

| WASTE STREAM | 6N104 | Decommissioning Mixed Metallic |
|--------------|-------|--------------------------------|
|--------------|-------|--------------------------------|

**SITE** Rutherford Appleton Laboratory

**SITE OWNER** UK Research and Innovation

**WASTE CUSTODIAN** UK Research and Innovation

**WASTE TYPE** LLW

#### 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:       | 1.4.2045 - 31.3.2058       | ~ 376.0      |                               |                            |
| Total future arisings: |                            | <b>376.0</b> |                               |                            |
| Total waste volume:    |                            | <b>376.0</b> |                               |                            |

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

Comment on arising rates: Estimated volumes of mixed metallic waste from the decommissioning of ISIS.

Additional information on quantities: Waste arising from the decommissioning of ISIS, dates not known at this time.

Uncertainty factors on volumes: Stock (upper): x - Arisings (upper): x 2.00  
Stock (lower): x - Arisings (lower): x 0.50

**WASTE SOURCE** Mixed metallic waste from the decommissioning of ISIS including TS1 and TS2 TSAs, synchrotron, EPB and instrumentation waste.

#### PHYSICAL CHARACTERISTICS

General description: Solid, dry metals

Changes since waste generated: Activated metals from ISIS decommissioning

Bulk density (t/m<sup>3</sup>): ~ 4.0

Comment on density: Calculated from weighted average density of mild steel, copper and stainless steel which are the main components of this stream with an assumed 50% volume fraction, therefore density is approx. 4 t/m<sup>3</sup>

#### CHEMICAL COMPOSITION

General description and components (%wt): Metallic waste

Chemical state: Neutral

Sheet metal proportion / thickness: Not quantitatively assessed, but expect to be a very small fraction

Metals and alloys (%wt):

|                           | (%wt)  | Type(s) / Grades(s) with proportions | % of total C14 activity |
|---------------------------|--------|--------------------------------------|-------------------------|
| Stainless steel.....      | ~ 46.6 | -                                    |                         |
| Other ferrous metals..... | ~ 38.1 | -                                    |                         |
| Iron.....                 | = 0    | -                                    |                         |
| Aluminium.....            | ~ 1.2  | -                                    |                         |
| Beryllium.....            | = 0    | -                                    |                         |
| Cobalt.....               | = 0    | -                                    |                         |
| Copper.....               | ~ 14.0 | inc. small quantities of brass       |                         |
| Lead.....                 | P      | -                                    |                         |
| Magnox/Magnesium.....     | = 0    | -                                    |                         |
| Nickel.....               | = 0    | -                                    |                         |
| Titanium.....             | = 0    | -                                    |                         |
| Uranium.....              | = 0    | -                                    |                         |
| Zinc.....                 | = 0    | -                                    |                         |
| Zircaloy/Zirconium.....   | = 0    | -                                    |                         |
| Other metals.....         | ~ 0.10 | Cadmium, Silver                      |                         |

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..... | P     | Borated Polyethylene         |                         |
| Condensation polymers.....          | = 0   | -                            |                         |
| Others.....                         | P     | -                            |                         |
| Organic ion exchange materials..... | = 0   | -                            |                         |
| Total rubber.....                   | = 0   | -                            |                         |
| Halogenated rubber.....             | = 0   | -                            |                         |
| Non-halogenated rubber.....         | = 0   | -                            |                         |
| Hydrocarbons.....                   | P     | -                            |                         |
| Oil or grease.....                  | P     | vacuum oil residues on pumps |                         |
| Fuel.....                           | = 0   | -                            |                         |
| Asphalt/Tarmac (cont.coal tar)..... | = 0   | -                            |                         |
| Asphalt/Tarmac (no coal tar).....   | = 0   | -                            |                         |
| Bitumen.....                        | = 0   | -                            |                         |
| Others.....                         | = 0   | -                            |                         |
| 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.....                             | = 0   | -                   |                         |
| Glass/Ceramics.....                   | P     | Boron Carbide       |                         |
| Graphite.....                         | = 0   | -                   |                         |
| Desiccants/Catalysts.....             | = 0   | -                   |                         |
| Asbestos.....                         | = 0   | -                   |                         |
| Non/low friable.....                  | = 0   | -                   |                         |
| Moderately friable.....               | = 0   | -                   |                         |
| Highly friable.....                   | = 0   | -                   |                         |
| 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.....  | 0     | -                   |
| 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.....                    | 0     | -                   |
| Corrosive materials.....                       | 0     | -                   |
| Pyrophoric materials.....                      | 0     | -                   |
| Generating toxic gases.....                    | 0     | -                   |
| Reacting with water.....                       | 0     | -                   |
| Higher activity particles.....                 | 0     | -                   |
| Soluble solids as bulk chemical compounds..... | 0     | -                   |

