

| | | |
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| WASTE STREAM | 2C31 | Cobalt Cartridges |
|---------------------|-------------|--------------------------|

SITE Chapelcross
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Magnox Limited
WASTE TYPE ILW

WASTE VOLUMES

| | | |
|---------------------------------|----------------------------------|--------------------|
| | | Reported |
| Stocks: | At 1.4.2019..... | 0.1 m ³ |
| Total future arisings: | | 0 m ³ |
| Total waste volume: | | 0.1 m ³ |
| Comment on volumes: | The will be no further arisings. | |
| Uncertainty factors on volumes: | Stock (upper): x 1.2 | Arisings (upper) x |
| | Stock (lower): x 0.8 | Arisings (lower) x |

WASTE SOURCE Cobalt cartridges irradiated to produce high energy sources.

PHYSICAL CHARACTERISTICS

General description: Colbalt-60 pencils contained within magnox cartridges.
 Physical components (%vol): Magnox, Cobalt-60, Stainless Steel Pencil Liners.
 Sealed sources: -
 Bulk density (t/m³): 1.8
 Comment on density: The mean density of 1.8t/m³ refers to the mass of the components divided by the volume as stored.

CHEMICAL COMPOSITION

General description and components (%wt): Metals
 Chemical state: Neutral
 Chemical form of radionuclides: H-3: Present
 C-14: Present
 Se-79: Not Present
 Tc-99: Present
 Ra: Not Present
 Th: Not Present
 U: Not Present
 Np: Not Present
 Pu: Not Present
 Metals and alloys (%wt): -
 Stainless steel..... NE
 Other ferrous metals.....
 Iron.....
 Aluminium.....
 Beryllium.....
 Cobalt..... NE
 Copper.....
 Lead.....
 Magnox/Magnesium..... NE
 Nickel.....
 Titanium.....
 Uranium.....
 Zinc.....

WASTE STREAM**2C31****Cobalt Cartridges**

| | | | |
|-------------------------|-------------------------------------|--------|--|
| | Zircaloy/Zirconium..... | | |
| | Other metals..... | ~100.0 | Colbalt-60 pencils contained within magnox cartridges. |
| Organics (%wt): | - | | |
| | Total cellulosics..... | 0 | |
| | Paper, cotton..... | | |
| | Wood..... | | |
| | Halogenated plastics | | |
| | Total non-halogenated plastics..... | 0 | |
| | Condensation polymers..... | | |
| | Others..... | | |
| | Organic ion exchange materials.... | | |
| | Total rubber..... | 0 | |
| | Halogenated rubber | | |
| | Non-halogenated rubber..... | | |
| | Hydrocarbons..... | | |
| | Oil or grease | | |
| | Fuel..... | | |
| | Asphalt/Tarmac (cont.coal tar)... | | |
| | Asphalt/Tarmac (no coal tar).... | | |
| | Bitumen..... | | |
| | Others..... | | |
| | Other organics..... | | |
| Other materials (%wt): | - | | |
| | Inorganic ion exchange materials. | | |
| | Inorganic sludges and flocs..... | | |
| | Soil..... | | |
| | Brick/Stone/Rubble..... | | |
| | Cementitious material..... | | |
| | Sand..... | | |
| | Glass/Ceramics..... | | |
| | Graphite..... | | |
| | Desiccants/Catalysts..... | | |
| | Asbestos..... | | |
| | Non/low friable..... | | |
| | Moderately friable..... | | |
| | Highly friable..... | | |
| | Free aqueous liquids..... | | |
| | Free non-aqueous liquids..... | | |
| | Powder/Ash..... | | |
| Inorganic anions (%wt): | - | | |

Fluoride.....
 Chloride.....
 Iodide.....
 Cyanide.....
 Carbonate.....
 Nitrate.....
 Nitrite.....
 Phosphate.....
 Sulphate.....
 Sulphide.....

Materials of interest for
 waste acceptance criteria:

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

Hazardous substances /
 non hazardous pollutants:

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

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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: -
 Plant Name: -
 Location: Chapelcross.
 Plant startup date: -
 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 |
|------------------------|--------------------------|-----------------------|---------------------------------|---------------------------|--------------------|
| | 500 l RS drum (120mm Pb) | 100.0 | 0.013 | 0.166 | 9 |

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Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix: Not specified

Other information: -

Conditioned density (t/m³): 0.45

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing:

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

RADIOACTIVITY

Source: Radionuclide inventory determined through non-active characterisation and modeling assessment.

