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

SITE	Bradwell
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	1.4 m³	7.9 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		1.4 m³	7.9 m³
Number of waste packages in stock:	At 1.4.2022.....	6 package(s)	

Comment on volumes: Volume of each package from WD/CALC/4107 Issue 3.

Uncertainty factors on volumes:

Stock (upper):	x 1.1	Arisings (upper)	x
Stock (lower):	x 0.9	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.

Physical components (%wt): ADAP Sludge (92wt%), Graphite (2wt%), Swabs (6wt%)

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 0.7

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

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

Metals and alloys (%wt): No bulk or sheet metal items (the sludge has not been transferred in its container).

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	NE		
Other ferrous metals.....	NE		
Iron.....			
Aluminium.....	NE		

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

Beryllium	TR
Cobalt	
Copper	NE
Lead	TR
Magnox/Magnesium	TR
Nickel	
Titanium	
Uranium	
Zinc	NE
Zircaloy/Zirconium	NE
Other metals	NE

Organics (%wt): 6wt% is made up of swabs.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	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		

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

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

Inorganic anions (%wt): Carbonates are present.

	(%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		

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

Hazardous substances / non hazardous pollutants: -

	(%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.....		

Complexing agents (%wt): Yes

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

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

Potential for the waste to contain discrete items: No. In & of itself not a DI; assumed not likely to contain any "rogue" items that could be.

PACKAGING AND CONDITIONING

Container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l RS drum (0mm Pb)	100.0	0.24	0.24	6

Container type comment: Packaged into 6 MOSAIK T/ISAR IP-2 containers.

Range in container waste volume: -

Other information on containers: The container material is cast iron.

Conditioned density (t/m^3): 0.7

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

Other information on conditioning: -

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.

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 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 uncertaincy due to method used to calculate reference date of fingerprint. Decayed to 01/04/2022.

Other information: -

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

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	2.98E-01	C C 2			Gd 153		8		
Be 10		8			Ho 163	1.46E-08	C C 2		
C 14	9.14E-03	C C 2			Ho 166m	7.94E-08	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171	7.96E-09	C C 2		
Cl 36	1.6E-06	C C 2			Lu 174		8		
Ar 39	5.69E-04	C C 2			Lu 176		8		
Ar 42	2.13E-08	C C 2			Hf 178n	1.63E-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	4.42E-04	C C 2		
Mn 53		8			Tl 204	1.49E-07	C C 2		
Mn 54	1.34E-08	C C 2			Pb 205		8		
Fe 55	2.69E-02	C C 2			Pb 210		8		
Co 60	2.71E-02	C C 2			Bi 208		8		
Ni 59	1.41E-04	C C 2			Bi 210m		8		
Ni 63	8.41E-02	C C 2			Po 210		8		
Zn 65	7.6E-09	C C 2			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85	1.81E-05	C C 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	1.95E-04	C C 2			Th 227		8		
Zr 93	9.34E-06	C C 2			Th 228	1.88E-08	C C 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.98E-09	C C 2		
Nb 93m	5.84E-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	8.04E-08	C C 2			Pa 231		8		
Tc 97		8			Pa 233	3.73E-07	C C 2		
Tc 99	1.19E-06	C C 2			U 232	1.83E-08	C C 2		
Ru 106	7.23E-09	C C 2			U 233	3.56E-08	C C 2		
Pd 107		8			U 234	8.72E-06	C C 2		
Ag 108m	1.15E-04	C C 2			U 235	2.3E-07	C C 2		
Ag 110m		8			U 236	8.5E-07	C C 2		
Cd 109	9.55E-08	C C 2			U 238	3.06E-06	C C 2		
Cd 113m	5.19E-08	C C 2			Np 237	3.74E-07	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	5.77E-07	C C 2			Pu 238	6.39E-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	5.39E-07	C C 2			Pu 241	1.46E-02	C C 2		
Sb 126		8			Pu 242	1.54E-06	C C 2		
Te 125m	1.35E-07	C C 2			Am 241	4.42E-03	C C 2		
Te 127m		8			Am 242m	9.89E-06	C C 2		
I 129	1.23E-07	C C 2			Am 243	2.89E-06	C C 2		
Cs 134	6.62E-06	C C 2			Cm 242	8.13E-06	C C 2		
Cs 135	4.87E-09	C C 2			Cm 243	1.1E-06	C C 2		
Cs 137	4.31E-04	C C 2			Cm 244	1.78E-05	C C 2		
Ba 133	1.86E-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	2E-04	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	3.59E-04	C C 2			Other a				
Eu 152	8.57E-06	C C 2			Other b/g				
Eu 154	2.96E-04	C C 2			**Total a**	**7.43E-03**	**C C 2**	**0**	
Eu 155	4.56E-05	C C 2			**Total b/g**	**4.64E-01**	**C C 2**	**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 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