

| WASTE STREAM | 9G312 | Miscellaneous Metal (Reactor) ILW |
|--------------|-------|-----------------------------------|
|--------------|-------|-----------------------------------|

**SITE** Trawsfynydd

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Nuclear Restoration Services Ltd (NRS)

**WASTE TYPE** ILW

#### WASTE VOLUMES

|                        | Reported (m <sup>3</sup> ) | OR    | Conditioned (m <sup>3</sup> ) | Packaged (m <sup>3</sup> ) |
|------------------------|----------------------------|-------|-------------------------------|----------------------------|
| Stocks:                | At 1.4.2025                | = 0   |                               |                            |
| Future arisings:       | 1.4.2035 - 31.3.2059       | 143.0 |                               |                            |
| Total future arisings: |                            | 143.0 |                               |                            |
| Total waste volume:    |                            | 143.0 |                               |                            |

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: For inventory purposes the arisings are assumed to arise at a uniform rate over 25 years.

Additional information on quantities: Reactor dismantling is assumed to commence in 2035 and last for 25 years. The volumes and radioactivity have been calculated for 44 years after reactor shutdown, i.e. 2035

Uncertainty factors on volumes:

|                |     |                   |        |
|----------------|-----|-------------------|--------|
| Stock (upper): | x - | Arisings (upper): | x 1.20 |
| Stock (lower): | x - | Arisings (lower): | x 0.80 |

**WASTE SOURCE** Miscellaneous metallic wastes resulting from reactor dismantling.

#### PHYSICAL CHARACTERISTICS

General description: Boron steel control rods and Magnox seals.

Changes since waste generated: -

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): Boron steel (82%wt), Magnox incorporating zirconium (18% wt).

Chemical state: Neutral

Sheet metal proportion / thickness: All of the waste will have been cut, if necessary, to fit a standard ILW package.

Metals and alloys (%wt):

|                           | (%wt)  | Type(s) / Grades(s) with proportions                 | % of total C14 activity |
|---------------------------|--------|------------------------------------------------------|-------------------------|
| Stainless steel.....      | = 0    | -                                                    |                         |
| Other ferrous metals..... | = 82.0 | boron steel.                                         |                         |
| Iron.....                 |        | -                                                    |                         |
| Aluminium.....            | NE     | -                                                    |                         |
| Beryllium.....            | TR     | -                                                    |                         |
| Cobalt.....               | < 0.04 | Greatest measured value from the various components. |                         |
| Copper.....               | NE     | -                                                    |                         |
| Lead.....                 | NE     | -                                                    |                         |
| Magnox/Magnesium.....     | = 18.0 | -                                                    |                         |
| Nickel.....               |        | -                                                    |                         |
| Titanium.....             |        | -                                                    |                         |
| Uranium.....              |        | -                                                    |                         |
| Zinc.....                 | NE     | -                                                    |                         |
| Zircaloy/Zirconium.....   | P      | Zirconium is present in the Magnox.                  |                         |
| Other metals.....         | TR     | Silver and niobium.                                  |                         |

Organics (%wt):

|                                     | (%wt) | Type(s) and comment | % of total C14 activity |
|-------------------------------------|-------|---------------------|-------------------------|
| Total cellulose.....                | = 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.....                 | = 0   | -                   |                         |

Other materials (%wt):

|                                       | (%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.....             | = 0   | -                   |                         |
| Free non-aqueous liquids.....         | = 0   | -                   |                         |
| Powder/Ash.....                       | = 0   | -                   |                         |

#### COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

|                                                | (%wt)  | Type(s) and comment |
|------------------------------------------------|--------|---------------------|
| Combustible metals.....                        | = 18.0 | Magnox/Magnesium    |
| 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.....                    |        | -                   |
| Corrosive materials.....                       | = 0    | -                   |
| Pyrophoric materials.....                      | = 0    | -                   |
| Generating toxic gases.....                    | = 0    | -                   |
| Reacting with water.....                       | = 18.0 | Magnox/Magnesium    |
| Higher activity particles.....                 |        | -                   |
| Soluble solids as bulk chemical compounds..... |        | -                   |

Hazardous substances / non hazardous pollutants:

|                             | (%wt)  | Type(s) and comment                                  |
|-----------------------------|--------|------------------------------------------------------|
| Acrylamide.....             | 0      | -                                                    |
| Benzene.....                |        | -                                                    |
| Chlorinated solvents.....   |        | -                                                    |
| Formaldehyde.....           |        | -                                                    |
| Organometallics.....        |        | -                                                    |
| Phenol.....                 |        | -                                                    |
| Styrene.....                |        | -                                                    |
| Tri-butyl phosphate.....    |        | -                                                    |
| Other organophosphates..... |        | -                                                    |
| Vinyl chloride.....         |        | -                                                    |
| Arsenic.....                |        | -                                                    |
| Barium.....                 |        | -                                                    |
| Boron.....                  |        | -                                                    |
| Boron (in Boral).....       |        | -                                                    |
| Boron (non-Boral).....      |        | -                                                    |
| Cadmium.....                | < 0.01 | Greatest measured value from the various components. |
| Caesium.....                |        |                                                      |
| Selenium.....               |        |                                                      |
| Chromium.....               |        |                                                      |
| Molybdenum.....             |        |                                                      |
| Thallium.....               |        |                                                      |
| Tin.....                    |        |                                                      |
| Vanadium.....               |        |                                                      |
| Mercury compounds.....      |        |                                                      |
| Others.....                 |        |                                                      |