Uncertainty: Radionuclide inventory determined through non-active characterisation and modeling assessment.

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: Activation products. The above activities are specific activities and based on 48 cartridges with a volume of 0.12m³

Other information: -

WASTE STREAM 2C31 Cobalt Cartridges

| 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 | 2.01E-01 | CC 2 | | | Gd 153 | | | 8 | |
| Be 10 | 3.33E-08 | CC 2 | | | Ho 163 | | | 8 | |
| C 14 | 5.00E-08 | CC 2 | | | Ho 166m | | | 8 | |
| Na 22 | | | | | Tm 170 | | | 8 | |
| Al 26 | | | | | Tm 171 | | | 8 | |
| Cl 36 | 6.67E-08 | CC 2 | | | Lu 174 | | | 8 | |
| Ar 39 | 1.63E-04 | CC 2 | | | Lu 176 | | | 8 | |
| Ar 42 | | 8 | | | Hf 178n | | | 8 | |
| K 40 | | 8 | | | Hf 182 | | | 8 | |
| Ca 41 | 8.33E-06 | CC 2 | | | Pt 193 | | | 8 | |
| Mn 53 | | 8 | | | Tl 204 | | | 8 | |
| Mn 54 | | 8 | | | Pb 205 | | | 8 | |
| Fe 55 | 4.22E-03 | CC 2 | | | Pb 210 | | | 8 | |
| Co 60 | 5.14E+02 | CC 2 | | | Bi 208 | | | 8 | |
| Ni 59 | 4.17E-02 | CC 2 | | | Bi 210m | | | 8 | |
| Ni 63 | 3.13E+00 | CC 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 | | 8 | | | Th 227 | | | 8 | |
| Zr 93 | | 8 | | | Th 228 | | | 8 | |
| Nb 91 | | 8 | | | Th 229 | | | 8 | |
| Nb 92 | | 8 | | | Th 230 | | | 8 | |
| Nb 93m | 6.16E-04 | CC 2 | | | Th 232 | | | 8 | |
| Nb 94 | 2.5E-04 | CC 2 | | | Th 234 | | | 8 | |
| Mo 93 | 2.50E-04 | CC 2 | | | Pa 231 | | | 8 | |
| Tc 97 | | 8 | | | Pa 233 | | | 8 | |
| Tc 99 | 5E-06 | CC 2 | | | U 232 | | | 8 | |
| Ru 106 | | 8 | | | U 233 | | | 8 | |
| Pd 107 | | 8 | | | U 234 | | | 8 | |
| Ag 108m | 8.21E-04 | CC 2 | | | U 235 | | | 8 | |
| Ag 110m | | 8 | | | U 236 | | | 8 | |
| Cd 109 | | 8 | | | U 238 | | | 8 | |
| Cd 113m | 5.31E-03 | CC 2 | | | Np 237 | | | 8 | |
| Sn 119m | | 8 | | | Pu 236 | | | 8 | |
| Sn 121m | | 8 | | | Pu 238 | | | 8 | |
| Sn 123 | | 8 | | | Pu 239 | | | 8 | |
| Sn 126 | | 8 | | | Pu 240 | | | 8 | |
| Sb 125 | | 8 | | | Pu 241 | | | 8 | |
| Sb 126 | | 8 | | | Pu 242 | | | 8 | |
| Te 125m | | 8 | | | Am 241 | | | 8 | |
| Te 127m | | 8 | | | Am 242m | | | 8 | |
| I 129 | | 8 | | | Am 243 | | | 8 | |
| Cs 134 | | 8 | | | Cm 242 | | | 8 | |
| Cs 135 | | 8 | | | Cm 243 | | | 8 | |
| Cs 137 | | 8 | | | Cm 244 | | | 8 | |
| Ba 133 | 1.38E-05 | CC 2 | | | 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 | | 8 | | | Cf 251 | | | 8 | |
| Sm 147 | | 8 | | | Cf 252 | | | 8 | |
| Sm 151 | | 8 | | | Other a | | | | |
| Eu 152 | | 8 | | | Other b/g | | | | |
| Eu 154 | | 8 | | | Total a | 0 | | 0 | |
| Eu 155 | | 8 | | | Total b/g | 5.17E+02 | 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