## WASTE STREAM 9A48 FED Stainless Steel

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

**WASTE VOLUMES**

| | | Reported |
|---|---|---|
| Stocks: | At 1.4.2022..... | 0.4 $m^3$ |
| Total future arisings: | | 0 $m^3$ |
| Total waste volume: | | 0.4 $m^3$ |

Comment on volumes: Station operation ceased in March 1989. This waste stream was accumulated between April 1967 and October 1972. The stainless steel was used for flux flattening and was replaced by zirconium on later elements as fuel irradiation had increased and flux flattening by the stainless steel was not required. The volume quoted is the estimated bulk volume of the waste if separated from other wastes with which it is mixed.

Uncertainty factors on volumes:

| | | | |
|---|---|---|---|
| Stock (upper): | x 1.1 | Arisings (upper) | x |
| Stock (lower): | x 0.9 | Arisings (lower) | x |

**WASTE SOURCE** The source of the waste is the removal of graphite struts and associated zirconium and stainless steel bridge pieces from fuel elements prior to dispatch of the elements to Sellafield.

### PHYSICAL CHARACTERISTICS

General description: The waste comprises predominantly stainless steel bridge pieces. Approximately 38% of fuel elements used stainless steel top support bridges, (with the rest being zirconium). There will also be a small quantity of nimonic springs, which may be attached to thermocouple wires. A stainless steel top support bridge is 127mm in length and weighs aproximately 26g and a Nimonic spring weighs approximately 5g. The thermocouple wires are approximately 380mm in length. It is unlikely that there will be any large items which will require special handling. The waste is loose in the vaults.

Physical components (%wt): Stainless steel bridge pieces (>98.5% wt), Nimonic springs (~0.75% wt) and thermocouples wires (~0.75% wt).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/$m^3$): 2.6

Comment on density: The average bulk density 2.6 t/$m^3$ assumes a packing factor to give an overall volume of about three times the displacement volume of the waste.

### CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel will account for more than 98.5% of the waste, with 0.75% Nimonic and 0.25% alumina, magnesia and other minor constituents. The stainless steel may be contaminated with fission product, actinides and graphite.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Tritium will probably be present as surface contamination, possibly as water or perhaps as other inorganic or organic compounds.
C-14: Carbon 14 may be present as carbon incorporated in the stainless steel and is likely to be in the form of graphite contamination.
Cl-36: Chlorine 36 will probably be present in surface contamination.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
Ra: Radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: Chemical form of uranium isotopes has not been determined but may be uranium oxides.
Np: The neptunium content is insignificant.
Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): -

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| | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---|---|---|---|
| Stainless steel | ~99.0 | | 99.0 |
| Other ferrous metals | 0 | | |
| Iron | | | |
| Aluminium | 0 | | |
| Beryllium | 0 | | |
| Cobalt | | | |
| Copper | 0 | | |
| Lead | 0 | | |
| Magnox/Magnesium | 0 | | |
| Nickel | ~0.75 | Nimonic. | |
| Titanium | | | |
| Uranium | | | |
| Zinc | 0 | | |
| Zircaloy/Zirconium | 0 | | |
| Other metals | 0 | No "other" metals have been identified. | |

Organics (%wt): This loose stainless steel is currently stored in the same vault as the drums of ion exchange material, although in different sub-sections. It may be possible that the stainless steel has been contaminated with the ion exchange material that has leaked from the drums.

| | (%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 | TR | | |
| Total rubber | 0 | | |
| Halogenated rubber | 0 | | |
| Non-halogenated rubber | 0 | | |
| Hydrocarbons | | | |
| Oil or grease | | | |
| Fuel | | | |
| Asphalt/Tarmac (cont.coal tar) | | | |
| Asphalt/Tarmac (no coal tar) | | | |
| Bitumen | | | |
| Others | | | |
| Other organics | TR | | |

Other materials (%wt): Graphite contamination.

