WASTE STREAM 2D11/C Conditioned Pond Sludge

SITE	Sellafield
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Sellafield Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	74.1 m³	89.6 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		74.1 m³	89.6 m³
Number of waste packages in stock:	At 1.4.2019.....	157 package(s)	

Comment on volumes: Future WEP arisings based on PFSP export arisings Estimate of pond sludge volumes indicates uncertainty in the range from 260 to 390m3.

Uncertainty factors on volumes:
Stock (upper): x 1.2 Arisings (upper) x
Stock (lower): x 0.8 Arisings (lower) x

WASTE SOURCE The waste is from corrosion of items stored in the pond, the pond structure and general pond debris (eg. wind blown, wildlife deposition).

PHYSICAL CHARACTERISTICS

General description: The sludge is a dark, brownish-green, flocculant material containing a small proportion by volume of gritty material. It comprises approx 14.5 wt% solids in aqueous medium. No large items present. The waste has been encapsulated in the Waste Encapsulation Plant.

Physical components (%wt): Sludges comprises water (85.5 wt%), solids (14.5 wt%). Target during first phase of PFSP sludge solids was 11 wt % the actual average 6%.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.1

Comment on density: The given density is the material density. Samples taken in October 1987 had a settled wet density of 1.0 - 1.2 t/m³ and a solids concentration of up to 22 wt%.

CHEMICAL COMPOSITION

General description and components (%wt): Sludge composition Fe (2%), Mg (0.9%), Al (0.5%), Ca (0.3%) and Zn (0.2%) mostly as oxides. Others include U (0.2%), Pu (3E-4%). The most recent sampling indicates that the soluble organic fraction is less than 1%. Also H2O (85.5%), SiO2 (balance). Conditioned product comprises cement (~96%) and sludge (~4%).

Chemical state: Alkali

Chemical form of radionuclides:
Th: No characterisation data available.
U: Oxides.
Pu: Oxides.

Metals and alloys (%wt): No sheet or bulk metal is present.

Stainless steel.....	0	
Other ferrous metals.....	P	Trace within sludge matrix from corrosion.
Iron.....		
Aluminium.....	P	
Beryllium.....	TR	
Cobalt.....	0	
Copper.....	0	
Lead.....	0	
Magnox/Magnesium.....	P	
Nickel.....		

WASTE STREAM 2D11/C Conditioned Pond Sludge

	Titanium	0	
	Uranium	0.26	May be traces of uranium metal fines.
	Zinc	TR	
	Zircaloy/Zirconium	0	
	Other metals		
Organics (%wt):	Most recent study found <1% ether or chloroform extractable organics. Any organic matter will have arisen from bird droppings and bioactivity in the pond. There are no organic ion exchange resins, and cellulosic material is not expected to be present.		
	Total cellulosics	0	
	Paper, cotton	0	
	Wood	0	
	Halogenated plastics	0	
	Total non-halogenated plastics	0	
	Condensation polymers	0	
	Others	0	
	Organic ion exchange materials	0	
	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	0.52	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	~2.6	
	Soil	0	
	Brick/Stone/Rubble	TR	
	Cementitious material	96.4	
	Sand	0.23	
	Glass/Ceramics		
	Graphite		
	Desiccants/Catalysts	0	
	Asbestos	0	
	Non/low friable		
	Moderately friable		
	Highly friable		
	Free aqueous liquids	~	
	Free non-aqueous liquids	0	

WASTE STREAM 2D11/C Conditioned Pond Sludge

	Powder/Ash..... 0	
Inorganic anions (%wt):	Waste contains traces of phosphates from guano, plus traces of chlorides, sulphates and carbonates from concrete pond structure.	
	Fluoride..... NE	
	Chloride..... <0.05	
	Iodide..... NE	
	Cyanide..... 0	
	Carbonate..... TR	
	Nitrate..... NE	
	Nitrite..... P	
	Phosphate..... TR	
	Sulphate..... TR	
	Sulphide..... NE	
Materials of interest for waste acceptance criteria:	The waste may contain metallic Magnox (fragments from incomplete corrosion of Magnox cladding/swarf), bird droppings, cyanobacteria and algae.	
	Combustible metals.....	
	Low flash point liquids..... 0	
	Explosive materials..... 0	
	Phosphorus..... 0	
	Hydrides..... 0	
	Biological etc. materials..... P	<1%.
	Biodegradable materials..... 0	
	Putrescible wastes..... 0	
	Non-putrescible wastes..... 0	
	Corrosive materials..... 0	
	Pyrophoric materials..... 0	
	Generating toxic gases..... 0	
	Reacting with water..... 0	
	Active particles..... 0	
	Soluble solids as bulk chemical compounds..... 0	
Hazardous substances / non hazardous pollutants:	Oxides (and possible metal fragments) of uranium, plutonium, barium and beryllium (from Magnox corrosion).	
	Acrylamide.....	
	Benzene..... 0	
	Chlorinated solvents.....	
	Formaldehyde.....	
	Organometallics.....	
	Phenol..... 0	
	Styrene.....	
	Tri-butyl phosphate..... 0	
	Other organophosphates.....	
	Vinyl chloride..... P	Trace within sludge matrix.
	Arsenic..... 0	

