

|                     |             |   |
|---------------------|-------------|---|
| <b>WASTE STREAM</b> | <b>9A66</b> | <b>Miscellaneous Contaminated Items from Post Irradiation Examination</b> |
|---------------------|-------------|---|

**SITE** Berkeley

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Magnox Limited

**WASTE TYPE** ILW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

|                                 |  | Reported           |
|---------------------------------|--|--------------------|
| Stocks:                         | At 1.4.2022.....   | 0.1 m <sup>3</sup> |
| Total future arisings:          |  | 0 m <sup>3</sup>   |
| Total waste volume:             |  | 0.1 m <sup>3</sup> |
| Comment on volumes:             | The waste was accumulated in 1971. There will be no further arisings of this waste stream. |                    |
| Uncertainty factors on volumes: | Stock (upper): x 1.1   | Arisings (upper) x |
|                                 | Stock (lower): x 0.9   | Arisings (lower) x |

**WASTE SOURCE** The waste is miscellaneous contaminated items arising at Berkeley Nuclear Laboratories (now Berkeley Technology Centre) from the examination of irradiated fuel, steel and graphite.

**PHYSICAL CHARACTERISTICS**

General description: The waste is miscellaneous contaminated combustible waste including tissues and paper contained in a thin walled mild steel black can liner of nominal length 1.219m and nominal diameter 0.343m. There are no large items that may require special handling.

Physical components (%vol): The waste consists of ~90% ferrous metals, ~5% paper/cotton and ~ 5% plastics

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 0.44

Comment on density: Calculated using mass of container and external volume.

**CHEMICAL COMPOSITION**

General description and components (%wt): The waste includes mild steel, paper and other materials.

Chemical state: Neutral

Chemical form of radionuclides: H-3: Most tritium is expected to be present as water but some may be in the form of other inorganic compounds or as organic compounds.  
 C-14: Chemical form of carbon 14 has not been determined but may be graphite.  
 Cl-36: The chemical form of chlorine 36 in these wastes is not known.  
 U: Chemical form of uranium isotopes has not been determined but may be uranium oxides.  
 Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): The only metal present will be the thin walled mild steel black can liner.

|                           | (%wt) | Type(s) / Grade(s) with proportions | % of total C14 activity |
|---------------------------|-------|-------------------------------------|-------------------------|
| Stainless steel.....      | 0     |                                     |                         |
| Other ferrous metals..... | ~90.0 |                                     |                         |
| Iron.....                 |       |                                     |                         |
| Aluminium.....            | 0     |                                     |                         |
| Beryllium.....            | NE    |                                     |                         |
| Cobalt.....               |       |                                     |                         |
| Copper.....               | 0     |                                     |                         |
| Lead.....                 | 0     |                                     |                         |

**WASTE STREAM**

**9A66**

**Miscellaneous Contaminated Items from Post Irradiation Examination**

|                         |   |                                  |
|-------------------------|---|----------------------------------|
| Magnox/Magnesium.....   | 0 |                                  |
| Nickel.....             |   |                                  |
| Titanium.....           |   |                                  |
| Uranium.....            |   |                                  |
| Zinc.....               | 0 |                                  |
| Zircaloy/Zirconium..... | 0 |                                  |
| Other metals.....       | 0 | No other metals are anticipated. |

Organics (%wt):                      The waste is in the same vault section as the ion exchange materials, so there may be trace contamination with Lewatit DN.

|                                     | (%wt) | Type(s) and comment | % of total C14 activity |
|-------------------------------------|-------|---------------------|-------------------------|
| Total cellulosics.....              | NE    |                     |                         |
| Paper, cotton.....                  | ~5.0  |                     |                         |
| Wood.....                           | NE    |                     |                         |
| Halogenated plastics .....          | NE    |                     |                         |
| Total non-halogenated plastics..... | ~0    |                     |                         |
| Condensation polymers.....          | NE    |                     |                         |
| Others.....                         | NE    |                     |                         |
| Organic ion exchange materials....  | TR    |                     |                         |
| Total rubber.....                   | NE    |                     |                         |
| Halogenated rubber .....            | NE    |                     |                         |
| Non-halogenated rubber.....         | NE    |                     |                         |
| Hydrocarbons.....                   |       |                     |                         |
| Oil or grease .....                 |       |                     |                         |
| Fuel.....                           |       |                     |                         |
| Asphalt/Tarmac (cont.coal tar)...   |       |                     |                         |
| Asphalt/Tarmac (no coal tar)....    |       |                     |                         |
| Bitumen.....                        |       |                     |                         |
| Others.....                         |       |                     |                         |
| Other organics.....                 | NE    |                     |                         |

