

| WASTE STREAM | 9A63 | FED Magnox from Post Irradiation Examination |
|--------------|------|----------------------------------------------|
|--------------|------|----------------------------------------------|

**SITE** Berkeley

**SITE OWNER** Nuclear Decommissioning Authority

**WASTE CUSTODIAN** Nuclear Restoration Services Ltd (NRS)

**WASTE TYPE** ILW

#### WASTE VOLUMES

|                        | Reported (m <sup>3</sup> ) | OR | Conditioned (m <sup>3</sup> ) | Packaged (m <sup>3</sup> ) |
|------------------------|----------------------------|----|-------------------------------|----------------------------|
| Stocks:                | At 1.4.2025                |    |                               |                            |
| Future arisings:       | = 0.1                      |    |                               |                            |
| Total future arisings: | 0.0                        |    |                               |                            |
| Total waste volume:    | 0.1                        |    |                               |                            |

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

Comment on arising rates: -

Additional information on quantities: There will be no further arisings of this waste stream. The volume given is the volume of Magnox fuel element debris as held in drums.

Uncertainty factors on volumes: Stock (upper): x 1.10 Arisings (upper): x -  
Stock (lower): x 0.90 Arisings (lower): x -

**WASTE SOURCE** The waste arose from the programme of post irradiation examination of Magnox fuel elements that was undertaken within the research facilities previously on the site.

#### PHYSICAL CHARACTERISTICS

General description: The waste is predominantly made up of Magnox metal generated from the post irradiation examination work, although it could include other fuel element components. The largest arisings are believed to be splitter cages. There may be a significant quantity of Magnox fuel canning material contaminated by fuel in the debris. There will also be some Sintox discs, along with graphite, stainless steel and zirconium. The waste may be contaminated with Ternary Eutectic Chloride (TEC) (a fire extinguishant). All of the waste is containerised in mild steel black cans. The waste containers will be processed with this waste stream. There are no large items that may require special handling.

Changes since waste generated: -

Bulk density (t/m<sup>3</sup>): = 0.54

Comment on density: Density is calculated from the total mass of the loose waste, and the containerised waste (including the containers), and the volume.

#### CHEMICAL COMPOSITION

General description and components (%wt): The component breakdown of the FED from Berkeley Centre is 98%wt Magnox, 1.6%wt Zirconium, 0.1%wt Sintox discs (sintered alumina), 0.23%wt. Other components (Nimonic springs, graphite, stainless steel) and <<0.1%wt Thermocouples. There will also be small amounts of mild steel from the containers, and there may be traces of Ternary Eutectic Chloride present.

Chemical state: Alkali

Sheet metal proportion / thickness: Bulk items are not expected to be present. Nearly all of the waste is expected to be only 1 or 2 mm thick.

Metals and alloys (%wt):

|                           | (%wt)  | Type(s) / Grades(s) with proportions                    | % of total C14 activity |
|---------------------------|--------|---------------------------------------------------------|-------------------------|
| Stainless steel.....      | < 0.20 | -                                                       |                         |
| Other ferrous metals..... | NE     | Mild steel will be present as the waste container.      |                         |
| Iron.....                 | -      | -                                                       |                         |
| Aluminium.....            | -      | -                                                       |                         |
| Beryllium.....            | TR     | -                                                       |                         |
| Cobalt.....               | -      | -                                                       |                         |
| Copper.....               | = 0    | -                                                       |                         |
| Lead.....                 | = 0    | -                                                       |                         |
| Magnox/Magnesium.....     | = 98.0 | 0.8 wt% aluminium as an alloying constituent of Magnox. |                         |
| Nickel.....               | ~ 0.20 | Nimonic.                                                |                         |
| Titanium.....             | -      | -                                                       |                         |
| Uranium.....              | -      | -                                                       |                         |
| Zinc.....                 | TR     | -                                                       |                         |
| Zircaloy/Zirconium.....   | = 1.6  | -                                                       |                         |
| Other metals.....         | TR     | "Other" metals could include thermocouple wires.        |                         |

Organics (%wt):

|                                     | (%wt) | Type(s) and comment | % of total C14 activity |
|-------------------------------------|-------|---------------------|-------------------------|
| Total cellulotics.....              | = 0   | -                   |                         |
| Paper, cotton.....                  | = 0   | -                   |                         |
| Wood.....                           | = 0   | -                   |                         |
| Halogenated plastics.....           | = 0   | -                   |                         |
| Total non-halogenated plastics..... | = 0   | -                   |                         |
| Condensation polymers.....          | = 0   | -                   |                         |
| Others.....                         | = 0   | -                   |                         |
| Organic ion exchange materials..... | TR    | -                   |                         |
| 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.....                 | TR    | -                   |                         |

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.....                         | TR    | -                   |                         |
| Desiccants/Catalysts.....             | -     | -                   |                         |
| Asbestos.....                         | = 0   | -                   |                         |
| Non/low friable.....                  | -     | -                   |                         |
| Moderately friable.....               | -     | -                   |                         |
| Highly friable.....                   | -     | -                   |                         |
| Free aqueous liquids.....             | = 0   | -                   |                         |
| Free non-aqueous liquids.....         | = 0   | -                   |                         |
| Powder/Ash.....                       | P     | -                   |                         |

#### COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

|                                                | (%wt)  | Type(s) and comment |
|------------------------------------------------|--------|---------------------|
| Combustible metals.....                        | = 98.0 | -                   |
| 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.....                       | = 98.0 | -                   |
| Higher activity particles.....                 | -      | -                   |
| Soluble solids as bulk chemical compounds..... | -      | -                   |

Hazardous substances / non hazardous pollutants:

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

Complexing agents (%wt):

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

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 |                    |                 |

Comments on planned treatments:

-

Conditioning method:

This stream is to be co-packaged with 9A64, 9A83, 9A84, 9A33, 9A34, 9A35, 9A41, 9A42, 9A43, 9A49, 9A50, 9A51, 9A54, 9A55, 9A56, 9A74. Packages are assigned to 9A33/C, 9A34, 9A74.

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                                     |                 |                  |            |
| Expected to be consigned to a Landfill Facility                                    |                 |                  |            |
| Expected to be disposed On-Site                                                    |                 |                  |            |
| Expected to be managed by In-Situ Disposal                                         |                 |                  |            |
| Expected to be consigned to an Incineration Facility                               |                 |                  |            |
| Expected to be consigned to a Metal Treatment Facility                             |                 |                  |            |
| Expected to be Out of Scope                                                        |                 |                  |            |
| Expected to be recycled / reused                                                   |                 |                  |            |
| Disposal route not known                                                           |                 |                  |            |

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: No

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

#### RADIOACTIVITY

Source: Activation when the associated fuel elements were irradiated, of nuclides incorporated in the Magnox and other materials, contamination by fission products and actinides during fuel element examination at Berkeley Technology Centre.

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

Measurement of radioactivities: Values were derived from measurements, calculations of induced activity and estimates of likely contamination.

Chemical form of radionuclides: H-3: Tritium is expected to be present as surface contamination, possibly as water, but perhaps in the form of other inorganic or organic compounds.  
C-14: Carbon 14 will probably be present as graphite.  
Cl-36: Chlorine 36 incorporated in the Magnox may be associated with barium impurity (barium chloride).  
  
Se-79: The selenium content is insignificant.  
Tc-99: The technetium content is insignificant.  
I-129: -  
Ra: Radium isotope content is insignificant.  
Th: The thorium isotope content is insignificant.  
U: Chemical form of U isotopes has not been determined but may be oxides.  
Np: The neptunium content is insignificant.  
Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

