



**WASTE STREAM**

**9E24 FED Magnox**

|                        |   |       |   |
|------------------------|---|-------|---|
|                        | Cobalt.....   |       |   |
|                        | Copper.....   | 0     |   |
|                        | Lead.....   | 0     |   |
|                        | Magnox/Magnesium.....   | >99.5 | Will consist predominantly of<br>Magnox alloy ZR55. includes<br>0.55% zirconium and 0.5%<br>aluminium |
|                        | Nickel.....   |       |   |
|                        | Titanium.....   |       |   |
|                        | Uranium.....  |       |   |
|                        | Zinc.....   |       |   |
|                        | Zircaloy/Zirconium.....   | P     | some zirconium as alloy in the<br>Magnox and as a "free" metal.                                       |
|                        | Other metals.....   |       |   |
| Organics (%wt):        | There may be organics present in trace quantities.  |       |   |
|                        | Total cellulose.....  | 0     |   |
|                        | Paper, cotton.....  | 0     |   |
|                        | Wood.....   | 0     |   |
|                        | Halogenated plastics .....  | 0     |   |
|                        | Total non-halogenated plastics.....   | 0     | There are no halogenated<br>plastics or rubbers present.  |
|                        | Condensation polymers.....  | 0     |   |
|                        | Others.....   | 0     |   |
|                        | Organic ion exchange materials....  | 0     |   |
|                        | Total rubber.....   | 0     | There are no halogenated<br>plastics or rubbers present.  |
|                        | 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 expected. Magnox with impurities which may include beryllium. Also<br>some zirconium as alloy in the Magnox and as a "free" metal. |       |   |
|                        | 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    |   |

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|  |   |       |
|--|---|-------|
|  | Desiccants/Catalysts.....   |       |
|  | Asbestos.....   |       |
|  | Non/low friable.....  |       |
|  | Moderately friable.....   |       |
|  | Highly friable.....   |       |
|  | Free aqueous liquids.....   | TR    |
|  | Free non-aqueous liquids.....   | 0     |
|  | Powder/Ash.....   | NE    |
| Inorganic anions (%wt):                              | Inorganic anions are not expected to be present at greater than trace concentrations. |       |
|  | 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: | Magnox will ignite under appropriate conditions.                                      |       |
|  | Combustible metals.....   | >99.5 |
|  | 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.....  | >99.5 |
|  | Active particles.....   |       |
|  | Soluble solids as bulk chemical compounds.....  |       |
| Hazardous substances / non hazardous pollutants:     | -   |       |
|  | Acrylamide.....   |       |
|  | Benzene.....  |       |
|  | Chlorinated solvents.....   |       |
|  | Formaldehyde.....   |       |

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Organometallics.....  
 Phenol.....  
 Styrene.....  
 Tri-butyl phosphate.....  
 Other organophosphates.....  
 Vinyl chloride.....  
 Arsenic.....  
 Barium.....  
 Boron.....  
 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): Yes  
     EDTA.....  
     DPTA.....  
     NTA.....  
     Polycarboxylic acids.....  
     Other organic complexants.....  
     Total complexing agents..... TR

**LAW TREATMENT, PACKAGING AND DISPOSAL****Waste that is currently ILW: -**

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Planned on-site / off-site treatments(s):

| Treatment  | On-site / Off site | Stream volume % |
|--|--------------------|-----------------|
| Low force compaction<br>Supercompaction (HFC)<br>Incineration<br>Solidification<br>Decontamination<br>Metal treatment<br>Size reduction<br>Decay storage<br>Recycling / reuse<br>Other / various<br>None |                    | 100.0           |

Comment on planned treatments:

-

**Disposal Routes:**

| Disposal Route  | Stream volume % |
|---|-----------------|
| Expected to be consigned to the LLW Repository<br>Expected to be consigned to a Landfill Facility<br>Expected to be consigned to an On-Site Disposal Facility<br>Expected to be consigned to an Incineration Facility<br>Expected to be consigned to a Metal Treatment Facility<br>Expected to be consigned as Out of Scope<br>Expected to be recycled / reused<br>Disposal route not known | 100.0           |

**Upcoming (2019/20-2021/22) waste routing (if expected to change from above)**

| Disposal Route  | Stream volume % |         |         |
|---|-----------------|---------|---------|
|   | 2019/20         | 2020/21 | 2021/22 |
| Expected to be consigned to the LLW Repository<br>Expected to be consigned to a Landfill Facility<br>Expected to be consigned to an On-Site Disposal Facility<br>Expected to be consigned to an Incineration Facility<br>Expected to be consigned to a Metal Treatment Facility<br>Expected to be consigned as Out of Scope<br>Expected to be recycled / reused<br>Disposal route not known |                 |         |         |

**Waste Packaging for Disposal:**

| Container  | Stream volume % | Waste loading m <sup>3</sup> | 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 | 100.0           | 14.4                         | 6                  |

Other information:

-

**Waste Consigned to the LLW Repository:**

Container voidage:

-

Waste Characterisation Form (WCH):

-

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Waste consigned for disposal to LLWR in year of generation: -

Potential for the waste to contain discrete items: -

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

Source: The source of the waste is the removal of splitters from fuel prior to dispatch of the elements to Sellafield. Activation of trace nuclides in the Magnox and contamination by fission products and actinides will be main sources of activity.