Other materials (%wt):                      -

|                                    | (%wt) | Type(s) and comment | % of total C14 activity |
|------------------------------------|-------|---------------------|-------------------------|
| Inorganic ion exchange materials.. | TR    |                     |                         |
| Inorganic sludges and flocs.....   | 0     |                     |                         |
| Soil.....                          | 0     |                     |                         |
| Brick/Stone/Rubble.....            | 0     |                     |                         |
| Cementitious material.....         | 0     |                     |                         |
| Sand.....                          |       |                     |                         |
| Glass/Ceramics.....                | 0     |                     |                         |
| Graphite.....                      | NE    |                     |                         |
| Desiccants/Catalysts.....          |       |                     |                         |
| Asbestos.....                      | 0     |                     |                         |
| Non/low friable.....               |       |                     |                         |

**WASTE STREAM****9A66****Miscellaneous Contaminated Items from Post Irradiation Examination**

|                               |    |
|-------------------------------|----|
| Moderately friable.....       |    |
| Highly friable.....           |    |
| Free aqueous liquids.....     | 0  |
| Free non-aqueous liquids..... | NE |
| Powder/Ash.....               | 0  |

Inorganic anions (%wt):            Anions will probably not be present at concentrations greater than about 1% wt.

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

Materials of interest for            Trace quantities of magnox and uranium hydride might be present.  
waste acceptance criteria:

|   | (%wt) | Type(s) and comment |
|---|-------|---------------------|
| Combustible metals.....                           | TR    |                     |
| Low flash point liquids.....                      | 0     |                     |
| Explosive materials.....                          | 0     |                     |
| Phosphorus.....                                   | 0     |                     |
| Hydrides.....                                     | TR    |                     |
| 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.....                          | TR    |                     |
| Higher activity particles.....                    |       |                     |
| Soluble solids as bulk chemical<br>compounds..... |       |                     |

Hazardous substances /            Toxic metals are not expected to be present but further assessment is needed to confirm  
non hazardous pollutants:            this.

|                           | (%wt) | Type(s) and comment |
|---------------------------|-------|---------------------|
| Acrylamide.....           |       |                     |
| Benzene.....              |       |                     |
| Chlorinated solvents..... |       |                     |

**WASTE STREAM****9A66****Miscellaneous Contaminated Items from Post Irradiation Examination**

Formaldehyde.....  
 Organometallics.....  
 Phenol.....  
 Styrene.....  
 Tri-butyl phosphate.....  
 Other organophosphates.....  
 Vinyl chloride.....  
 Arsenic.....  
 Barium.....  
 Boron..... 0  
   Boron (in Boral).....  
   Boron (non-Boral).....  
 Cadmium.....  
 Caesium.....  
 Selenium.....  
 Chromium.....  
 Molybdenum.....  
 Thallium.....  
 Tin.....  
 Vanadium.....  
 Mercury compounds.....  
 Others.....  
 Electronic Electrical Equipment (EEE)  
   EEE Type 1.....  
   EEE Type 2.....  
   EEE Type 3.....  
   EEE Type 4.....  
   EEE Type 5.....

Complexing agents (%wt):    Yes

(%wt)    Type(s) and comment

EDTA.....  
 DPTA.....  
 NTA.....  
 Polycarboxylic acids.....  
 Other organic complexants.....

Organic complexing agents may be present in small quantities.

Total complexing agents..... &lt;1.0

Potential for the waste to contain discrete items:    Yes. In & of itself not a DI; waste stream may include DIs (notably any stainless steel components)

**PACKAGING AND CONDITIONING**

Conditioning method:    This stream will be co-packaged with 9A25, 9A31, 9A39, 9A47, 9A52, and 9A60 in Type VI DCIC containers. Remainder of vault 1 waste streams will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A32, 9A40, 9A48, 9A53, 9A73) Packages for vault 1 are assigned to 9A25, 9A32 & 9A73.

