

WASTE STREAM**9B31****Miscellaneous Activated Components - R2**

SITE Bradwell
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Magnox Limited
WASTE TYPE ILW; SPD3

WASTE VOLUMES

| | | |
|---------------------------------|----------------------|--------------------|
| | | Reported |
| Stocks: | At 1.4.2019..... | 3.2 m ³ |
| Total future arisings: | | 0 m ³ |
| Total waste volume: | | 3.2 m ³ |
| Comment on volumes: | - | |
| Uncertainty factors on volumes: | Stock (upper): x 1.2 | Arisings (upper) x |
| | Stock (lower): x 0.8 | Arisings (lower) x |

WASTE SOURCE Redundant or defective components and equipment removed from the reactor core and fuelling machines.

PHYSICAL CHARACTERISTICS

General description: Components such as control rods, and other irradiated items. The possibility of large items which may need special handling has not been assessed.
Physical components (%vol): Control rods and other irradiated items, the % volume/weight has not been estimated.
Sealed sources: -
Bulk density (t/m³): ~1
Comment on density: The assumption of 1 t/m³ as the average bulk density may be subject to revision.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is predominantly steel and boron steel.
Chemical state: Neutral
Chemical form of radionuclides:
 H-3: Chemical form of tritium has not been determined but is probably present as surface contamination.
 C-14: The chemical form of carbon 14 has not been determined but is probably present as graphite.
 Cl-36: The chemical form of chlorine 36 has not been determined.
 U: The chemical form of uranium isotopes has not been determined but may be present as uranium oxides.
 Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.
Metals and alloys (%wt): Predominantly bulk metal items on average between 5 and 30 mm in thickness.
 Stainless steel..... NE
 Other ferrous metals..... ~90.0 Carbon steel and boronated steel are present.
 Iron.....
 Aluminium..... NE
 Beryllium..... NE
 Cobalt.....
 Copper..... NE
 Lead..... NE
 Magnox/Magnesium..... NE
 Nickel.....
 Titanium.....
 Uranium.....

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| | | |
|-------------------------|--|----|
| | Zinc..... | NE |
| | Zircaloy/Zirconium..... | NE |
| | Other metals..... | NE |
| Organics (%wt): | The organic anion content has not been fully assessed. | |
| | 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 |
| | 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): | Traces of graphite may be present. | |
| | 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..... | 0 |
| | Free non-aqueous liquids..... | TR |
| | Powder/Ash..... | 0 |
| Inorganic anions (%wt): | Possibly trace quantities. | |

WASTE STREAM**9B31****Miscellaneous Activated Components - R2**

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

There are no materials identified in the waste likely to represent a fire or other non-radiological hazard.

| | |
|--|---|
| Combustible metals..... | 0 |
| Low flash point liquids..... | 0 |
| Explosive materials..... | 0 |
| Phosphorus..... | 0 |
| Hydrides..... | 0 |
| Biological etc. materials..... | 0 |
| Biodegradable materials..... | |
| Putrescible wastes..... | 0 |
| Non-putrescible wastes..... | |
| Corrosive materials..... | 0 |
| Pyrophoric materials..... | 0 |
| Generating toxic gases..... | 0 |
| Reacting with water..... | 0 |
| Active particles..... | |
| Soluble solids as bulk chemical compounds..... | |

Hazardous substances / non hazardous pollutants:

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

WASTE STREAM**9B31****Miscellaneous Activated Components - R2**

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
 EDTA.....
 DPTA.....
 NTA.....
 Polycarboxylic acids.....
 Other organic complexants.....
 Total complexing agents..... 0

PACKAGING AND CONDITIONING

Conditioning method: The waste is not expected to be supercompacted. The treatment envisaged is the placement of the waste in baskets followed by encapsulation. Container choice may be influenced by Transport Regulations at the time of Final Site Clearance.

Plant Name: None

Location: Bradwell Site

Plant startup date: 2087

Total capacity
(m³/y incoming waste): ~5000.0

Target start date for
packaging this stream: 2087

Throughput for this stream
(m³/y incoming waste): ~0.8

Other information: The current proposal is to store the waste until until reactor dismantling commences in 2087. All waste is expected to be retrieved and conditioned when the conditioning campaign is undertaken.

| Likely container type: | Container | Waste packaged (%vol) | Waste loading (m ³) | Payload (m ³) | Number of packages |
|------------------------|-----------------------------------|-----------------------|---------------------------------|---------------------------|--------------------|
| | 4m box (100mm concrete shielding) | 100.0 | 12.25 | 14.3 | < 1 |

