

WASTE STREAM	9B82/C	FED Magnox Dissolution Secondary Waste (Sludge)
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SITE Bradwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025		= 1.4	7.9
Future arisings:				0.0
Total future arisings:			0.0	0.0
Total waste volume:			1.4	7.9

Number of waste packages in stock: At 1.4.2025..... 6 packages

Comment on arising rates: -

Additional information on quantities: -

Uncertainty factors on volumes:

Stock (upper):	x 1.00	Arisings (upper):	x -
Stock (lower):	x 1.00	Arisings (lower):	x -

WASTE SOURCE The sludge and ion exchange material originate from the abatement of the dissolution plant discharges. During the abatement process, constituents that are insoluble in acid will be containerised in sludge tank(s).

PHYSICAL CHARACTERISTICS

General description: The waste consists of insoluble constituents of Magnox arising following the pH correction of FED dissolution discharges. Sludge arising from operation of the Aqueous Discharge Abatement Plant (ADAP); principally precipitated magnesium and other hydroxides with a small amount of PolyGold AD987 flocculant. There are no large items that may require special handling. Sludge particles (includes un-dissolved material) may be up to 3 millimetres in size.

Changes since waste generated: -

Bulk density (t/m³): = 0.70

Comment on density: The bulk density is calculated from the known waste mass and volume of the wastestream.

CHEMICAL COMPOSITION

General description and components (%wt): Insoluble residues from chemical dissolution of Magnox (including Fe, Ce, Co, Zn, Zr and Al). Siliceous materials including sand, some oil contamination and a range of other materials.

Chemical state: Alkali

Sheet metal proportion / thickness: No bulk or sheet metal items (the sludge has not been transferred in its container).

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	NE	-	
Other ferrous metals.....	NE	-	
Iron.....	-	-	
Aluminium.....	NE	-	
Beryllium.....	TR	-	
Cobalt.....	-	-	
Copper.....	NE	-	
Lead.....	TR	-	
Magnox/Magnesium.....	TR	-	
Nickel.....	-	-	
Titanium.....	-	-	
Uranium.....	-	-	
Zinc.....	NE	-	
Zircaloy/Zirconium.....	NE	-	
Other metals.....	NE	-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	NE	-	
Paper, cotton.....	NE	-	
Wood.....	NE	-	
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.....	= 6.0	Swabs	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	TR	-	
Inorganic sludges and flocs.....	= 92.0	ADAP sludge	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	= 0	-	
Cementitious material.....	= 0	-	
Sand.....		-	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 2.0	-	
Desiccants/Catalysts.....		-	
Asbestos.....	= 0	-	
Non/low friable.....		-	
Moderately friable.....		-	
Highly friable.....		-	
Free aqueous liquids.....	0	-	
Free non-aqueous liquids.....	TR	-	
Powder/Ash.....	= 0	-	

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

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride.....	NE	-
Chloride.....	NE	-
Iodide.....	NE	-
Cyanide.....	= 0	-
Carbonate.....	~ 6.0	4-8wt% dry weight as carbonate.
Nitrate.....	NE	-
Nitrite.....	NE	-
Phosphate.....	NE	-
Sulphate.....	NE	-
Sulphide.....	NE	-

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals.....	= 0	-
Low flash point liquids.....	= 0	-
Explosive materials.....	= 0	-
Phosphorus.....	= 0	-
Hydrides.....	= 0	-
Biological etc. materials.....	TR	-
Biodegradable materials.....	0	-
Putrescible wastes.....	= 0	-
Non-putrescible wastes.....		-
Corrosive materials.....	= 0	-
Pyrophoric materials.....	= 0	-
Generating toxic gases.....	NE	-
Reacting with water.....	= 0	-
Higher activity particles.....		-
Soluble solids as bulk chemical compounds.....		-

Hazardous substances / non hazardous pollutants:

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

Complexing agents (%wt):

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

Physical components:

	Number	Type(s) and comment
Sources.....		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		-
EEE Type 2.....		-
EEE Type 3.....		-
EEE Type 4.....		-
EEE Type 5.....		-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction		
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration		
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation		
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments:

-

The sludge has been conditioned using a thermal vacuum drying process. The conditioning process was cyclical and required alternate addition of sludge to the DCIC and drying of the contents of the DCIC until the required sludge packing density and dryness was achieved.

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
	500 l RS drum (0mm Pb)	100.0	0.24	0.24	6	-

Range in container waste loading: -

Other information on packaging and conditioning: The container material is cast iron.

Conditioned density (t/m³): = 0.70

Conditioned density comment: Conditioned density was calculated using the known mass and volume of the wastestream.

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)	100.0		
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: Contaminated sludge. Contamination by fission products, actinides and activation products.