**WASTE STREAM****9A66****Miscellaneous Contaminated Items from Post Irradiation Examination**

Plant Name: -  
 Location: Berkeley Site  
 Plant startup date: -  
 Total capacity (m<sup>3</sup>/y incoming waste): -  
 Target start date for packaging this stream: -  
 Throughput for this stream (m<sup>3</sup>/y incoming waste): -  
 Other information: -

| Likely container type: | Container | Waste packaged (%vol) | Waste loading (m <sup>3</sup> ) | Payload (m <sup>3</sup> ) | Number of packages |
|------------------------|-----------|-----------------------|---------------------------------|---------------------------|--------------------|
|                        |           |                       |                                 |                           |                    |

Likely container type comment: -  
 Range in container waste volume: -  
 Other information on containers: -  
 Likely conditioning matrix:  
 Other information: -  
 Conditioned density (t/m<sup>3</sup>): -  
 Conditioned density comment: -  
 Other information on conditioning: -  
 Opportunities for alternative disposal routing: -

| Baseline Management Route | Opportunity Management Route | Stream volume (%) | Estimated Date that Opportunity will be realised | Opportunity Confidence | Comment |
|---------------------------|------------------------------|-------------------|--|------------------------|---------|
| -                         | -                            | -                 | -  | -                      | -       |

**RADIOACTIVITY**

Source: The waste has become contaminated from the processes concerned with the examination of irradiated fuel, steel and graphite at Berkeley Nuclear Laboratories (now Berkeley Technology Centre).

Uncertainty: The values quoted are indicative of the expected activities.

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: Specific activities were derived by estimation based upon available information.

Other information: Specific activity is a function of operating history.