Hazardous substances / non hazardous pollutants:

|                             | (%wt)  | Type(s) and comment                  |
|-----------------------------|--------|--------------------------------------|
| Acrylamide.....             | = 0    | -                                    |
| Benzene.....                | = 0    | -                                    |
| Chlorinated solvents.....   | = 0    | -                                    |
| Formaldehyde.....           | = 0    | -                                    |
| Organometallics.....        | = 0    | -                                    |
| Phenol.....                 | = 0    | -                                    |
| Styrene.....                | = 0    | -                                    |
| Tri-butyl phosphate.....    | = 0    | -                                    |
| Other organophosphates..... | = 0    | -                                    |
| Vinyl chloride.....         | = 0    | -                                    |
| Arsenic.....                | = 0    | -                                    |
| Barium.....                 | = 0    | -                                    |
| Boron.....                  | P      | Borated polyethylene & Boron Carbide |
| Boron (in Boral).....       | -      | -                                    |
| Boron (non-Boral).....      | P      | -                                    |
| Cadmium.....                | ~ 0.10 | -                                    |
| Caesium.....                | = 0    | -                                    |
| Selenium.....               | = 0    | -                                    |
| Chromium.....               | = 0    | -                                    |
| Molybdenum.....             | = 0    | -                                    |
| Thallium.....               | = 0    | -                                    |
| Tin.....                    | = 0    | -                                    |
| Vanadium.....               | = 0    | -                                    |
| Mercury compounds.....      | = 0    | -                                    |
| Others.....                 | = 0    | -                                    |

Complexing agents (%wt):

|                                | (%wt) | Type(s) and comment |
|--------------------------------|-------|---------------------|
| EDTA.....                      | -     | -                   |
| 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                                             | On-site            | = 100.0         |
| Decay storage                                              |                    |                 |
| Low force compaction                                       |                    |                 |
| Supercompaction (HFC)                                      |                    |                 |
| Incineration                                               |                    |                 |
| Drying/dewatering/liquid separation                        | On-site            | ~ 25.0          |
| Tie down/fixatives/strippable coating/painting application |                    |                 |
| Decontamination                                            | Off-site           | ~ 80.0          |
| 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:

Segregation of activated componetns and decay storage can divert most waste to reuse or recycling

Conditioning method:

-

Conditioning plants:

| Plant Name | Location |
|------------|----------|
|            |          |

Likely conditioning matrix:

-

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 |
|------------------------|-----------|-----------------------|--------------------|--------------|--------------------|------------------------------------|
|                        | -         | -                     | -                  | -            | -                  | -                                  |

Range in container waste loading:

Other information on packaging and conditioning: -

Conditioned density (t/m³): -

Conditioned density comment: -

**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) |                 |                  |            |
| 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                                     | ~ 1.0           | ~ 2.0            | 2045       |
| Expected to be consigned to a Landfill Facility                                    | ~ 19.0          | ~ 2.0            | 2045       |
| 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                                                   | ~ 80.0          | ~ 2.0            | 2045       |
| Disposal route not known                                                           |                 |                  |            |

Classification codes for waste expected to be consigned to a landfill facility: 16 02 15\*, 16 02 16, 17 04 01, 17 04 02, 17 04 05, 17 04 07

Opportunities for alternative disposal routing: No

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

**RADIOACTIVITY**

Source: Activation by high-energy protons and neutrons.

Uncertainty: -

Measurement of radioactivities: Wastes are currently not characterised so data from operational mixed metallic 6N07 utilised.

Chemical form of radionuclides:

- H-3: Bound in the metal
- C-14: Bound in the metal
- Cl-36: -
- Se-79: -
- Tc-99: -
- I-129: -
- Ra: -
- Th: -
- U: -
- Np: -
- Pu: -

