

|                     |             |                 |
|---------------------|-------------|-----------------|
| <b>WASTE STREAM</b> | <b>5H18</b> | <b>H3AT LLW</b> |
|---------------------|-------------|-----------------|

**SITE** Culham  
**SITE OWNER** United Kingdom Atomic Energy Authority  
**WASTE CUSTODIAN** United Kingdom Atomic Energy Authority  
**WASTE TYPE** LLW

**WASTE VOLUMES**

|                        |                           | Reported              |
|------------------------|---------------------------|-----------------------|
| Stocks:                | At 1.4.2019.....          | 0 m <sup>3</sup>      |
| Future arisings -      | 1.4.2020 - 31.3.2035..... | ~~60.0 m <sup>3</sup> |
| Total future arisings: |                           | 60.0 m <sup>3</sup>   |
| Total waste volume:    |                           | 60.0 m <sup>3</sup>   |

Comment on volumes: As this is an operational waste stream the arisings will not be constant and will depend on the experimental programme, maintenance activities and breakdowns. This is a new facility yet to be constructed and therefore uncertainty in volumes of waste to be produced is high. A similar facility on site has been used to estimate volumes, but, a more accurate estimate is not possible until operational experience has been gained.

Uncertainty factors on volumes:  
 Stock (upper): x Arisings (upper) x 5.0  
 Stock (lower): x Arisings (lower) x 0.2

**WASTE SOURCE** H3AT tritium operations resulting in tritium contamination of waste and plant.

**PHYSICAL CHARACTERISTICS**

General description: Mostly metals such as inconel, steel, copper and aluminium. Includes small and volume reduced items packaged in to 200 litre steel drums and large items not suitable for volume reduction. Waste is seggregated, sorted, sampled and size reduced where possible to enable packaging in to disposal packages and to confirm disposal route. Beryllium contamination may be tied down to protect waste operators.

Physical components (%wt): Metals (95%), other materials (5%).

Sealed sources: The waste contains sealed sources. Sealed sources may be included in the waste stream but will be re-used, recycled or returned to manufacturer where possible.

Bulk density (t/m<sup>3</sup>): ~0.55

Comment on density: Individual packages vary, figure used is based on historical Net wt averages of all packages generated as part of the waste stream between 01/01/2010 and 01/04/2016.

**CHEMICAL COMPOSITION**

General description and components (%wt): Metals consisting of stainless, mild and galvanised steel, inconel, copper and aluminium (95%), other materials consisting of graphite, glass, rubble and concrete (5%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Mainly outgassed tritium present in the form of tritiated water vapour, and some absorbed into material surfaces.

Metals and alloys (%wt): Majority of metal present as size reduced items to enable packaging in 200l Steel Drums. <1% metal present as sheet and <5% bulk items. Dimensions of bulk items will vary but will be greater than 1mx1m.

|                           |       |   |
|---------------------------|-------|---|
| Stainless steel.....      | ~50.0 | 316 ~75%, other grades ~25%.              |
| Other ferrous metals..... | ~19.0 |   |
| Iron.....                 | ~1.0  | Potentially included as transformer cores |
| Aluminium.....            | ~11.0 |   |
| Beryllium.....            | <0.30 |   |
| Cobalt.....               | <1.0  | As part of specialist alloys.             |
| Copper.....               | ~7.0  |   |
| Lead.....                 | <0.10 |   |
| Magnox/Magnesium.....     | TR    | As part of specialist alloys.             |

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|-------------------------|-------|--|
| Nickel.....             | ~3.0  | Inconel 90%, pure nickel and other specialist alloys 10%.    |
| Titanium.....           | <<1.0 |  |
| Uranium.....            | 0     |  |
| Zinc.....               | ~2.0  |  |
| Zircaloy/Zirconium..... | TR    | Not expected but may be present as part of specialist alloys |
| Other metals.....       | <0.10 | Small quantities of silver and other metals may be present.  |

Organics (%wt):

Possible that a very small quantity (by weight) of PVC could be present.

|                                     |    |
|-------------------------------------|----|
| Total cellulose.....                | TR |
| Paper, cotton.....                  | TR |
| Wood.....                           | TR |
| Halogenated plastics .....          | TR |
| Total non-halogenated plastics..... | TR |
| Condensation polymers.....          | TR |
| Others.....                         | TR |
| Organic ion exchange materials....  | TR |
| Total rubber.....                   | TR |
| Halogenated rubber .....            | TR |
| Non-halogenated rubber.....         | TR |
| Hydrocarbons.....                   | TR |
| Oil or grease .....                 | TR |
| Fuel.....                           | TR |
| Asphalt/Tarmac (cont.coal tar)...   | TR |
| Asphalt/Tarmac (no coal tar)....    | TR |
| Bitumen.....                        | TR |
| Others.....                         | TR |
| Other organics.....                 | TR |

