

|                     |              |   |
|---------------------|--------------|---|
| <b>WASTE STREAM</b> | <b>3M311</b> | <b>Decommissioning stage 3: Stainless Steel (Reactor) ILW</b> |
|---------------------|--------------|---|

**SITE** Heysham 2

**SITE OWNER** EDFE NGL

**WASTE CUSTODIAN** EDFE NGL

**WASTE TYPE** ILW

**WASTE VOLUMES**

|                        |                           | Reported             |
|------------------------|---------------------------|----------------------|
| Stocks:                | At 1.4.2019.....          | 0 m <sup>3</sup>     |
| Future arisings -      | 1.4.2019 - 31.3.2118..... | 0 m <sup>3</sup>     |
|                        | 1.4.2118 - 31.3.2119..... | 44.7 m <sup>3</sup>  |
|                        | 1.4.2119 - 31.3.2120..... | 50.6 m <sup>3</sup>  |
|                        | 1.4.2120 - 31.3.2121..... | 45.8 m <sup>3</sup>  |
| Total future arisings: |                           | 141.0 m <sup>3</sup> |
| Total waste volume:    |                           | 141.0 m <sup>3</sup> |

Comment on volumes: Waste volumes will be variable depending on station operating conditions.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 1.5  
 Stock (lower): x Arisings (lower) x 0.5

**WASTE SOURCE** Stainless steel items (including Control rods) from reactor dismantling.

**PHYSICAL CHARACTERISTICS**

General description: A variety of stainless steel items. Waste can be packaged in standard NDA packages.

Physical components (%vol): Stainless steel items (100%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): ~1.4

Comment on density: The density is of the waste as cut for packaging.

**CHEMICAL COMPOSITION**

General description and components (%wt): Almost completely stainless steel (100%) with possibly a trace of other metals.

Chemical state: -

Chemical form of radionuclides: H-3: Diffused into matrix  
 C-14: Incorporated in the steel. There may be some surface contamination as graphite.  
 Cl-36: The chlorine will be incorporated in the steel  
 Se-79: Selenium content not expected to be significant  
 Tc-99: Not determined  
 I-129: Not determined  
 Ra: Radium content is insignificant  
 Th: Thorium content is Insignificant  
 U: Not determined  
 Np: The neptunium content is insignificant  
 Pu: Not determined

Metals and alloys (%wt): The waste will be bulk metal items which have been cut for packaging. Metal thicknesses will range from a few mm to about 50mm.

|                           |       |   |
|---------------------------|-------|---|
| Stainless steel.....      | 100.0 | 316SS (52.3%), 304SS(31.4%),<br>321SS(16.3%). |
| Other ferrous metals..... | 0     |   |
| Iron.....                 | 0     |   |
| Aluminium.....            | 0     |   |
| Beryllium.....            | 0     |   |
| Cobalt.....               | 0     |   |
| Copper.....               | 0     |   |
| Lead.....                 | 0     |   |

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|                        |                                     |   |
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|                        | Magnox/Magnesium.....               | 0 |
|                        | Nickel.....                         | 0 |
|                        | Titanium.....                       | 0 |
|                        | Uranium.....                        | 0 |
|                        | Zinc.....                           | 0 |
|                        | Zircaloy/Zirconium.....             | 0 |
|                        | Other metals.....                   | 0 |
| Organics (%wt):        | None expected.                      |   |
|                        | 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.....                   | 0 |
|                        | Oil or grease .....                 |   |
|                        | Fuel.....                           |   |
|                        | Asphalt/Tarmac (cont.coal tar)...   |   |
|                        | Asphalt/Tarmac (no coal tar)....    |   |
|                        | Bitumen.....                        |   |
|                        | Others.....                         |   |
|                        | Other organics.....                 | 0 |
| Other materials (%wt): | -                                   |   |
|                        | Inorganic ion exchange materials.   | 0 |
|                        | Inorganic sludges and flocs.....    | 0 |
|                        | Soil.....                           | 0 |
|                        | Brick/Stone/Rubble.....             | 0 |
|                        | Cementitious material.....          | 0 |
|                        | Sand.....                           | 0 |
|                        | Glass/Ceramics.....                 | 0 |
|                        | Graphite.....                       | 0 |
|                        | Desiccants/Catalysts.....           | 0 |
|                        | Asbestos.....                       | 0 |
|                        | 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):                              | None likely to be present.  |    |                 |
|  | 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: | No materials likely to pose a fire or other non-radiological hazard have been identified. |    |                 |
|  | 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  | May be present. |
|  | Soluble solids as bulk chemical compounds.....  | 0  |                 |
| Hazardous substances / non hazardous pollutants:     | -   |    |                 |
|  | Acrylamide.....   | NE |                 |
|  | Benzene.....  | NE |                 |
|  | Chlorinated solvents.....   | NE |                 |
|  | Formaldehyde.....   | NE |                 |
|  | Organometallics.....  | NE |                 |
|  | Phenol.....   | NE |                 |
|  | Styrene.....  | NE |                 |
|  | Tri-butyl phosphate.....  | NE |                 |
|  | Other organophosphates.....   | NE |                 |
|  | Vinyl chloride.....   | NE |                 |
|  | Arsenic.....  | NE |                 |

