WASTE STREAM 9B15/C 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.....	12.6 m³	43.5 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		12.6 m³	43.5 m³
Number of waste packages in stock:	At 1.4.2022.....	8 package(s)	

Comment on volumes: -

Uncertainty factors on volumes:

Stock (upper):	x 1.2	Arisings (upper)	x
Stock (lower):	x 0.8	Arisings (lower)	x

WASTE SOURCE Sludge heel arose from operation of Pond Water Treatment Plant (PWTP) and Active Effluent Treatment Plan (AETP) as well as decommissioning operations such as pond wall scabbling and pond skip decontamination. Some ADAP sludge, originating from the operation of the Aqueous Discharge Abatement Plant (ADAP) present, as well as sand from filter units used to treat effluent and gravel from the interface of FED storage vaults.

PHYSICAL CHARACTERISTICS

General description:	Sludge heel was consolidated and conditioned using Advanced Vacuum Drying System (AVDS), where possible the sludge was co-packaged with gravel, sand, ADAP sludge and other miscellaneous contaminated items (MCI).
Physical components (%vol):	Sludge, filter sand and gravel. Sludge waste is principally inorganic, including Magnox and steel corrosion products. Organic materials consist of oils, paint from decontamination operations, soaps and other products of laundry and personal washing.
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m³):	0.91
Comment on density:	The bulk density of the sludge was calculated using the total wastestream mass and total wastestream volume from package records.

CHEMICAL COMPOSITION

General description and components (%wt):	Sludge heel consisting of magnesium hydroxide, magnesium carbonate, ion exchange material as well as sand and concrete dust. Some organic materials present in form of oils, paint and soap. Gravel interface from FED vaults. Sludge (56 wt%), Sand (16 wt%), Gravel (28 wt%).
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 has not been assessed. Se-79: The chemical form of selenium has not been determined. Tc-99: The chemical form of technetium has not been determined. U: The chemical form of uranium isotopes has not been determined but may be uranium oxides. Np: The chemical form of neptunium has not been determined. Pu: The chemical form of plutonium isotopes has not been determined but may be plutonium oxides.
Metals and alloys (%wt):	-

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	(%wt)	Type(s) / Grade(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	P	Corroded Magnox within the sludge.	
Nickel			
Titanium			
Uranium			
Zinc	NE		
Zircaloy/Zirconium	NE		
Other metals	NE	"Other" metals have not been identified.	

Organics (%wt): Oil, paint and soap are present but not quantified.

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

Other materials (%wt): Sludge is principally inorganic and contains some ion exchange material.

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	TR		
Inorganic sludges and flocs.....	56.4	Majority 61V sludge, some ADAP sludge present.	
Soil.....	0		
Brick/Stone/Rubble.....	27.7	Gravel from the 8B Interface of FED Vaults	
Cementitious material.....	NE		
Sand.....	15.9	Contaminated sand co-packaged with sludge.	
Glass/Ceramics.....	0		
Graphite.....	TR		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	P		
Free non-aqueous liquids.....	P		
Powder/Ash.....	0		

Inorganic anions (%wt): Chemical analysis of samples shows only the inorganic anions indicated.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	0.01	
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	~6.0	Chemical analysis shows carbonate contents of 4-8wt(%).
Nitrate.....	0	
Nitrite.....	0	
Phosphate.....	0	
Sulphate.....	0.80	
Sulphide.....	0	

Materials of interest for waste acceptance criteria: <2% of the waste is oil and grease. There is not expected to be any biological material.

	(%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	

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Putrescible wastes.....	0
Non-putrescible wastes.....	
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	NE
Reacting with water.....	
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: None expected

	(%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): Yes

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

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
3m^3 RS box	100.0	1.576	1.576	8

Container type comment: -

Range in container waste volume: -

Other information on containers: -

Conditioned density (t/m^3): ~0.91

Conditioned density comment: Calculated using total waste volume and mass from package records

Other information on conditioning: -

RADIOACTIVITY

Source: Contaminated sludge, gravel, sand and other miscellaneous contaminated items. Contamination by fission products, actinides and activation products.

