

| WASTE STREAM | 2C38 | Miscellaneous Activated Reactor Components |
|--------------|------|--------------------------------------------|
|--------------|------|--------------------------------------------|

**SITE** Chapelcross

**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                | = 18.6 |                               |                            |
| Future arisings:       |                            |        |                               |                            |
| Total future arisings: |                            | 0.0    |                               |                            |
| Total waste volume:    |                            | 18.6   |                               |                            |

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

Comment on arising rates: The four reactors at Chapelcross ceased generating in the period from August 2001(R1) to February 2004 (R2). There will be no further waste arisings.

Additional information on quantities: There will be no further waste arisings.

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

**WASTE SOURCE** Miscellaneous reactor components stored within the reactor mortuary holes.

#### PHYSICAL CHARACTERISTICS

General description: The waste is comprised of activated reactor components e.g flux scanner tubes, control rods, etc. There are no large items that require special handling.

Changes since waste generated: -

Bulk density (t/m<sup>3</sup>): = 0.30

Comment on density: The density ranges from 0.2 to 0.6 t/m<sup>3</sup>, with an average density of 0.3 t/m<sup>3</sup>.

#### CHEMICAL COMPOSITION

General description and components (%wt): Mild Steel, Stainless Steel, Boron Steel.

Chemical state: Neutral

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

|                           | (%wt) | Type(s) / Grades(s) with proportions                                  | % of total C14 activity |
|---------------------------|-------|-----------------------------------------------------------------------|-------------------------|
| Stainless steel.....      | NE    | -                                                                     |                         |
| Other ferrous metals..... | NE    | Nickel and molybdenum are present in boron steel and stainless steel. |                         |
| Iron.....                 |       | -                                                                     |                         |
| Aluminium.....            | NE    | -                                                                     |                         |
| Beryllium.....            |       | -                                                                     |                         |
| Cobalt.....               |       | -                                                                     |                         |
| Copper.....               | NE    | -                                                                     |                         |
| Lead.....                 | NE    | -                                                                     |                         |
| Magnox/Magnesium.....     | = 0   | -                                                                     |                         |
| Nickel.....               |       | -                                                                     |                         |
| Titanium.....             |       | -                                                                     |                         |
| Uranium.....              |       | -                                                                     |                         |
| Zinc.....                 | NE    | -                                                                     |                         |
| Zircaloy/Zirconium.....   | = 0   | -                                                                     |                         |
| Other metals.....         | = 0   | -                                                                     |                         |

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.....                         | = 0   | -                   |                         |
| 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.....  | = 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.....                    |       | -                   |
| 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):

| No                             |       |                     |
|--------------------------------|-------|---------------------|
|                                | (%wt) | Type(s) and comment |
| EDTA.....                      | = 0   | -                   |
| 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:

The current proposal is to store the waste as at present until reactor dismantling. All waste is expected to be retrieved and conditioned when the conditioning campaign is undertaken. Currently assumed to be cement encapsulated in 4m Box.

Conditioning plants:

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

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         | 2                  | -                                  |

Range in container waste loading: -

Other information on packaging and conditioning: -

Conditioned density (t/m³): NE  
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) | NE              |                  |            |
| Expected to be Non-NSD HAW managed under Scottish Government's policy              | NE              |                  |            |
| 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: The main sources of activity are activated steels from reactor components containing Co-60.

Uncertainty: Activities have been estimated from non-active characterisation and modelling assessment. Other beta/gamma not specified.

Measurement of radioactivities: -

Chemical form of radionuclides: H-3: Not determined  
C-14: Not determined  
Cl-36: -  
Se-79: Not determined  
Tc-99: Not determined  
I-129: -  
Ra: Not present  
Th: Not present  
U: Not present  
Np: Not present  
Pu: Not present