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Barium..... NE  
 Boron..... NE  
 Cadmium..... NE  
 Caesium..... NE  
 Selenium..... NE  
 Chromium..... NE  
 Molybdenum..... NE  
 Thallium..... NE  
 Tin..... NE  
 Vanadium..... NE  
 Mercury compounds..... NE  
 Others..... NE  
 Electronic Electrical Equipment (EEE)  
   EEE Type 1..... 0  
   EEE Type 2..... 0  
   EEE Type 3..... 0  
   EEE Type 4..... 0  
   EEE Type 5..... 0

Complexing agents (%wt): Not yet determined  
 EDTA..... NE  
 DPTA..... NE  
 NTA..... NE  
 Polycarboxylic acids..... NE  
 Other organic complexants..... NE  
 Total complexing agents..... NE

Only trace quantities, if any.

**PACKAGING AND CONDITIONING**

Conditioning method: The waste is not expected to be supercompacted. It will be placed in 'baskets' in the waste packages, and is assumed to be encapsulated.  
 Plant Name: -  
 Location: -  
 Plant startup date: 85 years after reactor shut down.  
 Total capacity (m³/y incoming waste): ~5000.0  
 Target start date for packaging this stream: -  
 Throughput for this stream (m³/y incoming waste): -  
 Other information: Waste will be conditioned when removed from the reactor.

| Likely container type: | Container                         | Waste packaged (%vol) | Waste loading (m³) | Payload (m³) | Number of packages |
|------------------------|-----------------------------------|-----------------------|--------------------|--------------|--------------------|
|                        | 4m box (100mm concrete shielding) | 100.0                 | ~12.2              | ~14.3        | 12                 |

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Likely container type comment: -

Range in container waste volume: -

Other information on containers: Stainless Steel.

Likely conditioning matrix: BFS/OPC

Other information: -

Conditioned density (t/m<sup>3</sup>): ~3.06

Conditioned density comment: Assumes waste will be encapsulated, matrix would be likely to be BFS/OPC.

Other information on conditioning: The waste will be in baskets placed in the waste packages. Baskets of different Stage 3 ILW wastes may be in the same waste package.

Opportunities for alternative disposal routing: No

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

**RADIOACTIVITY**

Source: Activation of the stainless steel and impurities.

Uncertainty: The values quoted were derived by calculation from available material specification and are indicative of the activities that are expected. A major source of uncertainty is the impurity levels.

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/decay calculations based on neutron flux and projected operating history.

Other information: The activities quoted are for the time at which this waste will arise (i.e. ~85 years after end of generation). There may be some contamination by Cs137.

