containers internally contaminated with traces of activation and fission products from the spent fuel. These containers are obsolete and are nominally empty. The flasks are painted with CEGB System 6 epoxy paint. The flasks weigh up to 42.77 t each. All flasks have handling trunnions fitted. This is the maximum all up weight of a flask assembly. Actual disposal weight may be less. The waste is not anticipated to undergo any changes since it was generated as the flasks are presently stored dry and covered at Sellafield. Flasks sometimes undergo chemical decontamination as part of routine maintenance.

Physical components (%wt): Almost 100% by weight steel. Flask surfaces are painted with CEGB System 6 epoxy paint (~0.1% wt) and there is a rubber seal (viton) (<0.01% wt).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 3.47

Comment on density: The average density of 3.47 t/m³ refers to the mass of the components divided by the volume as stored prior to disposal.

**CHEMICAL COMPOSITION**

General description and components (%wt): Flask surfaces are painted with CEGB System 6 epoxy paint and there is a seal made of viton. The chemical components are Iron (approx. 98%) possibly with nickel, vanadium, molybdenum, manganese, niobium and chromium in alloying proportions, Viton (<0.01%), and CEGB System 6 epoxy based paint (~0.1%).

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Tritium may be present as water or as other inorganic or organic compounds.
C-14: The carbon 14 content is insignificant.
Se-79: The selenium isotope content is insignificant.
Tc-99: The technetium isotope content is insignificant.
Ra: The radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: The chemical form of uranium isotopes has not been determined but may be present as uranium oxides.
Np: The neptunium isotope content is insignificant.
Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.

Metals and alloys (%wt): Approximately 100% of waste is bulk metal in the form of transport flasks.

## WASTE STREAM 2D31 Magnox Fuel Transport Flasks

| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---|---|---|---|
| Stainless steel | 4.0 | | |
| Other ferrous metals | 96.0 | BS 1503, ASTM/A350. | |
| Iron | | | |
| Aluminium | | | |
| Beryllium | | | |
| Cobalt | 0 | | |
| Copper | | | |
| Lead | 0 | | |
| Magnox/Magnesium | TR | | |
| Nickel | TR | | |
| Titanium | | | |
| Uranium | | | |
| Zinc | 0 | | |
| Zircaloy/Zirconium | 0 | | |
| Other metals | 0 | No "other" metals present. | |

Organics (%wt): Viton "O" ring seals between flask lid and flask body, and around valves, are made of Viton B rubber. Flasks are coated with CEGB System 6 epoxy based. Viton B in "O" rings trapped into the assembly.

| | (%wt) | Type(s) and comment | % of total C14 activity |
|---|---|---|---|
| Total cellulosics | 0 | | |
| Paper, cotton | 0 | | |
| Wood | 0 | | |
| Halogenated plastics | 0 | | |
| Total non-halogenated plastics | 0 | | |
| Condensation polymers | 0 | | |
| Others | 0 | | |
| Organic ion exchange materials | 0 | | |
| Total rubber | <0.01 | | |
| Halogenated rubber | <0.01 | | |
| Non-halogenated rubber | 0 | | |
| Hydrocarbons | | | |
| Oil or grease | | | |
| Fuel | | | |
| Asphalt/Tarmac (cont.coal tar) | | | |
| Asphalt/Tarmac (no coal tar) | | | |
| Bitumen | | | |
| Others | | | |
| Other organics | ~0.10 | | |

Other materials (%wt): -

| | (%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............................................. | | | |
| Glass/Ceramics............................. | | | |
| Graphite......................................... | 0 | | |
| Desiccants/Catalysts..................... | | | |
| 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 are unlikely to be present.

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

Materials of interest for waste acceptance criteria: No materials likely to pose a fire or other non-radiological hazard have been identified.

| | (%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 | 2D31 | Magnox Fuel Transport Flasks |
|---|---|---|

| | | |
|---|---|---|
| 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: -

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

Complexing agents (%wt): No

| | (%wt) | Type(s) and comment |
|---|---|---|
| EDTA............................................ | | |
| DPTA............................................ | | |
| NTA............................................... | | |
| Polycarboxylic acids………………. | | |
| Other organic complexants.......... | | There are no organic complexing agents present. |
| Total complexing agents.............. | 0 | |

Potential for the waste to contain discrete items: Yes. Waste itself could be a discrete item

**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 | | |
| Decontamination | | |
| Metal treatment | Off-site | 100.0 |
| Size reduction | | |
| Decay storage | | |
| Recyling / reuse | | |
| Other / various | | |
| None | | |

Comment on planned treatments: Treatment will be via size reduction and decontamination, with an anticipated maximum of 5% of the flask assumed to then be disposed of to the LLWR as LLW. The remainder is anticipated to be free release scrap.

**Disposal Routes:**

| Disposal Route | Stream volume % | Disposal density t/m3 |
|---|---|---|
| Expected to be consigned to the LLW Repository | 5.0 | 3.5 |
| 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 | 95.0 | 3.5 |
| 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 2D31 Magnox Fuel Transport Flasks

**Opportunities for alternative disposal routing:** -

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

**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 | 5.0 | 10 | 3 |

Other information: After size reduction and dismantling only an anticipated maximum of 5% of the flask is assumed to then be disposed of to the LLWR as LLW. The remainder is anticipated to be free release scrap.

**Waste Planned for Disposal at the LLW Repository:**

Container voidage: -

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC). The waste does not have a current WCH.