| WASTE STREAM |                            | 2C38              |                 | Miscellaneous Activated Reactor Components |           |                            |                   |                 |                   |
|--------------|----------------------------|-------------------|-----------------|--------------------------------------------|-----------|----------------------------|-------------------|-----------------|-------------------|
| 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          |                            |                   | 5               |                                            | Gd 153    |                            |                   | 8               |                   |
| Be 10        |                            |                   | 8               |                                            | Ho 163    |                            |                   | 8               |                   |
| C 14         |                            |                   | 6               |                                            | Ho 166m   |                            |                   | 8               |                   |
| Na 22        |                            |                   | 8               |                                            | Tm 170    |                            |                   | 8               |                   |
| Al 26        |                            |                   | 8               |                                            | Tm 171    |                            |                   | 8               |                   |
| Cl 36        | 6.00E-05                   | B D               | 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               |                                            | Tl 204    |                            |                   | 8               |                   |
| Mn 54        | 1.05E-08                   | B D               | 2               |                                            | Pb 205    |                            |                   | 8               |                   |
| Fe 55        | 2.21E-02                   | B D               | 2               |                                            | Pb 210    |                            |                   | 4               |                   |
| Co 60        | 2.79E-02                   | B D               | 2               |                                            | Bi 208    |                            |                   | 8               |                   |
| Ni 59        | 1.00E-04                   | B D               | 2               |                                            | Bi 210m   |                            |                   | 8               |                   |
| Ni 63        | 9.01E-03                   | B D               | 2               |                                            | Po 210    |                            |                   | 4               |                   |
| Zn 65        | 3.54E-09                   | B D               | 2               |                                            | Ra 223    |                            |                   | 8               |                   |
| Se 79        |                            |                   | 4               |                                            | Ra 225    |                            |                   | 8               |                   |
| Kr 81        |                            |                   | 8               |                                            | Ra 226    |                            |                   | 4               |                   |
| Kr 85        |                            |                   | 8               |                                            | Ra 228    |                            |                   | 8               |                   |
| Rb 87        |                            |                   | 8               |                                            | Ac 227    |                            |                   | 8               |                   |
| Sr 90        |                            |                   | 4               |                                            | Th 227    |                            |                   | 8               |                   |
| Zr 93        |                            |                   | 4               |                                            | Th 228    |                            |                   | 8               |                   |
| Nb 91        |                            |                   | 8               |                                            | Th 229    |                            |                   | 4               |                   |
| Nb 92        |                            |                   | 8               |                                            | Th 230    |                            |                   | 4               |                   |
| Nb 93m       |                            |                   | 4               |                                            | Th 232    |                            |                   | 4               |                   |
| Nb 94        |                            |                   | 5               |                                            | Th 234    |                            |                   | 8               |                   |
| Mo 93        |                            |                   | 5               |                                            | Pa 231    |                            |                   | 4               |                   |
| Tc 97        |                            |                   | 8               |                                            | Pa 233    |                            |                   | 8               |                   |
| Tc 99        |                            |                   | 5               |                                            | U 232     |                            |                   | 8               |                   |
| Ru 106       |                            |                   | 5               |                                            | U 233     |                            |                   | 8               |                   |
| Pd 107       |                            |                   | 5               |                                            | U 234     |                            |                   | 8               |                   |
| Ag 108m      |                            |                   | 5               |                                            | 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      |                            |                   | 5               |                                            | Pu 238    |                            |                   | 8               |                   |
| Sn 123       |                            |                   | 8               |                                            | Pu 239    |                            |                   | 8               |                   |
| Sn 126       |                            |                   | 5               |                                            | 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        |                            |                   | 5               |                                            | Am 243    |                            |                   | 8               |                   |
| Cs 134       |                            |                   | 5               |                                            | Cm 242    |                            |                   | 8               |                   |
| Cs 135       |                            |                   | 5               |                                            | Cm 243    |                            |                   | 8               |                   |
| Cs 137       |                            |                   | 5               |                                            | Cm 244    |                            |                   | 8               |                   |
| Ba 133       |                            |                   | 8               |                                            | Cm 245    |                            |                   | 8               |                   |
| La 137       |                            |                   | 8               |                                            | Cm 246    |                            |                   | 8               |                   |
| La 138       |                            |                   | 8               |                                            | Cm 248    |                            |                   | 8               |                   |
| Ce 144       |                            |                   | 5               |                                            | Cf 249    |                            |                   | 8               |                   |
| Pm 145       |                            |                   | 8               |                                            | Cf 250    |                            |                   | 8               |                   |
| Pm 147       |                            |                   | 5               |                                            | Cf 251    |                            |                   | 8               |                   |
| Sm 147       |                            |                   | 8               |                                            | Cf 252    |                            |                   | 8               |                   |
| Sm 151       |                            |                   | 5               |                                            | Unsp a    |                            |                   |                 |                   |
| Eu 152       |                            |                   | 5               |                                            | Unsp b/g  |                            |                   |                 |                   |
| Eu 154       |                            |                   | 5               |                                            | Total a   | 0                          | *                 | 0               | *                 |
| Eu 155       |                            |                   | 5               |                                            | Total b/g | 5.91E-02                   | *                 | 0               | *                 |

#### 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