Other materials (%wt):

|                                   |       |  |
|-----------------------------------|-------|--|
| -                                 |       |  |
| Inorganic ion exchange materials. | 0     |  |
| Inorganic sludges and flocs.....  | ~1.0  |  |
| Soil.....                         | 0     |  |
| Brick/Stone/Rubble.....           | <0.20 |  |
| Cementitious material.....        | ~1.0  |  |
| Sand.....                         | ~1.0  |  |
| Glass/Ceramics.....               | <1.0  |  |
| Graphite.....                     | ~1.0  |  |
| Desiccants/Catalysts.....         | TR    |  |
| Asbestos.....                     | TR    | May be present in individual packages at trace levels. |
| Non/low friable.....              | TR    |  |
| Moderately friable.....           | TR    |  |
| Highly friable.....               | TR    |  |
| Free aqueous liquids.....         | 0     |  |

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|  |   |    |
|--|---|----|
|  | Free non-aqueous liquids.....   | 0  |
|  | Powder/Ash.....   | 0  |
| Inorganic anions (%wt):                              | No inorganic anions are present.  |    |
|  | Fluoride.....   | TR |
|  | Chloride.....   | TR |
|  | Iodide.....   | 0  |
|  | Cyanide.....  | 0  |
|  | Carbonate.....  | 0  |
|  | Nitrate.....  | 0  |
|  | Nitrite.....  | 0  |
|  | Phosphate.....  | 0  |
|  | Sulphate.....   | TR |
|  | Sulphide.....   | 0  |
| Materials of interest for waste acceptance criteria: | Beryllium dust contamination is present. There may be some solid beryllium items included in this stream which account for the <0.3% by wt. |    |
|  | Combustible metals.....   | 0  |
|  | Low flash point liquids.....  | 0  |
|  | Explosive materials.....  | 0  |
|  | Phosphorus.....   | 0  |
|  | Hydrides.....   | 0  |
|  | Biological etc. materials.....  | 0  |
|  | Biodegradable materials.....  | 0  |
|  | Putrescible wastes.....   | 0  |
|  | Non-putrescible wastes.....   | 0  |
|  | Corrosive materials.....  | 0  |
|  | Pyrophoric materials.....   | 0  |
|  | Generating toxic gases.....   | 0  |
|  | Reacting with water.....  | 0  |
|  | Active particles.....   | 0  |
|  | Soluble solids as bulk chemical compounds.....  | 0  |
| Hazardous substances / non hazardous pollutants:     | Beryllium dust is typically present at < 0.1% by weight, solid beryllium may be present in individual packages above 0.1%.                  |    |
|  | 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  |

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|                                       |      |   |
|---------------------------------------|------|---|
| Arsenic.....                          | 0    |   |
| Barium.....                           | 0    |   |
| Boron.....                            | P    | Included as boronated concrete.   |
| Cadmium.....                          | 0    |   |
| Caesium.....                          | 0    |   |
| Selenium.....                         | 0    |   |
| Chromium.....                         | P    | Included in specialist steels.  |
| Molybdenum.....                       | P    | Included in specialist steels.  |
| Thallium.....                         | 0    |   |
| Tin.....                              | P    | Included in solders.  |
| Vanadium.....                         | P    | Included in specialist steels.  |
| Mercury compounds.....                | 0    |   |
| Others.....                           | P    |   |
| Electronic Electrical Equipment (EEE) |      |   |
| EEE Type 1.....                       | TR   |   |
| EEE Type 2.....                       | <1.0 |   |
| EEE Type 3.....                       | <1.0 |   |
| EEE Type 4.....                       | 0    |   |
| EEE Type 5.....                       | 0    |   |
| Complexing agents (%wt):              | Yes  |   |
| EDTA.....                             | 0    |   |
| DPTA.....                             | 0    |   |
| NTA.....                              | 0    |   |
| Polycarboxylic acids.....             | TR   |   |
| Other organic complexants.....        | TR   | Trace quantities of complexing agents may be present from cleaning solutions. |
| Total complexing agents.....          | TR   |   |

**TREATMENT, PACKAGING AND DISPOSAL**

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

| Treatment             | On-site / Off site | Stream volume % |
|-----------------------|--------------------|-----------------|
| Low force compaction  | Off-site           | ~50.0           |
| Supercompaction (HFC) |                    |                 |
| Incineration          | Off-site           | ~10.0           |
| Solidification        |                    |                 |
| Decontamination       |                    |                 |
| Metal treatment       |                    |                 |
| Size reduction        |                    |                 |
| Decay storage         |                    |                 |
| Recycling / reuse     |                    |                 |
| Other / various       | ~40.0              |                 |
| None                  |                    |                 |

Comment on planned treatments:

Drummed waste will be supercompacted, bulk undrummed waste expected to be consigned in a third height ISO.

