

| | | |
|---------------------|-------------|----------------------------|
| WASTE STREAM | 2F31 | MSSS Compartment 11 |
|---------------------|-------------|----------------------------|

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

WASTE VOLUMES

| | Reported |
|--------------------------|---------------------|
| Stocks: At 1.4.2019..... | 74.4 m ³ |
| Total future arisings: | 0 m ³ |
| Total waste volume: | 74.4 m ³ |

Comment on volumes: There are no future arisings. Waste volume does not include cover liquor (520m³).

Uncertainty factors on volumes:

| | | | |
|----------------|-------|------------------|---|
| Stock (upper): | x 2.0 | Arisings (upper) | x |
| Stock (lower): | x 0.5 | Arisings (lower) | x |

WASTE SOURCE Leached oxide fuel hulls from reprocessing campaigns the head end plant from 1969 to 1974.

PHYSICAL CHARACTERISTICS

General description: The waste is Zircaloy fuel cladding from the reprocessing of Zircaloy clad oxide fuel. Also associated with the Zircaloy are fragments of undissolved uranium oxide fuel and stainless steel sheaths from the fuel assemblies. The waste is stored under water. Corrosion of Zircaloy is negligible. The waste includes some Beta/Gamma Waste which may include 2 m lengths of steel tubing.

Physical components (%wt): The main components are Zircaloy, Stainless Steel, Sand, Inconel, Uranium oxide and Aluminium oxide.

Sealed sources: Not yet determined.

Bulk density (t/m³): 0.58

Comment on density: Oxide Fuel Hulls and Sand

CHEMICAL COMPOSITION

General description and components (%wt): The main components are Zircaloy, Stainless Steel, Sand, Inconel, Uranium oxide and Aluminium oxide.

Chemical state: Alkali

Chemical form of radionuclides:

- H-3: Present in reacted forms.
- C-14: Present in reacted forms.
- Cl-36: Present in reacted forms.
- Se-79: Present in reacted forms.
- Tc-99: Present in reacted forms.
- I-129: Present in reacted forms.
- Ra: Present in reacted forms.
- Th: Present in reacted forms.
- U: Present in reacted forms.
- Np: Present in reacted forms.
- Pu: Present in reacted forms.

Metals and alloys (%wt): The waste comprises mainly short lengths of fuel cladding tube, typically 50-150mm long and 10-16mm in diameter.

| | |
|---------------------------|----|
| Stainless steel..... | P |
| Other ferrous metals..... | NE |
| Iron..... | NE |
| Aluminium..... | NE |
| Beryllium..... | NE |
| Cobalt..... | NE |
| Copper..... | NE |
| Lead..... | NE |

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| | | | |
|------------------------|-------------------------------------|----|----------|
| | Magnox/Magnesium..... | NE | |
| | Nickel..... | NE | Inconel. |
| | Titanium..... | NE | |
| | Uranium..... | P | |
| | Zinc..... | NE | |
| | Zircaloy/Zirconium..... | P | |
| | Other metals..... | NE | |
| Organics (%wt): | PVC. | | |
| | Total cellulose..... | 0 | |
| | Paper, cotton..... | | |
| | Wood..... | | |
| | Halogenated plastics | P | |
| | Total non-halogenated plastics..... | P | |
| | Condensation polymers..... | NE | |
| | Others..... | P | |
| | Organic ion exchange materials.... | 0 | |
| | Total rubber..... | NE | |
| | Halogenated rubber | | |
| | Non-halogenated rubber..... | | |
| | Hydrocarbons..... | NE | |
| | Oil or grease | NE | |
| | Fuel..... | NE | |
| | Asphalt/Tarmac (cont.coal tar)... | NE | |
| | Asphalt/Tarmac (no coal tar).... | NE | |
| | Bitumen..... | NE | |
| | Others..... | NE | |
| | Other organics..... | NE | |
| Other materials (%wt): | - | | |
| | Inorganic ion exchange materials. | 0 | |
| | Inorganic sludges and flocs..... | 0 | |
| | Soil..... | 0 | |
| | Brick/Stone/Rubble..... | P | |
| | Cementitious material..... | 0 | |
| | Sand..... | P | |
| | Glass/Ceramics..... | NE | |
| | Graphite..... | NE | |
| | Desiccants/Catalysts..... | NE | |
| | Asbestos..... | NE | |
| | Non/low friable..... | | |
| | Moderately friable..... | | |
| | Highly friable..... | | |
| | Free aqueous liquids..... | 0 | |
| | Free non-aqueous liquids..... | 0 | |

