

<b>WASTE STREAM</b>	<b>9A68</b>	<b>Miscellaneous Contaminated Items from Post Irradiation Examination</b>
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**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.....	53.2 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		53.2 m <sup>3</sup>
Comment on volumes:	The last arising of the waste was in 1975. There will be no future 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), principally from the examination of irradiated fuel, steel and graphite.

**PHYSICAL CHARACTERISTICS**

**General description:** The waste consists principally of non-fuel element debris from the post irradiation examination work carried out on fuel, steel and graphite in the BC caves and cells. This waste will also comprise combustible and non-combustible wastes, metals, glass and cave refurbishment wastes. There will be a small amount of fire suppressant powders and vermiculite. The waste is contained within mild steel black can liners and paint tin liners. Current plans are that the mild steel waste containers described in former stream 9A926 will not be separated from the waste in this stream. As the waste is containerised, it is unlikely that there will be any large items that will require special handling.

**Physical components (%wt):** The waste will include steel items such as tools, plastic items, tissues and swabs used for cleaning, fire suppressant powders and the absorber vermiculite. There may be small quantities of ion exchange material, although this will be treated with stream 9A25. % Breakdown ~25% ferrous metals, ~25% graphite, ~25% paper and ~25% plastics.

**Sealed sources:** The waste does not contain sealed sources.

**Bulk density (t/m<sup>3</sup>):** 0.3

**Comment on density:** Calculated using masses and external volumes of containers.

**CHEMICAL COMPOSITION**

**General description and components (%wt):** The waste will include steel, plastics, paper and graphite. There may be small amounts of ternary eutectic chloride (sodium chloride, barium chloride and potassium chloride) which was used as a fire extinguishant, and incinerator ash. Fission products, actinides and other activation products will be present as contaminants.

**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):** Much of the metal will be of only 1-2 mm thickness but there will be items of greater thickness.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	NE		
Other ferrous metals.....	~25.0		
Iron.....			
Aluminium.....	NE		
Beryllium.....	NE		
Cobalt.....			
Copper.....	NE		
Lead.....	NE		
Magnox/Magnesium.....	NE		
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....	NE		
Zircaloy/Zirconium.....	NE		
Other metals.....	NE	"Other" metals have not been identified.	

Organics (%wt):

There will be a number of organic materials present in the waste, including plastics, Perspex, polythene, PVC and paper. Specific organic chemical compounds identified as possibly present are: hexamine, methanol, Perklone D, acetone and epoxy resin. These compounds may adversely affect radionuclide mobility. No quantitative estimates of the various types or quantities of organics have been assessed. There may also be small quantities of liquid organic oils, e.g. oil on swabs and in hydraulic equipment.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	~25.0		
Paper, cotton.....	~25.0		
Wood.....	NE		
Halogenated plastics .....	NE		
Total non-halogenated plastics.....	NE		
Condensation polymers.....	NE		
Others.....	NE		
Organic ion exchange materials....	NE		
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):

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	0		
Sand.....			
Glass/Ceramics.....	NE		
Graphite.....	~25.0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	NE		
Powder/Ash.....	NE		

Inorganic anions (%wt):           The inorganic anion content of the waste has not been fully quantified.

	(%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 waste acceptance criteria:           Ternary eutectic chloride (TEC), the powdered fire extinguishant, is of potential concern owing to the corrosive effect of sodium chloride (one third of total contents of TEC) on the waste container. Barium chloride is also present in TEC and is a poison.

	(%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.....		

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Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	TR
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances /  
non hazardous pollutants:

Toxic metals are not expected to be present but further assessment is needed to confirm this.

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

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Complexing agents (%wt):

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	~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 is to be co-packaged with 9A36, 9A37, 9A38, 9A57, 9A58, 9A59, 9A65, 9A69, 9A70, 9A71, 9A72, 9A75, 9A77, 9A78, 9A82. Packages are assigned to 9A68, 9A71 & 9A75.

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
	6m <sup>3</sup> concrete box (SD)	100.0	0.95	5.8	56

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: -

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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 activities that might be expected.

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.

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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	2.58E-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	1.39E-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	1.71E-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>1.17E-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