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| Disposal Route   | Stream volume % |       |
|--|-----------------|-------|
| Expected to be consigned to the LLW Repository           | ~90.0           |       |
| Expected to be consigned to a Landfill Facility          |                 |       |
| Expected to be consigned to an On-Site Disposal Facility |                 |       |
| Expected to be consigned to an Incineration Facility     |                 |       |
| Expected to be consigned to a Metal Treatment Facility   |                 | ~10.0 |
| Expected to be consigned as Out of Scope                 |                 |       |
| Expected to be recycled / reused                         |                 |       |
| Disposal route not known                                 |                 |       |

**Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):**

| Disposal Route  | Stream volume % |         |         |
|---|-----------------|---------|---------|
|   | 2019/20         | 2020/21 | 2021/22 |
| Expected to be consigned to the LLW Repository<br>Expected to be consigned to a Landfill Facility<br>Expected to be consigned to an On-Site Disposal Facility<br>Expected to be consigned to an Incineration Facility<br>Expected to be consigned to a Metal Treatment Facility<br>Expected to be consigned as Out of Scope<br>Expected to be recycled / reused<br>Disposal route not known |                 |         |         |

**Waste Packaging for Disposal:**

| Container  | Stream volume % | Waste loading m <sup>3</sup> | Number of packages |
|--|-----------------|------------------------------|--------------------|
| 1/3 Height IP-1 ISO<br>2/3 Height IP-2 ISO<br>1/2 Height WAMAC IP-2 ISO<br>1/2 Height IP-2 Disposal/Re-usable ISO<br>2m box (no shielding)<br>4m box (no shielding)<br>Other | 90.0            | <9.3                         | 6                  |

Other information: -

**Waste Planned for Disposal at the LLW Repository:**

Container voidage: &lt;10%

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).  
The waste does not have a current WCH.

Waste consigned for disposal to LLWR in year of generation: No. There will always be a quantity of waste collected towards the end of a year which is not processed for disposal until the following year. Quite likely that this type of waste will not be despatched for a year after generation.

Potential for the waste to contain discrete items: Yes, discrete items may be included but not expected in large quantities.

**Non-Containerised Waste for In-Vault Grouting:**

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

|   |  |
|---|--|
| Source:   | The main sources of activity are tritium contamination and neutron activation. Loose activated carbon/beryllium dust contaminating material surfaces.  |
| Uncertainty:                                    | Nuclide activities are only indicative and relate to operational waste already analysed by JET. In the future the activities may increase according to changes in the experimental programme and related, further exposure to activating neutrons. |
| Definition of total alpha and total beta/gamma: | Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.  |
| Measurement of radioactivities:                 | Nuclide activities are only indicative and are based on combustion followed by liquid scintillation counting and gamma spectroscopy. Future neutron activation and tritium contamination levels will be determined by the experimental programme.  |
| Other information:                              | -  |

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| Nuclide | Mean radioactivity, TBq/m <sup>3</sup> |                |                 |                | Nuclide          | Mean radioactivity, TBq/m <sup>3</sup> |                |                 |                |
|---------|--|----------------|-----------------|----------------|------------------|--|----------------|-----------------|----------------|
|         | Waste at 1.4.2019                      | Bands and Code | Future arisings | Bands and Code |                  | Waste at 1.4.2019                      | Bands and Code | Future arisings | Bands and Code |
| H 3     |  |                | ~1.8E-03        | C C 2          | Gd 153           |  |                |                 |                |
| Be 10   |  |                |                 |                | Ho 163           |  |                |                 |                |
| C 14    |  |                |                 |                | Ho 166m          |  |                |                 |                |
| Na 22   |  |                |                 |                | 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   |  |                |                 |                | Pb 205           |  |                |                 |                |
| Fe 55   |  |                |                 |                | Pb 210           |  |                |                 |                |
| Co 60   |  |                |                 |                | Bi 208           |  |                |                 |                |
| Ni 59   |  |                |                 |                | Bi 210m          |  |                |                 |                |
| Ni 63   |  |                |                 |                | 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  |  |                |                 |                | Other a          |  |                |                 |                |
| Eu 152  |  |                |                 |                | Other b/g        |  |                |                 |                |
| Eu 154  |  |                |                 |                | <b>Total a</b>   | <b>0</b>                               |                | <b>0</b>        |                |
| Eu 155  |  |                |                 |                | <b>Total b/g</b> | <b>0</b>                               |                | <b>~1.8E-03</b> | <b>C C 2</b>   |

**Bands (Upper and Lower)**

- A a factor of 1.5
- B a factor of 3
- C a factor of 10
- D a factor of 100
- E a factor of 1000

Note: Bands quantify uncertainty in mean radioactivity.

**Code**

- 1 Measured activity
- 2 Derived activity (best estimate)
- 3 Derived activity (upper limit)
- 4 Not present
- 5 Present but not significant
- 6 Likely to be present but not assessed
- 7 Present in significant quantities but not determined
- 8 Not expected to be present in significant quantity