

WASTE STREAM	9B86/C	Sludge
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SITE Bradwell
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Magnox Limited
WASTE TYPE ILW

WASTE VOLUMES		Conditioned	Packaged
Stocks:	At 1.4.2019.....	2.3 m ³	7.9 m ³
Total future arisings:		0 m ³	0 m ³
Total waste volume:		2.3 m ³	7.9 m ³
Number of waste packages in stock:	At 1.4.2019.....	6 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.

PHYSICAL CHARACTERISTICS

General description: The 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. Bulk sludge was retrieved from mules from where it was pumped to a buffer tank that was used to fill the three 400 litre barrels attached to the processing plant. These were filled in several stages with periods of in-vessel drying between fillings. This sequence was repeated until the packages were filled to the required level. The barrels were then transferred to MOSAIK® EIs creating the disposable package. More watery sludge (mainly supernatant and flush water) was also transferred and conditioned into 3 MOSAIK® T-ISAR. These form the origin for this waste stream.

Physical components (%vol): Sludge, and bound water (100 wt%) not removed by drying. No other constituents anticipated.

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): Magnesium hydroxide, magnesium carbonate, ion exchange material and a range of other materials. Some oil and grease.

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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Stainless steel.....	NE	
Other ferrous metals.....	NE	
Iron.....		
Aluminium.....	<0.30	
Beryllium.....	TR	
Cobalt.....		
Copper.....	NE	
Lead.....	TR	
Magnox/Magnesium.....	<0.04	Unreacted Magnox is expected.
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 cellulose.....	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	
Fuel.....	
Asphalt/Tarmac (cont.coal tar)...	
Asphalt/Tarmac (no coal tar)....	
Bitumen.....	
Others.....	
Other organics.....	NE

Other materials (%wt):

-	
Inorganic ion exchange materials.	0
Inorganic sludges and flocs.....	100.0
Soil.....	0
Brick/Stone/Rubble.....	TR
Cementitious material.....	NE
Sand.....	

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	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.....	2.2
	Nitrate.....	0
	Nitrite.....	0
	Phosphate.....	0
	Sulphate.....	1.8
	Sulphide.....	0
Materials of interest for waste acceptance criteria:	The waste is unlikely to present a fire hazard due to the high water content. <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.....	
Hazardous substances / non hazardous pollutants:	None expected.	
	Acrylamide.....	
	Benzene.....	

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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): Yes
 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
	500 l RS drum (0mm Pb)	100.0	0.379	0.379	6

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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:

The waste has been conditioned into 6 MOSAIKS from 9B15, there are a number of Type VI DCICs also created under 9B15/C.

RADIOACTIVITY

Source:

Contaminated sludge. Contamination by fission products, actinides and activation products.

Uncertainty:

Specific activity is a function of Station operating history. 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:

The values quoted were derived by extrapolation from available measurements. Copied from 9B15/C

Other information:

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	6.04E-04	BB 2			Gd 153		8		
Be 10	2.76E-08	BB 2			Ho 163	2.84E-06	BB 2		
C 14	1.57E-04	BB 2			Ho 166m	2.98E-06	BB 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	3.96E-07	BB 2			Lu 174		8		
Ar 39	1.56E-04	BB 2			Lu 176		8		
Ar 42		8			Hf 178n	4.43E-06	BB 2		
K 40		8			Hf 182		8		
Ca 41	4.06E-06	BB 2			Pt 193	3.75E-08	BB 2		
Mn 53		8			Tl 204	2.78E-07	BB 2		
Mn 54	1.82E-09	BB 2			Pb 205		8		
Fe 55	1.63E-03	BB 2			Pb 210		8		
Co 60	1.96E-03	BB 1			Bi 208		8		
Ni 59	4.06E-06	BB 2			Bi 210m		8		
Ni 63	3.19E-05	BB 2			Po 210		8		
Zn 65	3.62E-09	BB 2			Ra 223		8		
Se 79	9.49E-09	BB 2			Ra 225		8		
Kr 81	1.01E-09	BB 2			Ra 226		8		
Kr 85	2.59E-04	BB 2			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	3.19E-03	BB 2			Th 227		8		
Zr 93	4.06E-07	BB 2			Th 228	1.42E-08	BB 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	2.42E-09	BB 2		
Nb 93m	6.15E-07	BB 2			Th 232		8		
Nb 94	8.64E-06	BB 2			Th 234	3.63E-06	BB 2		
Mo 93	2.04E-06	BB 2			Pa 231		8		
Tc 97		8			Pa 233	3.62E-07	BB 2		
Tc 99	2.63E-06	BB 2			U 232	1.38E-08	BB 2		
Ru 106		8			U 233	3.07E-08	BB 2		
Pd 107	1.84E-08	BB 2			U 234	4.77E-06	BB 2		
Ag 108m	9.95E-09	BB 2			U 235	1.99E-07	BB 2		
Ag 110m		8			U 236	7.35E-07	BB 2		
Cd 109		8			U 238	3.63E-06	BB 2		
Cd 113m	5.07E-08	BB 2			Np 237	3.62E-07	BB 2		
Sn 119m		8			Pu 236		8		
Sn 121m	1.20E-03	BB 2			Pu 238	1.70E-03	BB 2		
Sn 123		8			Pu 239	2.80E-03	BB 2		
Sn 126	4.01E-08	BB 2			Pu 240	2.78E-03	BB 2		
Sb 125		8			Pu 241	3.61E-02	BB 2		
Sb 126	5.61E-09	BB 2			Pu 242	7.22E-07	BB 2		
Te 125m		8			Am 241	1.24E-02	BB 2		
Te 127m		8			Am 242m	7.99E-06	BB 2		
I 129	4.79E-09	BB 2			Am 243	2.49E-06	BB 2		
Cs 134	5.24E-06	BB 2			Cm 242	6.59E-06	8		
Cs 135	2.76E-09	BB 2			Cm 243	1.05E-06	BB 2		
Cs 137	1.20E-02	BB 1			Cm 244	1.35E-05	BB 2		
Ba 133	8.67E-06	BB 2			Cm 245	1.06E-09	BB 2		
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	1.88E-05	BB 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	1.89E-04	BB 2			Other a				
Eu 152	2.73E-07	BB 2			Other b/g				
Eu 154	2.65E-04	BB 2			Total a	1.97E-02	BB 2	0	
Eu 155	5.45E-05	BB 2			Total b/g	5.78E-02	BB 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