Uncertainty: Specific activities of all 6 waste packages were determined using gamma spectroscopy and fingerprints.

Measurement of radioactivities: Specific activities of all 6 waste packages were measured and derived using gamma spectroscopy and the application of fingerprints. Specific activity for the wastestream was calculated using the specific activity of individual packages. The presence of ADAP sludge introduces some uncertainty due to method used to calculate reference date of fingerprint. Decayed to 01/04/2025.

Chemical form of radionuclides:

H-3: Most tritium is expected to be present as water but some may be present in the form of other inorganic compounds or as organic compounds.

C-14: Carbon 14 may be present as graphite.

Cl-36: The chemical form of chlorine 36 may be inorganic chloride.

Se-79: -

Tc-99: -

I-129: -

Ra: -

Th: -

U: The chemical form of uranium isotopes has not been determined but will probably be uranium oxides.

Np: -

Pu: The chemical form of plutonium isotopes has not been determined but will probably be plutonium oxides.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	2.52E-01	C C 2			Gd 153		8		
Be 10		8			Ho 163	1.46E-08	C C 2		
C 14	9.13E-03	C C 2			Ho 166m	7.93E-08	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171	2.70E-09	C C 2		
Cl 36	1.60E-06	C C 2			Lu 174		8		
Ar 39	5.65E-04	C C 2			Lu 176		8		
Ar 42	2.00E-08	C C 2			Hf 178n	1.52E-07	C C 2		
K 40	7.76E-09	C C 2			Hf 182		8		
Ca 41	2.15E-04	C C 2			Pt 193	4.24E-04	C C 2		
Mn 53		8			Ti 204	8.61E-08	C C 2		
Mn 54	1.18E-09	C C 2			Pb 205		8		
Fe 55	1.26E-02	C C 2			Pb 210		8		
Co 60	1.83E-02	C C 2			Bi 208		8		
Ni 59	1.41E-04	C C 2			Bi 210m		8		
Ni 63	8.24E-02	C C 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85	1.49E-05	C C 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	1.81E-04	C C 2			Th 227		8		
Zr 93	9.34E-06	C C 2			Th 228	1.83E-08	C C 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	2.22E-09	C C 2		
Nb 93m	5.25E-05	C C 2			Th 232		8		
Nb 94	9.94E-07	C C 2			Th 234	3.06E-06	C C 2		
Mo 93	8.03E-08	C C 2			Pa 231		8		
Tc 97		8			Pa 233	3.78E-07	C C 2		
Tc 99	1.19E-06	C C 2			U 232	1.78E-08	C C 2		
Ru 106		8			U 233	3.56E-08	C C 2		
Pd 107		8			U 234	8.73E-06	C C 2		
Ag 108m	1.14E-04	C C 2			U 235	2.30E-07	C C 2		
Ag 110m		8			U 236	8.50E-07	C C 2		
Cd 109	1.85E-08	C C 2			U 238	3.06E-06	C C 2		
Cd 113m	4.46E-08	C C 2			Np 237	3.78E-07	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	5.56E-07	C C 2			Pu 238	6.24E-04	C C 2		
Sn 123		8			Pu 239	1.17E-03	C C 2		
Sn 126	2.42E-09	C C 2			Pu 240	1.16E-03	C C 2		
Sb 125	2.54E-07	C C 2			Pu 241	1.26E-02	C C 2		
Sb 126		8			Pu 242	1.54E-06	C C 2		
Te 125m	6.35E-08	C C 2			Am 241	4.47E-03	C C 2		
Te 127m		8			Am 242m	9.75E-06	C C 2		
I 129	1.23E-07	C C 2			Am 243	2.89E-06	C C 2		
Cs 134	2.42E-06	C C 2			Cm 242	8.04E-06	C C 2		
Cs 135	4.87E-09	C C 2			Cm 243	1.03E-06	C C 2		
Cs 137	4.03E-04	C C 2			Cm 244	1.59E-05	C C 2		
Ba 133	1.53E-04	C C 2			Cm 245	1.23E-09	C C 2		
La 137	3.76E-09	C C 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147	9.05E-05	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	3.51E-04	C C 2			Unsp a				
Eu 152	7.35E-06	C C 2			Unsp b/g				
Eu 154	2.32E-04	C C 2			Total a	7.46E-03	*	0	*
Eu 155	2.97E-05	C C 2			Total b/g	3.90E-01	*	0	*

Bands (Upper and Lower)

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

Note: Bands quantify uncertainty in the mean radioactivity.

Code

1 Measured activity
2 Derived activity (best estimate)
3 Derived activity (upper limit)
4 Not present
5 Present but not significant
6 Likely to be present but not assessed
7 Present in significant quantities but not determined
8 Not expected to be present in significant quantity
* Total calculated from the 114 declared radionuclides