**WASTE STREAM**

**9A66**

**Miscellaneous Contaminated Items from Post Irradiation Examination**

| Nuclide | Mean radioactivity, TBq/m <sup>3</sup> |                |                 |                | Nuclide          | Mean radioactivity, TBq/m <sup>3</sup> |                |                 |                |
|---------|--|----------------|-----------------|----------------|------------------|--|----------------|-----------------|----------------|
|         | Waste at 1.4.2022                      | Bands and Code | Future arisings | Bands and Code |                  | Waste at 1.4.2022                      | Bands and Code | Future arisings | Bands and Code |
| H 3     | 8.63E-04                               | CC 2           |                 |                | Gd 153           |  | 8              |                 |                |
| Be 10   |  | 8              |                 |                | Ho 163           |  | 8              |                 |                |
| C 14    | 9.99E-06                               | CC 2           |                 |                | Ho 166m          |  | 8              |                 |                |
| Na 22   |  | 8              |                 |                | Tm 170           |  | 8              |                 |                |
| Al 26   |  | 8              |                 |                | Tm 171           |  | 8              |                 |                |
| Cl 36   | 7E-07                                  | CC 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   |  | 8              |                 |                | Pb 205           |  | 8              |                 |                |
| Fe 55   | 8.74E-07                               | CC 2           |                 |                | Pb 210           |  | 8              |                 |                |
| Co 60   | 2.79E-05                               | CC 2           |                 |                | Bi 208           |  | 8              |                 |                |
| Ni 59   | 1E-06                                  | CC 2           |                 |                | Bi 210m          |  | 8              |                 |                |
| Ni 63   | 7.21E-05                               | CC 2           |                 |                | Po 210           |  | 8              |                 |                |
| Zn 65   |  | 8              |                 |                | Ra 223           |  | 8              |                 |                |
| Se 79   | 1.21E-08                               | CC 2           |                 |                | Ra 225           |  | 8              |                 |                |
| Kr 81   |  | 8              |                 |                | Ra 226           |  | 8              |                 |                |
| Kr 85   |  | 8              |                 |                | Ra 228           |  | 8              |                 |                |
| Rb 87   |  | 8              |                 |                | Ac 227           |  | 8              |                 |                |
| Sr 90   | 4.89E-03                               | CC 2           |                 |                | Th 227           |  | 8              |                 |                |
| Zr 93   | 6E-07                                  | CC 2           |                 |                | Th 228           |  | 8              |                 |                |
| Nb 91   |  | 8              |                 |                | Th 229           |  | 8              |                 |                |
| Nb 92   |  | 8              |                 |                | Th 230           |  | 8              |                 |                |
| Nb 93m  | 3.85E-07                               | CC 2           |                 |                | Th 232           |  | 8              |                 |                |
| Nb 94   |  | 8              |                 |                | Th 234           | 3E-07                                  | CC 2           |                 |                |
| Mo 93   |  | 8              |                 |                | Pa 231           |  | 8              |                 |                |
| Tc 97   |  | 8              |                 |                | Pa 233           | 4.16E-08                               | CC 2           |                 |                |
| Tc 99   | 3E-06                                  | CC 2           |                 |                | U 232            |  | 8              |                 |                |
| Ru 106  |  | 8              |                 |                | U 233            |  | 8              |                 |                |
| Pd 107  |  | 8              |                 |                | U 234            | 3.09E-07                               | CC 2           |                 |                |
| Ag 108m | <2.94E-06                              | C 3            |                 |                | U 235            | 7E-09                                  | CC 2           |                 |                |
| Ag 110m |  | 8              |                 |                | U 236            | 4.00E-08                               | CC 2           |                 |                |
| Cd 109  |  | 8              |                 |                | U 238            | 3E-07                                  | CC 2           |                 |                |
| Cd 113m |  | 8              |                 |                | Np 237           | 4.16E-08                               | CC 2           |                 |                |
| Sn 119m |  | 8              |                 |                | Pu 236           |  | 8              |                 |                |
| Sn 121m |  | 8              |                 |                | Pu 238           | 1.78E-04                               | CC 2           |                 |                |
| Sn 123  |  | 8              |                 |                | Pu 239           | 1.00E-04                               | CC 2           |                 |                |
| Sn 126  | 4.35E-08                               | CC 2           |                 |                | Pu 240           | 2.00E-04                               | CC 2           |                 |                |
| Sb 125  |  | 8              |                 |                | Pu 241           | 1.46E-03                               | CC 2           |                 |                |
| Sb 126  | 6.09E-09                               | CC 2           |                 |                | Pu 242           | 1E-07                                  | CC 2           |                 |                |
| Te 125m |  | 8              |                 |                | Am 241           | 3.44E-04                               | CC 2           |                 |                |
| Te 127m |  | 8              |                 |                | Am 242m          | 8.36E-07                               | CC 2           |                 |                |
| I 129   | 6E-09                                  | CC 2           |                 |                | Am 243           | 3.00E-07                               | CC 2           |                 |                |
| Cs 134  |  | 8              |                 |                | Cm 242           | 6.90E-07                               | CC 2           |                 |                |
| Cs 135  | 1E-07                                  | CC 2           |                 |                | Cm 243           | 1.41E-07                               | CC 2           |                 |                |
| Cs 137  | 4.95E-03                               | CC 2           |                 |                | Cm 244           | 1.13E-06                               | CC 2           |                 |                |
| Ba 133  |  | 8              |                 |                | Cm 245           |  | 8              |                 |                |
| La 137  |  | 8              |                 |                | Cm 246           |  | 8              |                 |                |
| La 138  |  | 8              |                 |                | Cm 248           |  | 8              |                 |                |
| Ce 144  |  | 8              |                 |                | Cf 249           |  | 8              |                 |                |
| Pm 145  |  | 8              |                 |                | Cf 250           |  | 8              |                 |                |
| Pm 147  | 3.81E-08                               | CC 2           |                 |                | Cf 251           |  | 8              |                 |                |
| Sm 147  |  | 8              |                 |                | Cf 252           |  | 8              |                 |                |
| Sm 151  | 1.78E-05                               | CC 2           |                 |                | Other a          |  |                |                 |                |
| Eu 152  | 9.19E-08                               | CC 2           |                 |                | Other b/g        |  |                |                 |                |
| Eu 154  | 5.95E-06                               | CC 2           |                 |                | <b>Total a</b>   | <b>8.24E-04</b>                        | <b>CC 2</b>    | <b>0</b>        |                |
| Eu 155  | 2.38E-07                               | CC 2           |                 |                | <b>Total b/g</b> | <b>1.23E-02</b>                        | <b>CC 2</b>    | <b>0</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