

| WASTE STREAM | 9A311 | Mild Steel (Reactor) ILW |
|--------------|-------|--------------------------|
|--------------|-------|--------------------------|

**SITE** Berkeley

**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:       | 1.4.2060 - 31.3.2079       | 270.0 |                               |                            |
| Total future arisings: |                            | 270.0 |                               |                            |
| Total waste volume:    |                            | 270.0 |                               |                            |

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

Comment on arising rates: For inventory purposes waste arisings are assumed to occur at a uniform rate over 20 years

Additional information on quantities: Reactor Dismantling and Site Clearance is assumed to commence in 2060 and last for 20 years. The volumes and radioactivity have been calculated for 72 years after reactor shutdown i.e. 2060.

Uncertainty factors on volumes: Stock (upper): x - Arisings (upper): x 1.20  
Stock (lower): x - Arisings (lower): x 0.80

**WASTE SOURCE** Mild steel items from the reactor structure.

#### PHYSICAL CHARACTERISTICS

General description: A variety of mild steel items including charge pan and restraint beam components. Waste can be packaged in standard containers.

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): Mild steel (100%).

Chemical state: Neutral

Sheet metal proportion / thickness: All of the waste will be bulk metal items which will be cut for packaging. Metal thicknesses will probably range from a few mm to about 100 mm.

Metals and alloys (%wt):

|                           | (%wt)   | Type(s) / Grades(s) with proportions                 | % of total C14 activity |
|---------------------------|---------|------------------------------------------------------|-------------------------|
| Stainless steel.....      | = 0     | -                                                    |                         |
| Other ferrous metals..... | = 100.0 | Grade JTA-101.                                       | 100.0                   |
| Iron.....                 | -       | -                                                    |                         |
| Aluminium.....            | = 0     | -                                                    |                         |
| Beryllium.....            | 0       | -                                                    |                         |
| Cobalt.....               | < 0.01  | Greatest measured value from the various components. |                         |
| Copper.....               | = 0     | -                                                    |                         |
| Lead.....                 | = 0     | -                                                    |                         |
| Magnox/Magnesium.....     | = 0     | -                                                    |                         |
| Nickel.....               | < 0.01  | Greatest measured value from the various components. |                         |
| Titanium.....             | -       | -                                                    |                         |
| Uranium.....              | -       | -                                                    |                         |
| Zinc.....                 | = 0     | -                                                    |                         |
| Zircaloy/Zirconium.....   | = 0     | -                                                    |                         |
| Other metals.....         | TR      | Trace 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.....                        | = 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.....                    |       | -                   |
| Corrosive materials.....                       | = 0   | -                   |
| Pyrophoric materials.....                      | = 0   | -                   |
| Generating toxic gases.....                    | = 0   | -                   |
| Reacting with water.....                       | = 0   | -                   |
| 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.....                |       | -                   |
| Caesium.....                |       | -                   |
| Selenium.....               |       | -                   |
| Chromium.....               |       | -                   |
| Molybdenum.....             |       | -                   |
| Thallium.....               |       | -                   |
| Tin.....                    |       | -                   |
| Vanadium.....               |       | -                   |
| Mercury compounds.....      |       | -                   |
| Others.....                 |       | -                   |

Complexing agents (%wt):

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

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

Comments on planned treatments:

-

Conditioning method:

It is currently intended that these wastes will be grouted. The waste is not expected to be supercompacted. It will be placed in baskets in the waste packages followed by encapsulation with BFS/OPC.

Conditioning plants:

| Plant Name    | Location |
|---------------|----------|
| RDC Encap BRK | Berkeley |

Likely conditioning matrix:

Unknown

Further information on the conditioning matrix:

-

**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 (0 mm concrete shielding) | 100.0                 | 16.2               | 18.9         | 17                 | -                                  |

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

Other information on packaging and conditioning: The waste will be in baskets placed in the waste packages. Baskets of different reactor dismantling and site clearance ILW wastes may be in the same waste package. As encapsulation is now intended, the matrix is likely to be BFS/OPC and the density of the conditioned waste product will be about 3 t/m³.

Conditioned density (t/m³): ~ 3.0  
 Conditioned density comment: The conditioned waste density assumes 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 mild steel and its impurities.

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

Measurement of radioactivities: The specific activities were estimated from neutron activation calculations of impurities in mild steel. The activities quoted are those at 72 years after reactor shutdown, i.e. in 2060. There may be some contamination by Cs137.

Chemical form of radionuclides: H-3: -  
 C-14: The carbon 14 is incorporated in the steel. There may also be some contamination as graphite.  
 Cl-36: The chemical form of chlorine 36 has not been determined.  
 Se-79: -  
 Tc-99: -  
 I-129: -  
 Ra: -  
 Th: -  
 U: -  
 Np: -  
 Pu: -

| WASTE STREAM 9A311 Mild Steel (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                                        |                            |                | 5.94E-03        | C C 2          | Ho 166m          |                            |                |                 | 8              |
| Na 22                                       |                            |                |                 | 8              | Tm 170           |                            |                |                 | 8              |
| Al 26                                       |                            |                |                 | 8              | Tm 171           |                            |                |                 | 8              |
| Cl 36                                       |                            |                | 1.84E-06        | 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              | Pt 193           |                            |                |                 | 8              |
| Mn 53                                       |                            |                |                 | 8              | Ti 204           |                            | 2.27E-07       | C C 2           | 8              |
| Mn 54                                       |                            |                |                 | 8              | Pb 205           |                            |                |                 | 8              |
| Fe 55                                       |                            |                | 2.36E-06        | C C 2          | Pb 210           |                            |                |                 | 8              |
| Co 60                                       |                            |                | 9.60E-04        | C C 2          | Bi 208           |                            |                |                 | 8              |
| Ni 59                                       |                            |                | 1.91E-03        | C C 2          | Bi 210m          |                            |                |                 | 8              |
| Ni 63                                       |                            |                | 1.27E-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                                       |                            |                | 9.95E-05        | C C 2          | Th 234           |                            |                |                 | 8              |
| Mo 93                                       |                            |                | 3.93E-05        | C C 2          | Pa 231           |                            |                |                 | 8              |
| Tc 97                                       |                            |                |                 | 8              | Pa 233           |                            |                |                 | 8              |
| Tc 99                                       |                            |                | 8.55E-06        | C C 2          | U 232            |                            |                |                 | 8              |
| Ru 106                                      |                            |                |                 | 8              | U 233            |                            |                |                 | 8              |
| Pd 107                                      |                            |                |                 | 8              | U 234            |                            |                |                 | 8              |
| Ag 108m                                     |                            |                | 2.88E-06        | 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                                     |                            |                | 7.44E-05        | 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           |                            |                |                 |                |
| Eu 152                                      |                            |                | 4.58E-06        | C C 2          | Unsp b/g         |                            |                |                 |                |
| Eu 154                                      |                            |                | 3.67E-08        | C C 2          | <b>Total a</b>   | <b>0</b>                   | <b>*</b>       | <b>0</b>        | <b>*</b>       |
| Eu 155                                      |                            |                |                 | 8              | <b>Total b/g</b> | <b>0</b>                   | <b>*</b>       | <b>1.36E-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