Complexing agents (%wt):

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

Physical components:

|                                         | Number | Type(s) and comment |
|-----------------------------------------|--------|---------------------|
| Sources.....                            |        | -                   |
| Electronic & Electrical Equipment (EEE) |        | -                   |
| EEE Type 1.....                         |        | -                   |
| EEE Type 2.....                         |        | -                   |
| EEE Type 3.....                         |        | -                   |
| EEE Type 4.....                         |        | -                   |
| EEE Type 5.....                         |        | -                   |

## TREATMENT, PACKAGING AND DISPOSAL

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

| Treatment                                                  | On-site / Off-site | Stream volume % |
|------------------------------------------------------------|--------------------|-----------------|
| Size reduction                                             | On-site            | 100.0           |
| Decay storage                                              |                    |                 |
| Low force compaction                                       |                    |                 |
| Supercompaction (HFC)                                      |                    |                 |
| Incineration                                               |                    |                 |
| Drying/dewatering/liquid separation                        |                    |                 |
| Tie down/fixatives/strippable coating/painting application |                    |                 |
| Decontamination                                            |                    |                 |
| Metal treatment                                            |                    |                 |
| Recycling / reuse                                          |                    |                 |
| Thermal treatment, including vitrification                 |                    |                 |
| Encapsulation                                              |                    |                 |
| Polymer encapsulation                                      |                    |                 |
| Other physical treatment                                   |                    |                 |
| Other chemical treatment                                   |                    |                 |
| Containerisation                                           |                    |                 |
| Treatment not yet determined                               |                    |                 |
| None                                                       |                    |                 |

Comments on planned treatments:

-

The processing strategy has not yet been determined. The waste is not expected to be supercompacted. The treatment envisaged is the placement of the waste in baskets followed by encapsulation.

Conditioning plants:

| Plant Name    | Location    |
|---------------|-------------|
| RDC Encap TRW | Trawsfynydd |

Likely conditioning matrix:

Unknown

Further information on the conditioning matrix:

The waste is assumed to be encapsulated.

#### Waste Packaging:

| Likely container type: | Container                           | Waste packaged (vol%) | Waste loading (m³) | Payload (m³) | Number of packages | Estimated start date for packaging |
|------------------------|-------------------------------------|-----------------------|--------------------|--------------|--------------------|------------------------------------|
|                        | 4 m box (200 mm concrete shielding) | 100.0                 | 9.3                | 10.9         | 16                 | -                                  |

Range in container waste loading: Not yet determined. No significant variability is expected.

Other information on packaging and conditioning:

The container material is expected to be stainless steel. The waste will be in baskets placed in the waste packages. Baskets of different Reactor Dismantling & Site Clearance ILW wastes may be in the same waste package. The encapsulation matrix is likely to be BFS/OPC and the density of the conditioned waste product would be about 3 t/m³. The volume of this stream is small and will not fill one box. Data have been presented as if the waste will be placed in a container with other ILW.

Conditioned density (t/m³):

~ 3.0

Conditioned density comment:

The conditioned waste density assumes that the waste will be encapsulated.

#### Management Routes:

| Disposal Route                                                                     | Stream volume % | Raw density t/m³ | Start date |
|------------------------------------------------------------------------------------|-----------------|------------------|------------|
| Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland) | 100.0           |                  |            |
| Expected to be Non-NSD HAW managed under Scottish Government's policy              |                 |                  |            |
| Expected to be disposed to LLW Vaults NRS Dounreay                                 |                 |                  |            |
| Expected to be consigned to the Geological Disposal Facility                       |                 |                  |            |
| Expected to be consigned to a Near Surface Disposal Facility                       |                 |                  |            |
| Expected to be consigned to the LLW Repository                                     |                 |                  |            |
| Expected to be consigned to a Landfill Facility                                    |                 |                  |            |
| Expected to be disposed On-Site                                                    |                 |                  |            |
| Expected to be managed by In-Situ Disposal                                         |                 |                  |            |
| Expected to be consigned to an Incineration Facility                               |                 |                  |            |
| Expected to be consigned to a Metal Treatment Facility                             |                 |                  |            |
| Expected to be Out of Scope                                                        |                 |                  |            |
| Expected to be recycled / reused                                                   |                 |                  |            |
| Disposal route not known                                                           |                 |                  |            |

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: No

| Baseline Management Route | Opportunity Management Route | Stream volume (%) | Opportunity Confidence | Comment |
|---------------------------|------------------------------|-------------------|------------------------|---------|
| -                         | -                            | -                 | -                      | -       |

#### RADIOACTIVITY

Source:

Activation of the metals and impurities. There may be some contamination by Cs-137.