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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..... | | | |
| Glass/Ceramics..... | 0 | | |
| Graphite..... | TR | | |
| Desiccants/Catalysts..... | | | |
| Asbestos..... | 0 | | |
| Non/low friable..... | | | |
| Moderately friable..... | | | |
| Highly friable..... | | | |
| Free aqueous liquids..... | TR | | |
| Free non-aqueous liquids..... | 0 | | |
| Powder/Ash..... | P | | |

Inorganic anions (%wt): None of the inorganic anions listed in the table is expected to be present at greater than trace concentration.

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

Materials of interest for waste acceptance criteria: There are no identified materials likely to represent a fire or other non-radiological hazard.

| | (%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 | |

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| | | |
|---|---|---|
| Non-putrescible wastes..... | | |
| 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: None expected.

| | (%wt) | Type(s) and comment |
|---|---|---|
| Acrylamide..... | | |
| Benzene..... | | |
| Chlorinated solvents..... | | |
| Formaldehyde..... | | |
| Organometallics..... | | |
| Phenol..... | | |
| Styrene..... | | |
| Tri-butyl phosphate..... | | |
| Other organophosphates..... | | |
| Vinyl chloride..... | | |
| Arsenic..... | | |
| Barium..... | | |
| Boron..... | 0 | |
| 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..... | | |

## WASTE STREAM 9A48 FED Stainless Steel

Complexing agents (%wt): Yes

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

Potential for the waste to contain discrete items: Yes. Stainless Steel so DI by definition

### PACKAGING AND CONDITIONING

Conditioning method: This stream will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A32, 9A40, 9A53, 9A73). The remainder of vault 1 waste will be co-packaged together in Type VI DCIC containers (9A25, 9A31, 9A39, 9A47, 9A52, 9A60 and 9A66). Packages for vault 1 are assigned to 9A25, 9A32 & 9A73.

Plant Name: -

Location: Berkeley Site

Plant startup date: -

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: -

Likely container type:

| Container | Waste packaged (%vol) | Waste loading ($m^3$) | Payload ($m^3$) | Number of packages |
|---|---|---|---|---|
| | | | | |

Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix:

Other information: -

Conditioned density (t/$m^3$): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: -

## WASTE STREAM 9A48 FED Stainless Steel

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

### RADIOACTIVITY

| | |
|---|---|
| Source: | Activation when the associated fuel elements were irradiated, of nuclides incorporated into the stainless steel. Contamination by fission products and actinides when the fuel elements were in the fuel pond. |
| Uncertainty: | The values quoted are indicative of the activities that might be expected. |
| 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: | Specific activity is a function of Station operating history. Values were derived from calculations of induced activity and estimates of likely contamination. |
| Other information: | - |