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: Values were derived from measurements.

Other information: Although the gross beta/gamma activity in the FED material is LLW, this waste stream is not discrete. The FED material is intimately mixed with highly active Niomonic Springs.

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| Nuclide | Mean radioactivity, TBq/m <sup>3</sup> |                |                 | Nuclide          | Mean radioactivity, TBq/m <sup>3</sup> |                |                 |
|---------|--|----------------|-----------------|------------------|--|----------------|-----------------|
|         | Waste at 1.4.2019                      | Bands and Code | Future arisings |                  | Waste at 1.4.2019                      | Bands and Code | Future arisings |
| H 3     | 1.21E-04                               | CC 2           |                 | Gd 153           |  | 8              |                 |
| Be 10   |  | 8              |                 | Ho 163           |  | 8              |                 |
| C 14    | 1.00E-04                               | CC 2           |                 | Ho 166m          |  | 8              |                 |
| Na 22   |  |                |                 | Tm 170           |  | 8              |                 |
| Al 26   | 4E-07                                  | CC 2           |                 | Tm 171           |  | 8              |                 |
| Cl 36   |  | 8              |                 | 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   | 9.12E-07                               | CC 2           |                 | Pb 210           |  | 8              |                 |
| Co 60   | 1.53E-05                               | CC 2           |                 | Bi 208           |  | 8              |                 |
| Ni 59   |  | 8              |                 | Bi 210m          |  | 8              |                 |
| Ni 63   | 5.64E-04                               | 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   | 6.45E-05                               | CC 2           |                 | Th 227           |  | 8              |                 |
| Zr 93   | <2E-06                                 | C 3            |                 | Th 228           |  | 8              |                 |
| Nb 91   |  | 8              |                 | Th 229           |  | 8              |                 |
| Nb 92   |  | 8              |                 | Th 230           |  | 8              |                 |
| Nb 93m  | 7.64E-07                               | CC 2           |                 | Th 232           |  | 8              |                 |
| Nb 94   |  | 8              |                 | Th 234           |  | 8              |                 |
| Mo 93   |  | 8              |                 | Pa 231           |  | 8              |                 |
| Tc 97   |  | 8              |                 | Pa 233           |  | 8              |                 |
| Tc 99   |  | 8              |                 | U 232            |  | 8              |                 |
| Ru 106  |  | 8              |                 | U 233            |  | 8              |                 |
| Pd 107  |  | 8              |                 | U 234            |  | 8              |                 |
| Ag 108m | 9.85E-07                               | CC 2           |                 | U 235            |  | 8              |                 |
| Ag 110m |  | 8              |                 | U 236            |  | 8              |                 |
| Cd 109  |  | 8              |                 | U 238            |  | 8              |                 |
| Cd 113m |  | 8              |                 | Np 237           |  | 8              |                 |
| Sn 119m |  | 8              |                 | Pu 236           |  | 8              |                 |
| Sn 121m |  | 8              |                 | Pu 238           | 1.86E-06                               | CC 2           |                 |
| Sn 123  |  | 8              |                 | Pu 239           | 3E-06                                  | CC 2           |                 |
| Sn 126  |  | 8              |                 | Pu 240           | 4.00E-06                               | CC 2           |                 |
| Sb 125  | <5.18E-08                              | C 3            |                 | Pu 241           | 5.83E-05                               | CC 2           |                 |
| Sb 126  |  | 8              |                 | Pu 242           |  | 8              |                 |
| Te 125m | 1.30E-08                               | CC 2           |                 | Am 241           | 7.94E-06                               | CC 2           |                 |
| Te 127m |  | 8              |                 | Am 242m          |  | 8              |                 |
| I 129   |  | 8              |                 | Am 243           |  | 8              |                 |
| Cs 134  | <1.45E-08                              | C 3            |                 | Cm 242           |  | 8              |                 |
| Cs 135  |  | 8              |                 | Cm 243           |  | 8              |                 |
| Cs 137  | 2.44E-04                               | CC 2           |                 | Cm 244           | 2.12E-08                               | CC 2           |                 |
| Ba 133  | <3.32E-07                              | C 3            |                 | 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  | <2.43E-07                              | C 3            |                 | <b>Total a</b>   | <b>1.68E-05</b>                        | <b>CC 2</b>    | <b>0</b>        |
| Eu 155  | <1.95E-07                              | C 3            |                 | <b>Total b/g</b> | <b>1.17E-03</b>                        | <b>CC 2</b>    | <b>0</b>        |

**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