WASTE STREAM 2D11/C Conditioned Pond Sludge

Barium.....		
Boron.....	0	
Cadmium.....	0	
Caesium.....		
Selenium.....	0	
Chromium.....	0	
Molybdenum.....	0	
Thallium.....		
Tin.....	0	
Vanadium.....	0	
Mercury compounds.....		
Others.....	0	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		
Complexing agents (%wt): Not yet determined		
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids……	0	
Other organic complexants.....	NE	Not estimated but unlikely to be present.
Total complexing agents.....	NE	

PACKAGING AND CONDITIONING

Container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
500 l drum	100.0	~0.472	0.472	157

Container type comment: Sludge will be dewatered and will then be transferred to WEP in drums for final conditioning in line with WEP cfa and LoC requirements.

Range in container waste volume: -

Other information on containers: Stainless steel.

Conditioned density (t/m³): ~1.6

Conditioned density comment: This is the bulk density of the waste ~1.1 t/m3 with the addition of conditioning material.

Other information on conditioning: Package numbers are for stocks only. Unconditioned sludge is reported in stream 2D11.

RADIOACTIVITY

Source: The source of the activity is corrosion debris from fuel elements, isotope cartridges and miscellaneous active wastes stored in the pond. The main components are Cs-137 and Sr-

WASTE STREAM 2D11/C Conditioned Pond Sludge

	90, with isotopes of Mn, Co, Zr, Ru, Nb, Ce, Sb, Am, U, Pu and Eu also present.
Uncertainty:	The accuracy of the information is the best available. It is derived from 2 separate sampling exercises, yielding 21 samples from various areas of the pond. Wide variations were observed in the analyses of differing samples. The average specific activity data is the average of these 21 samples.
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:	By theoretical calculation, except Cs and Sr which are measured activities.
Other information:	Other alpha and other beta/gamma nuclides not specified.

WASTE STREAM 2D11/C Conditioned Pond 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					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	1.73E-06	B B 2			Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	9.90E-15	A A 2			Pb 205				
Fe 55					Pb 210	8.61E-13	C C 2		
Co 60	3.85E-06	B C 2			Bi 208				
Ni 59					Bi 210m				
Ni 63	7.25E-04	C C 2			Po 210	7.90E-13	C C 2		
Zn 65					Ra 223	1.11E-10	C C 2		
Se 79					Ra 225	1.70E-14	C C 2		
Kr 81					Ra 226	5.31E-12	C C 2		
Kr 85					Ra 228				
Rb 87					Ac 227	1.11E-10	C C 2		
Sr 90	9.48E-02	C D 2			Th 227	1.09E-10	C C 2		
Zr 93	8.76E-07	C C 2			Th 228				
Nb 91					Th 229	1.71E-14	C C 2		
Nb 92					Th 230	1.36E-09	C C 2		
Nb 93m	4.65E-07	C C 2			Th 232				
Nb 94					Th 234	8.24E-06	C C 2		
Mo 93					Pa 231	3.12E-10	C C 2		
Tc 97					Pa 233	3.35E-07	C C 2		
Tc 99	3.45E-06	C C 2			U 232				
Ru 106	2.19E-12	B C 2			U 233	2.17E-11	C C 2		
Pd 107					U 234	8.25E-06	C C 2		
Ag 108m					U 235	3.30E-07	C C 2		
Ag 110m					U 236	8.78E-10	C D 2		
Cd 109					U 238	8.24E-06	C C 2		
Cd 113m					Np 237	3.36E-07	C C 2		
Sn 119m					Pu 236				
Sn 121m					Pu 238	2.66E-04	C D 2		
Sn 123					Pu 239	2.47E-04	C D 2		
Sn 126					Pu 240	1.65E-03	C D 2		
Sb 125	2.16E-07	B C 2			Pu 241	1.17E-03	C D 2		
Sb 126					Pu 242	3.30E-07	C D 2		
Te 125m	5.40E-08	B C 2			Am 241	1.91E-02	C D 2		
Te 127m					Am 242m				
I 129	6.70E-10	C C 2			Am 243	2.88E-07	C C 2		
Cs 134	3.75E-09	B C 2			Cm 242				
Cs 135	1.70E-07	C C 2			Cm 243				
Cs 137	3.84E-02	B D 2			Cm 244	5.86E-07	C C 2		
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	1.31E-17	C C 2			Cf 249				
Pm 145					Cf 250				
Pm 147	1.03E-06	C C 2			Cf 251				
Sm 147	2.94E-15	C C 2			Cf 252				
Sm 151	1.04E-04	C C 2			Other a	2.91E-02	C D 2		
Eu 152	1.90E-05	C C 2			Other b/g	1.97E-01	C C 2		
Eu 154	6.48E-05	A B 2			**Total a**	**5.04E-02**	**C D 1**	**0**	
Eu 155	1.23E-05	C C 2			**Total b/g**	**3.33E-01**	**C D 1**	**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