## WASTE STREAM 9A48 FED Stainless Steel

| 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 | 8.63E-03 | C C 2 | | | Gd 153 | | 8 | | |
| Be 10 | | 8 | | | Ho 163 | | 8 | | |
| C 14 | 4.00E-01 | C C 2 | | | Ho 166m | | 8 | | |
| Na 22 | | 8 | | | Tm 170 | | 8 | | |
| Al 26 | 2E-06 | C C 2 | | | Tm 171 | | 8 | | |
| Cl 36 | 7E-06 | C C 2 | | | Lu 174 | | 8 | | |
| Ar 39 | | 8 | | | Lu 176 | | 8 | | |
| Ar 42 | | 8 | | | Hf 178n | | 8 | | |
| K 40 | | 8 | | | Hf 182 | | 8 | | |
| Ca 41 | | 8 | | | Pt 193 | | 8 | | |
| Mn 53 | | 8 | | | Tl 204 | | 8 | | |
| Mn 54 | | 8 | | | Pb 205 | | 8 | | |
| Fe 55 | 1.09E-02 | C C 2 | | | Pb 210 | | 8 | | |
| Co 60 | <6.95E-01 | C 3 | | | Bi 208 | | 8 | | |
| Ni 59 | 1E+00 | C C 2 | | | Bi 210m | | 8 | | |
| Ni 63 | 9.00E+01 | C C 2 | | | Po 210 | | 8 | | |
| Zn 65 | | 8 | | | Ra 223 | | 8 | | |
| Se 79 | | 8 | | | Ra 225 | | 8 | | |
| Kr 81 | | 8 | | | Ra 226 | | 8 | | |
| Kr 85 | | 8 | | | Ra 228 | | 8 | | |
| Rb 87 | | 8 | | | Ac 227 | | 8 | | |
| Sr 90 | 3.50E-04 | C C 2 | | | Th 227 | | 8 | | |
| Zr 93 | 4E-08 | C C 2 | | | Th 228 | | 8 | | |
| Nb 91 | | 8 | | | Th 229 | | 8 | | |
| Nb 92 | 7E-08 | C C 2 | | | Th 230 | | 8 | | |
| Nb 93m | 3.18E-01 | C C 2 | | | Th 232 | | 8 | | |
| Nb 94 | 5.00E-03 | C C 2 | | | Th 234 | <7E-07 | C 3 | | |
| Mo 93 | 3.99E-03 | C C 2 | | | Pa 231 | | 8 | | |
| Tc 97 | | 8 | | | Pa 233 | <4.16E-08 | C 3 | | |
| Tc 99 | 9E-04 | C C 2 | | | U 232 | | 8 | | |
| Ru 106 | | 8 | | | U 233 | | 8 | | |
| Pd 107 | | 8 | | | U 234 | 6.04E-07 | C C 2 | | |
| Ag 108m | 9.75E-03 | C C 2 | | | U 235 | 2E-08 | C C 2 | | |
| Ag 110m | | 8 | | | U 236 | 5.00E-08 | C C 2 | | |
| Cd 109 | | 8 | | | U 238 | 7E-07 | C C 2 | | |
| Cd 113m | 1.42E-08 | C C 2 | | | Np 237 | 4.16E-08 | C C 2 | | |
| Sn 119m | | 8 | | | Pu 236 | | 8 | | |
| Sn 121m | | 8 | | | Pu 238 | 7.11E-05 | C C 2 | | |
| Sn 123 | | 8 | | | Pu 239 | 2E-04 | C C 2 | | |
| Sn 126 | 3.04E-09 | C C 2 | | | Pu 240 | 2.00E-04 | C C 2 | | |
| Sb 125 | | 8 | | | Pu 241 | 1.46E-03 | C C 2 | | |
| Sb 126 | | 8 | | | Pu 242 | 6E-08 | C C 2 | | |
| Te 125m | | 8 | | | Am 241 | 3.44E-04 | C C 2 | | |
| Te 127m | | 8 | | | Am 242m | 3.71E-07 | C C 2 | | |
| I 129 | | 8 | | | Am 243 | 8.00E-08 | C C 2 | | |
| Cs 134 | | 8 | | | Cm 242 | 3.06E-07 | C C 2 | | |
| Cs 135 | 6E-09 | C C 2 | | | Cm 243 | 4.25E-08 | C C 2 | | |
| Cs 137 | 4.95E-04 | C C 2 | | | Cm 244 | 2.25E-07 | C C 2 | | |
| Ba 133 | | 8 | | | Cm 245 | | 8 | | |
| La 137 | | 8 | | | Cm 246 | | 8 | | |
| La 138 | | 8 | | | Cm 248 | | 8 | | |
| Ce 144 | | 8 | | | Cf 249 | | 8 | | |
| Pm 145 | | 8 | | | Cf 250 | | 8 | | |
| Pm 147 | 3.81E-09 | C C 2 | | | Cf 251 | | 8 | | |
| Sm 147 | | 8 | | | Cf 252 | | 8 | | |
| Sm 151 | 1.78E-06 | C C 2 | | | Other a | | | | |
| Eu 152 | 9.19E-09 | C C 2 | | | Other b/g | | | | |
| Eu 154 | 5.95E-07 | C C 2 | | | **Total a** | **8.17E-04** | **C C 2** | **0** | |
| Eu 155 | 2.38E-08 | C C 2 | | | **Total b/g** | **9.25E+01** | **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