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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 | Bands and Code |                  | Waste at 1.4.2019                      | Bands and Code   | Future arisings | Bands and Code |
| H 3     |  |                |                 | 8              | Gd 153           |  |                  |                 |                |
| Be 10   |  |                |                 | 8              | Ho 163           |  |                  |                 |                |
| C 14    |  |                | 1.59E-02        | C C 2          | Ho 166m          |  |                  |                 |                |
| Na 22   |  |                |                 | 4              | Tm 170           |  |                  |                 |                |
| Al 26   |  |                |                 | 4              | Tm 171           |  |                  |                 |                |
| Cl 36   |  |                | 1E-05           | C C 2          | Lu 174           |  |                  |                 |                |
| Ar 39   |  |                |                 |                | Lu 176           |  |                  |                 |                |
| Ar 42   |  |                |                 |                | Hf 178n          |  |                  |                 |                |
| K 40    |  |                |                 |                | Hf 182           |  |                  |                 |                |
| Ca 41   |  |                |                 | 8              | Pt 193           |  |                  |                 |                |
| Mn 53   |  |                |                 |                | Tl 204           |  |                  |                 |                |
| Mn 54   |  |                |                 | 8              | Pb 205           |  |                  |                 |                |
| Fe 55   |  |                | 1.86E-08        | C C 2          | Pb 210           |  |                  |                 | 8              |
| Co 60   |  |                | 1.6E-04         | C C 2          | Bi 208           |  |                  |                 |                |
| Ni 59   |  |                | 4.25E-02        | C C 2          | Bi 210m          |  |                  |                 |                |
| Ni 63   |  |                | 2.75E+00        | C C 2          | Po 210           |  |                  |                 | 8              |
| Zn 65   |  |                |                 | 8              | Ra 223           |  |                  |                 |                |
| Se 79   |  |                |                 | 8              | Ra 225           |  |                  |                 |                |
| Kr 81   |  |                |                 |                | Ra 226           |  |                  |                 | 8              |
| Kr 85   |  |                |                 |                | Ra 228           |  |                  |                 |                |
| Rb 87   |  |                |                 |                | Ac 227           |  |                  |                 |                |
| Sr 90   |  |                |                 | 8              | Th 227           |  |                  |                 |                |
| Zr 93   |  |                |                 | 8              | Th 228           |  |                  |                 |                |
| Nb 91   |  |                |                 |                | Th 229           |  |                  |                 | 8              |
| Nb 92   |  |                |                 |                | Th 230           |  |                  |                 | 8              |
| Nb 93m  |  |                | 5.67E-06        | C C 2          | Th 232           |  |                  |                 | 8              |
| Nb 94   |  |                | 3.27E-05        | C C 2          | Th 234           |  |                  |                 |                |
| Mo 93   |  |                | 4.05E-04        | C C 2          | Pa 231           |  |                  |                 | 8              |
| Tc 97   |  |                |                 |                | Pa 233           |  |                  |                 |                |
| Tc 99   |  |                | 5.09E-05        | C C 2          | U 232            |  |                  |                 |                |
| Ru 106  |  |                |                 | 8              | U 233            |  |                  |                 | 8              |
| Pd 107  |  |                |                 | 8              | U 234            |  |                  |                 | 8              |
| Ag 108m |  |                | 2.09E-06        | C C 2          | U 235            |  |                  |                 | 8              |
| Ag 110m |  |                |                 |                | U 236            |  |                  |                 | 8              |
| Cd 109  |  |                |                 |                | U 238            |  |                  |                 | 8              |
| Cd 113m |  |                |                 |                | Np 237           |  |                  |                 | 8              |
| Sn 119m |  |                |                 |                | Pu 236           |  |                  |                 |                |
| Sn 121m |  |                |                 | 8              | Pu 238           |  |                  |                 | 8              |
| Sn 123  |  |                |                 |                | Pu 239           |  |                  |                 | 8              |
| Sn 126  |  |                |                 | 8              | Pu 240           |  |                  |                 | 8              |
| Sb 125  |  |                |                 |                | Pu 241           |  |                  |                 | 8              |
| Sb 126  |  |                |                 |                | Pu 242           |  |                  |                 | 8              |
| Te 125m |  |                |                 |                | Am 241           |  |                  |                 | 8              |
| Te 127m |  |                |                 |                | 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  |  |                |                 |                | Cm 245           |  |                  |                 | 8              |
| La 137  |  |                |                 |                | Cm 246           |  |                  |                 | 8              |
| La 138  |  |                |                 |                | Cm 248           |  |                  |                 |                |
| Ce 144  |  |                |                 | 8              | Cf 249           |  |                  |                 |                |
| Pm 145  |  |                |                 |                | Cf 250           |  |                  |                 |                |
| Pm 147  |  |                |                 | 8              | Cf 251           |  |                  |                 |                |
| Sm 147  |  |                |                 |                | Cf 252           |  |                  |                 |                |
| Sm 151  |  |                |                 | 8              | Other a          |  |                  |                 | 8              |
| Eu 152  |  |                |                 | 8              | Other b/g        |  |                  |                 | 8              |
| Eu 154  |  |                |                 | 8              | <b>Total a</b>   | <b>0</b>                               | <b>&lt;1E-09</b> |                 | <b>8</b>       |
| Eu 155  |  |                |                 | 8              | <b>Total b/g</b> | <b>0</b>                               | <b>2.81E+00</b>  | <b>C C 2</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