WASTE STREAM**9B31****Miscellaneous Activated Components - R2**

| | |
|---|--|
| Likely container type comment: | The waste is assumed to be in baskets in the waste package so the occupied volume in the package is greater than the original waste volume. |
| Range in container waste volume: | No significant variability is expected. |
| Other information on containers: | The container material is expected to be stainless steel. |
| Likely conditioning matrix: | Blast Furnace Slag / Ordinary Portland Cement |
| Other information: | The waste is assumed to be encapsulated. |
| Conditioned density (t/m ³): | ~3.0 |
| Conditioned density comment: | The conditioned waste density assumes that the waste will be encapsulated. |
| Other information on conditioning: | The waste will be in baskets placed in the waste packages. Baskets of different Final Dismantling ILW wastes may be in the same waste packages. The encapsulation matrix would be likely to be BFS/OPC. The density of the encapsulated waste would probably be about 3 t/m ³ . |
| Opportunities for alternative disposal routing: | No |

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

RADIOACTIVITY

| | |
|---|---|
| Source: | Irradiated components that have been removed from the reactor. Control rods are likely to be components of high activity, the majority of the activity coming from activation. |
| Uncertainty: | Specific activity is a function of Station operating history. 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: | Estimates are based upon theoretical assessments. |
| Other information: | - |

WASTE STREAM

9B31

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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 | <1.53E+00 | D 3 | | | Gd 153 | | 8 | | |
| Be 10 | | 8 | | | Ho 163 | | 8 | | |
| C 14 | 2.00E-02 | CD 2 | | | Ho 166m | | 8 | | |
| Na 22 | | 8 | | | Tm 170 | | 8 | | |
| Al 26 | | 8 | | | Tm 171 | | 8 | | |
| Cl 36 | 3E-05 | CC 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 | 1.79E-06 | CD 2 | | | Pb 205 | | 8 | | |
| Fe 55 | 4.22E+00 | CD 2 | | | Pb 210 | | 8 | | |
| Co 60 | 2.06E+00 | CD 2 | | | Bi 208 | | 8 | | |
| Ni 59 | 4E-02 | CD 2 | | | Bi 210m | | 8 | | |
| Ni 63 | 3.68E+00 | CD 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 | <3.76E-05 | D 3 | | | Th 227 | | 8 | | |
| Zr 93 | | 8 | | | Th 228 | | 8 | | |
| Nb 91 | | 8 | | | Th 229 | | 8 | | |
| Nb 92 | | 8 | | | Th 230 | | 8 | | |
| Nb 93m | | 8 | | | Th 232 | | 8 | | |
| Nb 94 | 4E-05 | CD 2 | | | Th 234 | 7E-09 | CC 2 | | |
| Mo 93 | | 8 | | | Pa 231 | | 8 | | |
| Tc 97 | | 8 | | | Pa 233 | | 8 | | |
| Tc 99 | <1E-08 | D 3 | | | U 232 | | 8 | | |
| Ru 106 | | 8 | | | U 233 | | 8 | | |
| Pd 107 | | 8 | | | U 234 | <6.09E-09 | D 3 | | |
| Ag 108m | 3.92E-05 | CD 2 | | | U 235 | | 8 | | |
| Ag 110m | | 8 | | | U 236 | | 8 | | |
| Cd 109 | | 8 | | | U 238 | <7E-09 | D 3 | | |
| Cd 113m | | 8 | | | Np 237 | | 8 | | |
| Sn 119m | | 8 | | | Pu 236 | | 8 | | |
| Sn 121m | | 8 | | | Pu 238 | <2.73E-06 | D 3 | | |
| Sn 123 | | 8 | | | Pu 239 | <3E-06 | D 3 | | |
| Sn 126 | | 8 | | | Pu 240 | <4.00E-06 | D 3 | | |
| Sb 125 | | 8 | | | Pu 241 | <5.05E-05 | D 3 | | |
| Sb 126 | | 8 | | | Pu 242 | <2E-09 | D 3 | | |
| Te 125m | | 8 | | | Am 241 | <8.16E-06 | D 3 | | |
| Te 127m | | 8 | | | Am 242m | <1.88E-08 | D 3 | | |
| I 129 | | 8 | | | Am 243 | <6.00E-09 | D 3 | | |
| Cs 134 | <3.55E-08 | D 3 | | | Cm 242 | <1.55E-08 | D 3 | | |
| Cs 135 | | 8 | | | Cm 243 | <3.80E-09 | D 3 | | |
| Cs 137 | <1.51E-04 | D 3 | | | Cm 244 | <5.68E-08 | D 3 | | |
| 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 | <1.68E-07 | D 3 | | | Cf 251 | | 8 | | |
| Sm 147 | | 8 | | | Cf 252 | | 8 | | |
| Sm 151 | <8.20E-07 | D 3 | | | Other a | | | | |
| Eu 152 | 1.07E-05 | CD 2 | | | Other b/g | | | | |
| Eu 154 | 7.58E-06 | CD 2 | | | Total a | 1.80E-05 | CD 3 | 0 | |
| Eu 155 | | 8 | | | Total b/g | 1.16E+01 | CD 3 | 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