| WASTE STREAM 9A63 FED Magnox from Post Irradiation Examination |                            |                |                 |                |                  |                            |                |                 |                |
|----------------------------------------------------------------|----------------------------|----------------|-----------------|----------------|------------------|----------------------------|----------------|-----------------|----------------|
| Nuclide                                                        | Mean radioactivity, TBq/m³ |                |                 |                | Nuclide          | Mean radioactivity, TBq/m³ |                |                 |                |
|                                                                | Waste at 1.4.2025          | Bands and Code | Future Arisings | Bands and Code |                  | Waste at 1.4.2025          | Bands and Code | Future Arisings | Bands and Code |
| H 3                                                            | 7.29E-03                   | C C 2          |                 |                | Gd 153           |                            | 8              |                 |                |
| Be 10                                                          | 2.00E-07                   | C C 2          |                 |                | Ho 163           |                            | 8              |                 |                |
| C 14                                                           | 9.99E-05                   | C C 2          |                 |                | Ho 166m          |                            | 8              |                 |                |
| Na 22                                                          |                            | 8              |                 |                | Tm 170           |                            | 8              |                 |                |
| Al 26                                                          | 6.00E-05                   | C C 2          |                 |                | Tm 171           |                            | 8              |                 |                |
| Cl 36                                                          | 2.00E-04                   | C C 2          |                 |                | Lu 174           |                            | 8              |                 |                |
| Ar 39                                                          |                            | 8              |                 |                | Lu 176           |                            | 8              |                 |                |
| Ar 42                                                          |                            | 8              |                 |                | Hf 178n          |                            | 8              |                 |                |
| K 40                                                           |                            | 8              |                 |                | Hf 182           |                            | 8              |                 |                |
| Ca 41                                                          | < 3.00E-05                 | C 3            |                 |                | Pt 193           |                            | 8              |                 |                |
| Mn 53                                                          |                            | 8              |                 |                | Tl 204           |                            | 8              |                 |                |
| Mn 54                                                          |                            | 8              |                 |                | Pb 205           |                            | 8              |                 |                |
| Fe 55                                                          | 1.02E-06                   | C C 2          |                 |                | Pb 210           |                            | 8              |                 |                |
| Co 60                                                          | < 3.77E-03                 | C 3            |                 |                | Bi 208           |                            | 8              |                 |                |
| Ni 59                                                          | 1.00E-02                   | C C 2          |                 |                | Bi 210m          |                            | 8              |                 |                |
| Ni 63                                                          | 8.82E-01                   | C C 2          |                 |                | Po 210           |                            | 8              |                 |                |
| Zn 65                                                          |                            | 8              |                 |                | Ra 223           |                            | 8              |                 |                |
| Se 79                                                          | 3.45E-08                   | C C 2          |                 |                | Ra 225           |                            | 8              |                 |                |
| Kr 81                                                          |                            | 8              |                 |                | Ra 226           |                            | 8              |                 |                |
| Kr 85                                                          |                            | 8              |                 |                | Ra 228           |                            | 8              |                 |                |
| Rb 87                                                          |                            | 8              |                 |                | Ac 227           |                            | 8              |                 |                |
| Sr 90                                                          | 1.95E-02                   | C C 2          |                 |                | Th 227           |                            | 8              |                 |                |
| Zr 93                                                          | 2.00E-06                   | C C 2          |                 |                | Th 228           |                            | 8              |                 |                |
| Nb 91                                                          |                            | 8              |                 |                | Th 229           |                            | 8              |                 |                |
| Nb 92                                                          |                            | 8              |                 |                | Th 230           |                            | 8              |                 |                |
| Nb 93m                                                         | 1.08E-06                   | C C 2          |                 |                | Th 232           |                            | 8              |                 |                |
| Nb 94                                                          |                            | 8              |                 |                | Th 234           | 3.00E-06                   | C C 2          |                 |                |
| Mo 93                                                          |                            | 8              |                 |                | Pa 231           |                            | 8              |                 |                |
| Tc 97                                                          |                            | 8              |                 |                | Pa 233           | 1.13E-07                   | C C 2          |                 |                |
| Tc 99                                                          | 1.00E-05                   | C C 2          |                 |                | U 232            |                            | 8              |                 |                |
| Ru 106                                                         |                            | 8              |                 |                | U 233            |                            | 8              |                 |                |
| Pd 107                                                         |                            | 8              |                 |                | U 234            | 2.01E-06                   | C C 2          |                 |                |
| Ag 108m                                                        | 3.88E-06                   | C C 2          |                 |                | U 235            | 6.00E-08                   | C C 2          |                 |                |
| Ag 110m                                                        |                            | 8              |                 |                | U 236            | 3.00E-07                   | C C 2          |                 |                |
| Cd 109                                                         |                            | 8              |                 |                | U 238            | 3.00E-06                   | C C 2          |                 |                |
| Cd 113m                                                        | < 8.12E-05                 | C 3            |                 |                | Np 237           | 1.13E-07                   | C C 2          |                 |                |
| Sn 119m                                                        |                            | 8              |                 |                | Pu 236           |                            | 8              |                 |                |
| Sn 121m                                                        | < 3.16E-04                 | C 3            |                 |                | Pu 238           | 3.48E-04                   | C C 2          |                 |                |
| Sn 123                                                         |                            | 8              |                 |                | Pu 239           | 9.00E-04                   | C C 2          |                 |                |
| Sn 126                                                         | 3.04E-07                   | C C 2          |                 |                | Pu 240           | 9.99E-04                   | C C 2          |                 |                |
| Sb 125                                                         | 4.28E-08                   | C C 2          |                 |                | Pu 241           | 8.43E-03                   | C C 2          |                 |                |
| Sb 126                                                         | 4.26E-08                   | C C 2          |                 |                | Pu 242           | 6.00E-07                   | C C 2          |                 |                |
| Te 125m                                                        | 1.07E-08                   | C C 2          |                 |                | Am 241           | 2.33E-03                   | C C 2          |                 |                |
| Te 127m                                                        |                            | 8              |                 |                | Am 242m          | 3.66E-06                   | C C 2          |                 |                |
| I 129                                                          | 2.00E-08                   | C C 2          |                 |                | Am 243           | 9.99E-07                   | C C 2          |                 |                |
| Cs 134                                                         | 4.74E-09                   | C C 2          |                 |                | Cm 242           | 3.02E-06                   | C C 2          |                 |                |
| Cs 135                                                         | 7.00E-07                   | C C 2          |                 |                | Cm 243           | 4.61E-07                   | C C 2          |                 |                |
| Cs 137                                                         | 2.64E-02                   | C C 2          |                 |                | Cm 244           | 5.02E-06                   | C C 2          |                 |                |
| Ba 133                                                         | < 2.76E-05                 | C 3            |                 |                | 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                                                         | 6.87E-07                   | C C 2          |                 |                | Cf 251           |                            | 8              |                 |                |
| Sm 147                                                         |                            | 8              |                 |                | Cf 252           |                            | 8              |                 |                |
| Sm 151                                                         | 1.74E-04                   | C C 2          |                 |                | Unsp a           |                            |                |                 |                |
| Eu 152                                                         | 1.19E-06                   | C C 2          |                 |                | Unsp b/g         |                            |                |                 |                |
| Eu 154                                                         | 4.67E-05                   | C C 2          |                 |                | <b>Total a</b>   | <b>4.59E-03</b>            | *              | <b>0</b>        | *              |
| Eu 155                                                         | 4.66E-06                   | C C 2          |                 |                | <b>Total b/g</b> | <b>9.58E-01</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 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