Uncertainty: Specific activities of all 8 waste packages were determined using gamma spectroscopy and fingerprints. The above values (Tbq/m3) are calculated by summing individual package activities. The presence of ADAP sludge introduces some uncertainty due to method used to calculate reference date of fingerprint. Decayed to 01/04/2022.

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 8 waste packages were measured and derived using gamma spectroscopy and the application of fingerprints.

Other information: -

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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	3.27E-02	C C 2			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	1.20E-03	C C 2			Ho 166m	7.9E-06	C C 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	5.97E-07	C C 2			Lu 174		8		
Ar 39	7.83E-06	C C 2			Lu 176		8		
Ar 42		8			Hf 178n	1.22E-05	C C 2		
K 40	3.48E-09	C C 2			Hf 182		8		
Ca 41	1.09E-04	C C 2			Pt 193	1.63E-04	C C 2		
Mn 53		8			Tl 204	1.26E-06	C C 2		
Mn 54		8			Pb 205		8		
Fe 55	2.25E-03	C C 2			Pb 210		8		
Co 60	3.03E-03	C C 2			Bi 208	1.78E-03	C C 2		
Ni 59	7.87E-05	C C 2			Bi 210m		8		
Ni 63	9.77E-03	C C 2			Po 210	3.24E-06	C C 2		
Zn 65		8			Ra 223		8		
Se 79	2.67E-08	C C 2			Ra 225		8		
Kr 81	1.35E-09	C C 2			Ra 226		8		
Kr 85	3.38E-04	C C 2			Ra 228		8		
Rb 87		8			Ac 227	1.53E-03	C C 2		
Sr 90	9.94E-03	C C 2			Th 227		8		
Zr 93	5.52E-06	C C 2			Th 228	5.46E-08	C C 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	2.02E-07	C C 2		
Nb 93m	7.49E-06	C C 2			Th 232	3.39E-08	C C 2		
Nb 94	5.24E-07	C C 2			Th 234		8		
Mo 93	1.96E-08	C C 2			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99	5.71E-06	C C 2			U 232	1.07E-08	C C 2		
Ru 106	4.97E-09	C C 2			U 233	2.19E-08	C C 2		
Pd 107	6.52E-08	C C 2			U 234	1.94E-06	C C 2		
Ag 108m	3.65E-05	C C 2			U 235	5.46E-08	C C 2		
Ag 110m		8			U 236	2.02E-07	C C 2		
Cd 109	4.15E-09	C C 2			U 238	6.39E-07	C C 2		
Cd 113m	2.25E-06	C C 2			Np 237	9.83E-05	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	2.78E-06	C C 2			Pu 238	5.41E-04	C C 2		
Sn 123		8			Pu 239	8.43E-04	C C 2		
Sn 126	2.43E-07	C C 2			Pu 240	9.95E-04	C C 2		
Sb 125	1.47E-06	C C 2			Pu 241	1.65E-02	C C 2		
Sb 126	3.4E-08	C C 2			Pu 242	6.27E-06	C C 2		
Te 125m	3.69E-07	C C 2			Am 241	4.99E-03	C C 2		
Te 127m		8			Am 242m	3.78E-06	C C 2		
I 129	9.7E-07	C C 2			Am 243	1.77E-06	C C 2		
Cs 134	1.93E-06	C C 2			Cm 242	4.10E-03	C C 2		
Cs 135	4.88E-07	C C 2			Cm 243	2.28E-06	C C 2		
Cs 137	1.49E-02	C C 2			Cm 244	2.84E-05	C C 2		
Ba 133	4.15E-05	C C 2			Cm 245		8		
La 137	1.38E-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	3.77E-05	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	2.91E-04	C C 2			Other a				
Eu 152	2.83E-06	C C 2			Other b/g				
Eu 154	1.01E-04	C C 2			**Total a**	**1.16E-02**	**C C 2**	**0**	
Eu 155	2.05E-05	C C 2			**Total b/g**	**9.48E-02**	**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