| WASTE STREAM |                            | 6N104             |                 | Decommissioning Mixed Metallic |           |                            |                   |                 |                   |
|--------------|----------------------------|-------------------|-----------------|--------------------------------|-----------|----------------------------|-------------------|-----------------|-------------------|
| Nuclide      | Mean radioactivity, TBq/m³ |                   |                 |                                | Nuclide   | Mean radioactivity, TBq/m³ |                   |                 |                   |
|              | Waste at<br>1.4.2025       | Bands and<br>Code | Future Arisings | Bands and<br>Code              |           | Waste at<br>1.4.2025       | Bands and<br>Code | Future Arisings | Bands and<br>Code |
| H 3          |                            |                   | ~~ 1.57E-05     | A C 3                          | Gd 153    |                            |                   |                 |                   |
| Be 10        |                            |                   |                 |                                | Ho 163    |                            |                   |                 |                   |
| C 14         |                            |                   |                 |                                | Ho 166m   |                            |                   |                 |                   |
| Na 22        |                            |                   | ~~ 5.00E-04     | D D 2                          | Tm 170    |                            |                   |                 |                   |
| Al 26        |                            |                   |                 |                                | Tm 171    |                            |                   |                 |                   |
| Cl 36        |                            |                   |                 |                                | Lu 174    |                            |                   |                 |                   |
| Ar 39        |                            |                   |                 |                                | Lu 176    |                            |                   |                 |                   |
| Ar 42        |                            |                   |                 |                                | Hf 178n   |                            |                   |                 |                   |
| K 40         |                            |                   |                 |                                | Hf 182    |                            |                   |                 |                   |
| Ca 41        |                            |                   |                 |                                | Pt 193    |                            |                   |                 |                   |
| Mn 53        |                            |                   |                 |                                | Tl 204    |                            |                   |                 |                   |
| Mn 54        |                            |                   | ~~ 8.79E-04     | D A 3                          | Pb 205    |                            |                   |                 |                   |
| Fe 55        |                            |                   | ~~ 7.59E-03     | B A 3                          | Pb 210    |                            |                   |                 |                   |
| Co 60        |                            |                   | ~~ 2.48E-04     | A A 3                          | Bi 208    |                            |                   |                 |                   |
| Ni 59        |                            |                   |                 |                                | Bi 210m   |                            |                   |                 |                   |
| Ni 63        |                            |                   | ~~ 5.00E-04     | D D 2                          | Po 210    |                            |                   |                 |                   |
| Zn 65        |                            |                   |                 |                                | Ra 223    |                            |                   |                 |                   |
| Se 79        |                            |                   |                 |                                | Ra 225    |                            |                   |                 |                   |
| Kr 81        |                            |                   |                 |                                | Ra 226    |                            |                   |                 |                   |
| Kr 85        |                            |                   |                 |                                | Ra 228    |                            |                   |                 |                   |
| Rb 87        |                            |                   |                 |                                | Ac 227    |                            |                   |                 |                   |
| Sr 90        |                            |                   |                 |                                | Th 227    |                            |                   |                 |                   |
| Zr 93        |                            |                   |                 |                                | Th 228    |                            |                   |                 |                   |
| Nb 91        |                            |                   |                 |                                | Th 229    |                            |                   |                 |                   |
| Nb 92        |                            |                   |                 |                                | Th 230    |                            |                   |                 |                   |
| Nb 93m       |                            |                   |                 |                                | Th 232    |                            |                   |                 |                   |
| Nb 94        |                            |                   |                 |                                | Th 234    |                            |                   |                 |                   |
| Mo 93        |                            |                   |                 |                                | Pa 231    |                            |                   |                 |                   |
| Tc 97        |                            |                   |                 |                                | Pa 233    |                            |                   |                 |                   |
| Tc 99        |                            |                   |                 |                                | U 232     |                            |                   |                 |                   |
| Ru 106       |                            |                   |                 |                                | U 233     |                            |                   |                 |                   |
| Pd 107       |                            |                   |                 |                                | U 234     |                            |                   |                 |                   |
| Ag 108m      |                            |                   |                 |                                | U 235     |                            |                   |                 |                   |
| Ag 110m      |                            |                   |                 |                                | U 236     |                            |                   |                 |                   |
| Cd 109       |                            |                   |                 |                                | U 238     |                            |                   |                 |                   |
| Cd 113m      |                            |                   |                 |                                | Np 237    |                            |                   |                 |                   |
| Sn 119m      |                            |                   |                 |                                | Pu 236    |                            |                   |                 |                   |
| Sn 121m      |                            |                   |                 |                                | Pu 238    |                            |                   |                 |                   |
| Sn 123       |                            |                   |                 |                                | Pu 239    |                            |                   |                 |                   |
| Sn 126       |                            |                   |                 |                                | Pu 240    |                            |                   |                 |                   |
| Sb 125       |                            |                   |                 |                                | Pu 241    |                            |                   |                 |                   |
| Sb 126       |                            |                   |                 |                                | Pu 242    |                            |                   |                 |                   |
| Te 125m      |                            |                   |                 |                                | Am 241    |                            |                   |                 |                   |
| Te 127m      |                            |                   |                 |                                | Am 242m   |                            |                   |                 |                   |
| I 129        |                            |                   |                 |                                | Am 243    |                            |                   |                 |                   |
| Cs 134       |                            |                   |                 |                                | Cm 242    |                            |                   |                 |                   |
| Cs 135       |                            |                   |                 |                                | Cm 243    |                            |                   |                 |                   |
| Cs 137       |                            |                   |                 |                                | Cm 244    |                            |                   |                 |                   |
| Ba 133       |                            |                   |                 |                                | Cm 245    |                            |                   |                 |                   |
| La 137       |                            |                   |                 |                                | Cm 246    |                            |                   |                 |                   |
| La 138       |                            |                   |                 |                                | Cm 248    |                            |                   |                 |                   |
| Ce 144       |                            |                   |                 |                                | Cf 249    |                            |                   |                 |                   |
| Pm 145       |                            |                   |                 |                                | Cf 250    |                            |                   |                 |                   |
| Pm 147       |                            |                   |                 |                                | Cf 251    |                            |                   |                 |                   |
| Sm 147       |                            |                   |                 |                                | Cf 252    |                            |                   |                 |                   |
| Sm 151       |                            |                   |                 |                                | Unsp a    |                            |                   |                 |                   |
| Eu 152       |                            |                   |                 |                                | Unsp b/g  |                            |                   |                 |                   |
| Eu 154       |                            |                   |                 |                                | Total a   | 0                          | *                 | 0               | *                 |
| Eu 155       |                            |                   |                 |                                | Total b/g | 0                          | *                 | 9.73E-03        | *                 |

#### 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