WASTE STREAM 9B15/C Sludge

SITE	Bradwell
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	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 1.4.2019.....	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

The sludge originates from routine filtration of liquid effluents and cooling pond water and from special clean-up operations on cooling ponds. Sludge heel, covered in this waste stream, is that material not readily mobilised during the initial campaigns. ADAP sludge originated from the operation of the Aqueous Discharge Abatement Plant (ADAP). Sand originates from filter units used to treat effluent and gravel originated from the interface of FED tanks.

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 consists of debris washed from persons, floors and clothing, corrosion products such as magnesium hydroxide and carbonate detached from fuel elements and materials such as flakes of paint. Also there is some oil and grease. Sludge particles may be up to millimetre size, and there will probably be approximately 210 kg/m3 of solid material.
Sealed sources:	-
Bulk density (t/m³):	1.1
Comment on density:	The bulk density of the sludge ranges from 1.0 to 1.2 t/m3 with an average of about 1.1 t/m3.

CHEMICAL COMPOSITION

General description and components (%wt):	Sludge heel (53 wt%) consisting of magnesium hydroxide, magnesium carbonate, ion exchange material and a range of other materials. Some oil and grease. Gravel (25 wt%), sand (17 wt%), and ADAP sludge (5 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):	-

WASTE STREAM 9B15/C Sludge

	Stainless steel	NE	
	Other ferrous metals	NE	
	Iron		
	Aluminium	<0.30	
	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):	The cellulosic material content of the waste has not been assessed. Ion exchange materials (probably organic) are present. Oil and grease are present.		
	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):	-		
	Inorganic ion exchange materials.	<1.0	
	Inorganic sludges and flocs	58.0	
	Soil	0	
	Brick/Stone/Rubble	25.0	Interfacial gravel from FED vaults.
	Cementitious material	NE	

WASTE STREAM 9B15/C Sludge

Sand	17.0
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.

Fluoride	0
Chloride	TR
Iodide	0
Cyanide	0
Carbonate	~2.0
Nitrate	0
Nitrite	0
Phosphate	0
Sulphate	1.8
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. The possible presence of items that are not estimated is to be determined.

Combustible metals	<0.04
Low flash point liquids	0
Explosive materials	0
Phosphorus	0
Hydrides	0
Biological etc. materials	TR
Biodegradable materials	
Putrescible wastes	0
Non-putrescible wastes	
Corrosive materials	0
Pyrophoric materials	0
Generating toxic gases	NE
Reacting with water	
Active particles	
Soluble solids as bulk chemical compounds	

WASTE STREAM 9B15/C Sludge

Hazardous substances / non hazardous pollutants: None expected

Acrylamide.....
Benzene.....
Chlorinated solvents.....
Formaldehyde.....
Organometallics.....
Phenol.....
Styrene.....
Tri-butyl phosphate.....
Other organophosphates.....
Vinyl chloride.....
Arsenic.....
Barium.....
Boron.....
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):

EDTA.....
DPTA.....
NTA.....
Polycarboxylic acids……
Other organic complexants.....
Total complexing agents..... TR

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	1.575	1.575	8

WASTE STREAM 9B15/C Sludge

Container type comment:	-
Range in container waste volume:	-
Other information on containers:	-
Conditioned density (t/m³):	~0.6
Conditioned density comment:	-
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 representative of the waste across the packages and each package's specific activity falls within the quoted uncertainty bands.
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:	-

WASTE STREAM 9B15/C Sludge

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	4.10E-03	C C 2			Gd 153		8		
Be 10		8			Ho 163	1.45E-08	C C 2		
C 14	1.81E-04	B B 2			Ho 166m	8.79E-06	C C 2		
Na 22	5.3E-07	B B 2			Tm 170		8		
Al 26		8			Tm 171	5.15E-09	B B 2		
Cl 36		8			Lu 174		8		
Ar 39	1.05E-05	B B 2			Lu 176		8		
Ar 42		8			Hf 178n	1.36E-05	B B 2		
K 40	2.63E-09	B B 2			Hf 182		8		
Ca 41	8.24E-05	C C 2			Pt 193	1.19E-04	B B 2		
Mn 53		8			Tl 204	1.12E-06	B B 2		
Mn 54		8			Pb 205		8		
Fe 55	1.16E-03	B B 2			Pb 210		8		
Co 60	1.17E-03	B B 1			Bi 208		8		
Ni 59	5.94E-05	C C 2			Bi 210m		8		
Ni 63	4.67E-04	B B 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	2.97E-08	C C 2			Ra 225		8		
Kr 81	1.8E-09	B B 2			Ra 226		8		
Kr 85	5.47E-04	C C 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	1.33E-02	B B 2			Th 227		8		
Zr 93	4.35E-06	B B 2			Th 228	8.77E-09	B B 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.36E-09	B B 2		
Nb 93m	6.2E-06	B B 2			Th 232		8		
Nb 94	3.98E-07	B B 2			Th 234	1.16E-06	B B 2		
Mo 93	1.75E-08	B B 2			Pa 231		8		
Tc 97		8			Pa 233	2.12E-07	B B 2		
Tc 99	6.58E-06	B B 2			U 232	8.52E-09	B B 2		
Ru 106	4.44E-09	B B 2			U 233	1.87E-08	B B 2		
Pd 107	7.25E-08	C C 2			U 234	9.8E-07	B B 2		
Ag 108m	2.35E-05	C C 2			U 235	2.88E-08	B B 2		
Ag 110m		8			U 236	1.07E-07	B B 2		
Cd 109	5.31E-09	C C 2			U 238	1.16E-06	B B 2		
Cd 113m	2.99E-06	C C 2			Np 237	2.13E-07	B B 2		
Sn 119m		8			Pu 236		8		
Sn 121m	4.01E-06	B B 2			Pu 238	5.08E-04	B B 2		
Sn 123		8			Pu 239	9.44E-04	B B 2		
Sn 126	2.7E-07	B B 2			Pu 240	9.36E-04	B B 2		
Sb 125	2.62E-06	C C 2			Pu 241	1.67E-02	B B 2		
Sb 126	3.78E-08	C C 2			Pu 242	8.06E-07	B B 2		
Te 125m	6.56E-07	C C 2			Am 241	4.99E-03	B B 2		
Te 127m		8			Am 242m	4.89E-06	B B 2		
I 129	1.28E-06	B B 2			Am 243	1.51E-06	B B 2		
Cs 134	3.48E-06	B B 2			Cm 242	4.05E-06	B B 2		
Cs 135	5.42E-07	B B 2			Cm 243	2.53E-06	B B 2		
Cs 137	1.46E-02	B B 1			Cm 244	3.29E-05	B B 2		
Ba 133	2.93E-05	B B 2			Cm 245		8		
La 137	1.15E-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	7.06E-05	B B 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	2.77E-04	B B 2			Other a				
Eu 152	1.91E-06	B B 2			Other b/g				
Eu 154	9.59E-05	C C 2			**Total a**	**7.42E-03**	**B B 2**	**0**	
Eu 155	2.41E-05	C C 2			**Total b/g**	**5.3E-02**	**B B 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