It is assumed that the WAC will be prepared in the future in line with the precedent already set for the disposal of a cylindrical package previously consigned to LLWR.

Waste consigned for disposal to LLWR in year of generation: No. The waste will be disposed of when the flasks are prepared for disposal. This is dependent upon work load and NDA strategy.

**Non-Containerised Waste for In-Vault Grouting:**

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

## RADIOACTIVITY

Source: Contamination from Magnox fuel cooling pond water.

Uncertainty: The activity values are current best estimates. The waste is expected to be LLW but levels of contamination have to be determined.

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: Estimated from sampling and analysis data.

Other information: There may be contamination by fission products, actinides and activation products in Magnox fuel. The values quoted are indicative of the values that might be expected.

## WASTE STREAM 2D31 Magnox Fuel Transport Flasks

| 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 | | 6 | | | Gd 153 | | | | |
| Be 10 | | 8 | | | Ho 163 | | | | |
| C 14 | | 8 | | | Ho 166m | | | | |
| Na 22 | | | | | Tm 170 | | | | |
| Al 26 | | | | | Tm 171 | | | | |
| Cl 36 | | 8 | | | Lu 174 | | | | |
| Ar 39 | | | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | | | | | Hf 182 | | | | |
| Ca 41 | | 8 | | | Pt 193 | | | | |
| Mn 53 | | | | | Tl 204 | | | | |
| Mn 54 | 1.20E-18 | C C 2 | | | Pb 205 | | | | |
| Fe 55 | | 6 | | | Pb 210 | 7.73E-16 | C C 2 | | |
| Co 60 | 6.35E-09 | C C 2 | | | Bi 208 | | | | |
| Ni 59 | | 6 | | | Bi 210m | | | | |
| Ni 63 | | 6 | | | Po 210 | 7.34E-16 | C C 2 | | |
| Zn 65 | | 6 | | | Ra 223 | | 5 | | |
| Se 79 | | 6 | | | Ra 225 | 2.62E-12 | C C 2 | | |
| Kr 81 | | | | | Ra 226 | 3.20E-15 | C C 2 | | |
| Kr 85 | | | | | Ra 228 | | 5 | | |
| Rb 87 | | | | | Ac 227 | | 5 | | |
| Sr 90 | 1.93E-06 | C C 2 | | | Th 227 | | 5 | | |
| Zr 93 | | 6 | | | Th 228 | | 5 | | |
| Nb 91 | | | | | Th 229 | 2.63E-12 | C C 2 | | |
| Nb 92 | | | | | Th 230 | 5.12E-13 | C C 2 | | |
| Nb 93m | | 6 | | | Th 232 | | 5 | | |
| Nb 94 | | 6 | | | Th 234 | 2.89E-09 | C C 2 | | |
| Mo 93 | | 6 | | | Pa 231 | | 5 | | |
| Tc 97 | | | | | Pa 233 | 5.49E-12 | C C 2 | | |
| Tc 99 | | 6 | | | U 232 | | | | |
| Ru 106 | 6.32E-16 | C C 2 | | | U 233 | 9.62E-10 | C C 2 | | |
| Pd 107 | | 6 | | | U 234 | 1.92E-09 | C C 2 | | |
| Ag 108m | | 6 | | | U 235 | 8.25E-15 | C C 2 | | |
| Ag 110m | | | | | U 236 | 8.25E-14 | C C 2 | | |
| Cd 109 | | | | | U 238 | 2.89E-09 | C C 2 | | |
| Cd 113m | | | | | Np 237 | 5.51E-12 | C C 2 | | |
| Sn 119m | | | | | Pu 236 | | | | |
| Sn 121m | | 6 | | | Pu 238 | 3.17E-09 | C C 2 | | |
| Sn 123 | | | | | Pu 239 | 2.89E-07 | C C 2 | | |
| Sn 126 | | 6 | | | Pu 240 | 9.60E-08 | C C 2 | | |
| Sb 125 | 1.23E-10 | C C 2 | | | Pu 241 | 1.91E-06 | C C 2 | | |
| Sb 126 | | | | | Pu 242 | | 6 | | |
| Te 125m | 3.08E-11 | C C 2 | | | Am 241 | 6.47E-07 | C C 2 | | |
| Te 127m | | | | | Am 242m | | 6 | | |
| I 129 | | 6 | | | Am 243 | | 6 | | |
| Cs 134 | 5.65E-11 | C C 2 | | | Cm 242 | 7.78E-28 | C C 2 | | |
| Cs 135 | | 6 | | | Cm 243 | | 6 | | |
| Cs 137 | 9.86E-06 | C C 2 | | | Cm 244 | | 6 | | |
| Ba 133 | | | | | Cm 245 | | 8 | | |
| La 137 | | | | | Cm 246 | | 8 | | |
| La 138 | | | | | Cm 248 | | | | |
| Ce 144 | 1.24E-18 | C C 2 | | | Cf 249 | | | | |
| Pm 145 | | | | | Cf 250 | | | | |
| Pm 147 | | 6 | | | Cf 251 | | | | |
| Sm 147 | | | | | Cf 252 | | | | |
| Sm 151 | | 6 | | | Other a | | 8 | | |
| Eu 152 | | 6 | | | Other b/g | | | | |
| Eu 154 | 6.50E-09 | C C 2 | | | **Total a** | **1.04E-06** | **C C 2** | **0** | |
| Eu 155 | | 6 | | | **Total b/g** | **1.37E-05** | **C C 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