Uncertainty:

The values quoted were derived by calculation from available material specifications and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels. The activities quoted are those at 44 years after shutdown, i.e. in 2035.

Measurement of radioactivities:

The specific activities were estimated from neutron activation calculations of the material and its impurities.

Chemical form of radionuclides:

H-3: The tritium content is insignificant.  
 C-14: Carbon 14 is incorporated in the Magnox. There may be some graphite contamination.  
 Cl-36: The chlorine 36 content is insignificant.  
 Se-79: The selenium content is insignificant.  
 Tc-99: The chemical form of technetium has not been determined.  
 I-129: -  
 Ra: The radium content is insignificant.  
 Th: The thorium content is insignificant.  
 U: The uranium content is insignificant.  
 Np: The neptunium content is insignificant.  
 Pu: The plutonium content is insignificant.

| WASTE STREAM 9G312 Miscellaneous Metal (Reactor) ILW |                            |                |                 |                |                  |                            |                |                 |                |
|------------------------------------------------------|----------------------------|----------------|-----------------|----------------|------------------|----------------------------|----------------|-----------------|----------------|
| Nuclide                                              | Mean radioactivity, TBq/m³ |                |                 |                | Nuclide          | Mean radioactivity, TBq/m³ |                |                 |                |
|                                                      | Waste at 1.4.2025          | Bands and Code | Future Arisings | Bands and Code |                  | Waste at 1.4.2025          | Bands and Code | Future Arisings | Bands and Code |
| H 3                                                  |                            |                |                 | 8              | Gd 153           |                            |                |                 | 8              |
| Be 10                                                |                            |                |                 | 8              | Ho 163           |                            |                |                 | 8              |
| C 14                                                 |                            |                | 3.75E-03        | C C 2          | Ho 166m          |                            |                |                 | 8              |
| Na 22                                                |                            |                |                 | 8              | Tm 170           |                            |                |                 | 8              |
| Al 26                                                |                            |                |                 | 8              | Tm 171           |                            |                |                 | 8              |
| Cl 36                                                |                            |                | 3.20E-04        | 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                                                |                            |                | 8.51E-04        | C C 2          | Pt 193           |                            |                |                 | 8              |
| Mn 53                                                |                            |                |                 | 8              | Ti 204           |                            |                | 6.14E-06        | C C 2          |
| Mn 54                                                |                            |                |                 | 8              | Pb 205           |                            |                |                 | 8              |
| Fe 55                                                |                            |                | 1.36E-04        | C C 2          | Pb 210           |                            |                |                 | 8              |
| Co 60                                                |                            |                | 4.50E-03        | C C 2          | Bi 208           |                            |                |                 | 8              |
| Ni 59                                                |                            |                | 5.38E-03        | C C 2          | Bi 210m          |                            |                |                 | 8              |
| Ni 63                                                |                            |                | 4.99E-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                                                |                            |                |                 | 8              | 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                                                |                            |                | 4.76E-05        | C C 2          | Th 234           |                            |                |                 | 8              |
| Mo 93                                                |                            |                | 5.93E-05        | C C 2          | Pa 231           |                            |                |                 | 8              |
| Tc 97                                                |                            |                |                 | 8              | Pa 233           |                            |                |                 | 8              |
| Tc 99                                                |                            |                | 1.13E-05        | C C 2          | U 232            |                            |                |                 | 8              |
| Ru 106                                               |                            |                |                 | 8              | U 233            |                            |                |                 | 8              |
| Pd 107                                               |                            |                |                 | 8              | U 234            |                            |                |                 | 8              |
| Ag 108m                                              |                            |                | 7.47E-03        | C C 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                                              |                            |                | 6.67E-04        | C C 2          | 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                                               |                            |                |                 | 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                                               |                            |                |                 | 8              | Cf 251           |                            |                |                 | 8              |
| Sm 147                                               |                            |                |                 | 8              | Cf 252           |                            |                |                 | 8              |
| Sm 151                                               |                            |                |                 | 8              | Unsp a           |                            |                |                 | 8              |
| Eu 152                                               |                            |                |                 | 8              | Unsp b/g         |                            |                |                 | 8              |
| Eu 154                                               |                            |                | 4.24E-05        | C C 2          | <b>Total a</b>   | <b>0</b>                   | <b>*</b>       | <b>0</b>        | <b>*</b>       |
| Eu 155                                               |                            |                | 1.62E-06        | C C 2          | <b>Total b/g</b> | <b>0</b>                   | <b>*</b>       | <b>5.22E-01</b> | <b>*</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 the 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  
\* Total calculated from the 114 declared radionuclides