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| | | |
|-------------------------|------------------------------|----|
| | Powder/Ash..... | 0 |
| Inorganic anions (%wt): | The water contains chloride. | |
| | Fluoride..... | NE |
| | Chloride..... | P |
| | Iodide..... | NE |
| | Cyanide..... | NE |
| | Carbonate..... | NE |
| | Nitrate..... | NE |
| | Nitrite..... | NE |
| | Phosphate..... | NE |
| | Sulphate..... | NE |
| | Sulphide..... | NE |

Materials of interest for waste acceptance criteria: Zircaloy is present in the waste which may be a combustible hazard, particularly in the form of fines. The waste is stored under water.

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

Hazardous substances / non hazardous pollutants:

| | |
|-----------------------------|----|
| Acrylamide..... | |
| Benzene..... | NE |
| Chlorinated solvents..... | |
| Formaldehyde..... | |
| Organometallics..... | |
| Phenol..... | NE |
| Styrene..... | |
| Tri-butyl phosphate..... | NE |
| Other organophosphates..... | |
| Vinyl chloride..... | NE |
| Arsenic..... | NE |

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Barium.....
 Boron..... NE
 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.....

Complexing agents (%wt): No
 EDTA.....
 DPTA.....
 NTA.....
 Polycarboxylic acids.....
 Other organic complexants.....
 Total complexing agents.....

PACKAGING AND CONDITIONING

Conditioning method: This waste stream is outside of the current cLoC. It is currently envisaged that it will be possible to use the same processing facility and package type as is the case for the other MSSS waste streams.

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: -

| Likely container type: | Container | Waste packaged (%vol) | Waste loading (m ³) | Payload (m ³) | Number of packages |
|------------------------|-----------------------------------------|-----------------------|---------------------------------|---------------------------|--------------------|
| | Sellafield enhanced 3m ³ box | 100.0 | ~0.940 | 2.15 | 80 |

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Likely container type comment:

-

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 will be different to that reported in the table since the raw volumes reported include waste and compartment liquor. The actual number of packages produced is identified in the 2018 Sellafield Decommissioning Product and Secondary Waste Plan.

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

| Treatment | Stream volume (%) | Comment |
|-----------|-------------------|---------|
| - | - | - |

RADIOACTIVITY

Source:

The main sources are fission and activation products from fuel carry-over.

Uncertainty:

The best available. Based on a short term oxide fuel reprocessing programme carried out between 1969 and 1974.

Definition of total alpha and total beta/gamma:

Best available data.

Measurement of radioactivities:

-

Other information:

-

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| Nuclide | Mean radioactivity, TBq/m ³ | | | | Nuclide | Mean radioactivity, TBq/m ³ | | | |
|---------|----------------------------------------|----------------|-----------------|----------------|------------------|----------------------------------------|----------------|-----------------|----------------|
| | Waste at 1.4.2019 | Bands and Code | Future arisings | Bands and Code | | Waste at 1.4.2019 | Bands and Code | Future arisings | Bands and Code |
| H 3 | 1.77E-01 | CC 2 | | | Gd 153 | | | | |
| Be 10 | 3.80E-10 | CC 2 | | | Ho 163 | | | | |
| C 14 | 9.65E-03 | CC 2 | | | Ho 166m | | | | |
| Na 22 | | | | | Tm 170 | | | | |
| Al 26 | | | | | Tm 171 | | | | |
| Cl 36 | 1.07E-05 | CC 2 | | | Lu 174 | | | | |
| Ar 39 | | | | | Lu 176 | | | | |
| Ar 42 | | | | | Hf 178n | | | | |
| K 40 | | | | | Hf 182 | | | | |
| Ca 41 | 4.92E-06 | CC 2 | | | Pt 193 | | | | |
| Mn 53 | | | | | Tl 204 | | | | |
| Mn 54 | | | | | Pb 205 | | | | |
| Fe 55 | 3.82E-04 | CC 2 | | | Pb 210 | 5.45E-10 | CC 2 | | |
| Co 60 | 1.48E-01 | CC 2 | | | Bi 208 | | | | |
| Ni 59 | 1.22E-01 | CC 2 | | | Bi 210m | | | | |
| Ni 63 | 1.09E+01 | CC 2 | | | Po 210 | 5.27E-10 | CC 2 | | |
| Zn 65 | | | | | Ra 223 | | | | |
| Se 79 | 1.66E-06 | CC 2 | | | Ra 225 | | | | |
| Kr 81 | | | | | Ra 226 | 1.67E-09 | CC 2 | | |
| Kr 85 | | | | | Ra 228 | | | | |
| Rb 87 | | | | | Ac 227 | | | | |
| Sr 90 | 1.93E+00 | CC 2 | | | Th 227 | | | | |
| Zr 93 | 2.04E-03 | CC 2 | | | Th 228 | | | | |
| Nb 91 | | | | | Th 229 | 1.32E-11 | CC 2 | | |
| Nb 92 | | | | | Th 230 | 2.03E-07 | CC 2 | | |
| Nb 93m | 1.80E-03 | CC 2 | | | Th 232 | | | | |
| Nb 94 | 4.43E-03 | CC 2 | | | Th 234 | | | | |
| Mo 93 | 3.41E-04 | CC 2 | | | Pa 231 | 1.46E-08 | CC 2 | | |
| Tc 97 | | | | | Pa 233 | | | | |
| Tc 99 | 1.85E-02 | CC 2 | | | U 232 | | | | |
| Ru 106 | 2.77E-11 | CC 2 | | | U 233 | 4.03E-09 | CC 2 | | |
| Pd 107 | | | | | U 234 | 7.02E-04 | CC 2 | | |
| Ag 108m | | | | | U 235 | 1.90E-05 | CC 2 | | |
| Ag 110m | | | | | U 236 | 5.58E-05 | CC 2 | | |
| Cd 109 | | | | | U 238 | 1.97E-04 | CC 2 | | |
| Cd 113m | | | | | Np 237 | 2.19E-05 | CC 2 | | |
| Sn 119m | | | | | Pu 236 | | | | |
| Sn 121m | 4.39E-03 | CC 2 | | | Pu 238 | 6.02E-02 | CC 2 | | |
| Sn 123 | | | | | Pu 239 | 7.11E-02 | CC 2 | | |
| Sn 126 | 1.54E-05 | CC 2 | | | Pu 240 | 2.43E-02 | CC 2 | | |
| Sb 125 | | | | | Pu 241 | 5.29E-01 | CC 2 | | |
| Sb 126 | | | | | Pu 242 | 4.20E-05 | CC 2 | | |
| Te 125m | | | | | Am 241 | 1.85E-01 | CC 2 | | |
| Te 127m | | | | | Am 242m | 3.06E-04 | CC 2 | | |
| I 129 | 1.99E-06 | CC 2 | | | Am 243 | 1.92E-04 | CC 2 | | |
| Cs 134 | 2.77E-07 | CC 2 | | | Cm 242 | 2.53E-04 | CC 2 | | |
| Cs 135 | 4.21E-05 | CC 2 | | | Cm 243 | 5.68E-05 | CC 2 | | |
| Cs 137 | 5.95E+00 | CC 2 | | | Cm 244 | 1.51E-03 | CC 2 | | |
| Ba 133 | | | | | Cm 245 | 6.09E-07 | CC 2 | | |
| La 137 | | | | | Cm 246 | 7.03E-05 | CC 2 | | |
| La 138 | | | | | Cm 248 | | | | |
| Ce 144 | 1.68E-17 | CC 2 | | | Cf 249 | | | | |
| Pm 145 | | | | | Cf 250 | | | | |
| Pm 147 | 1.25E-05 | CC 2 | | | Cf 251 | | | | |
| Sm 147 | | | | | Cf 252 | | | | |
| Sm 151 | 2.08E-02 | CC 2 | | | Other a | 7.34E-07 | CC 2 | | |
| Eu 152 | 2.50E-05 | CC 2 | | | Other b/g | 1.19E+01 | CC 2 | | |
| Eu 154 | 2.85E-03 | CC 2 | | | Total a | 3.44E-01 | CC 2 | 0 | |
| Eu 155 | 6.88E-05 | CC 2 | | | Total b/g | 3.17E+01 | CC 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