WASTE STREAM 2D74/C Conditioned Pile Fuel Storage Pond Ion Exchange

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

Is the waste subject to Scottish Policy:

No

WASTE VOLUMES

Number of waste packages

in stock:

At 1.4.2022...... 14 package(s)

Comment on volumes: Local Effluent Treatment Plant commenced operation in July 2007 and from this date

began to remove beta activity from the pond water on to lonsiv cartridges. During the 20 years of expected operations the plant will be operated to minimise the generation of this secondary waste but ensure discharges and plant conditions are acceptable and meet all regulatory and safety parameters. Note the lonsiv cartridge was designed to fit into a 250

litre liner for export in the plant 12te flask.

Uncertainty factors on

volumes:

Stock (upper): x 1.0 Stock (lower): x 1.0 Arisings (upper) x

Arisings (lower) x

WASTE SOURCE

The waste is a cartridge 580mm diameter 993mm in height containing the ion exchange medium Ionsiv IE-911 (165kg). This becomes radioactive by removing predominately Cs and Sr from the pond water. The cartridge was designed to fit into a 250 litre liner for waste export from the plant in the 12te flask. One of the fourteen packages in stock is a dummy

and has no associated inventory.

PHYSICAL CHARACTERISTICS

General description: The cartridge container has been designed so that it can be handled by the plant and its

flasking equipment and is suitable for a number of disposal options. The secondary waste package is not yet confirmed but a couple of options are being progressed with the regulators. Once created the waste will be stable and when the cartridge is fully loaded (used up) it will be stored in the pond. There will be some generation of hydrogen from the radiolysis of water and this is allowed for in the design of the cartridge. The lonsiv cartridges are placed into a 500L drum and grouted with typically 650kg of grout.

Physical components (%wt): Stainless steel cartridge container (67%), Ion exchange material Ionsiv 911 (33%). This

reverts to 29.1% and 14.3% respectively once grout is added.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~2

Comment on density: The envelope volume of the cartridge is approximately 0.250m3 and its overall mass is

approximately 500kg giving a bulk density of 500/0.250kg/m3 = 2,000kg/m3.

CHEMICAL COMPOSITION

General description and components (%wt):

67% cartridge is iron with small amounts of carbon, Cr. The lonsiv (33% of weight) is made up as follows: TiO2 28.6 to 34.8% wt; SiO2 14.8 to 18.2% wt; Nb2O5 18.5 to 22.7% wt;

Na2O 3.6% to 4.4% wt; ZrO2 14.1 to 18.8% wt; Cl 0.12 to 0.33% wt.

Chemical state: The waste is neutral and is not strongly oxidising or reducing.

Chemical form of radionuclides:

-

Metals and alloys (%wt): -

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Conditioned Pile Fuel Storage Pond Ion Exchange Material

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	~29.1		donvity
Other ferrous metals			
Iron			
Aluminium			
Beryllium			
Cobalt			
Copper			
Lead			
Magnox/Magnesium			
Nickel			
Titanium	0		
Uranium			
Zinc			
Zircaloy/Zirconium			
Other metals			
Organics (%wt):			
	(%wt)	Type(s) and comment	% of total C14
Total cellulosics			activity
Paper, cotton			
Wood			
Halogenated plastics			
Total non-halogenated plastics			
Condensation polymers			
Others			
Organic ion exchange materials			
Total rubber			
Halogenated rubber			
Non-halogenated rubber			
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics			
Other materials (%wt):			

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	~14.2	Ionsiv IE- 911.	
Inorganic sludges and flocs	0.10		
Soil			
Brick/Stone/Rubble			
Cementitious material	56.6		
Sand	0		
Glass/Ceramics			
Graphite			
Desiccants/Catalysts	0		
Asbestos	0		
Non/low friable			
Moderately friable			
Highly friable			
Free aqueous liquids			
Free non-aqueous liquids			
Powder/Ash			
Inorganic anions (%wt):			
	(%wt)	Type(s) and comment	
Fluoride			
Chloride			
lodide			
Cyanide			
Carbonate			
Nitrate			
Nitrite			
Phosphate			
Sulphate			
Sulphide			
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	0		
Biodegradable materials	0		
Putrescible wastes	0		

Non-putrescible wastes.....

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	Corrosive materials	0	
	Pyrophoric materials	0	
	Generating toxic gases	0	
	Reacting with water	0	
	Higher activity particles	0	
	Soluble solids as bulk chemical compounds	0	
Hazardous s	ubstances / - us pollutants:		
		(%wt)	Type(s) and comment
	Acrylamide		
	Benzene	0	
	Chlorinated solvents		
	Formaldehyde		
	Organometallics		
	Phenol	0	
	Styrene		
	Tri-butyl phosphate	0	
	Other organophosphates		
	Vinyl chloride	0	
	Arsenic	0	
	Barium		
	Boron	0	
	Boron (in Boral)		
	Boron (non-Boral)		
	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		
	1ypo 0		

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(%wt)	Type(s) and comment

DPTA.....

No

NTA.....

Total complexing agents...... 0

Potential for the waste to contain discrete items:

Complexing agents (%wt):

No.

PACKAGING AND CONDITIONING

Container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
500 l drum	100.0	~0.5	0.5	14

Container type comment: The current baseline strategy is that the used lonsiv cartridges loaded with predominately

Cs and Sr will initially be stored in the pond. The cartridges will be exported in a 250 litre liner to WEP. The envelope volume of 0.25m³ containing the ion exchange material loaded with beta activity will be immobilised in situ using either a cement grout formulation in a

500L Drum.

Range in container waste

volume:

Other information on

containers:

Conditioned density (t/m³): 2.3

Conditioned density

comment:

1150 kg / 0.5m3.

Other information on

conditioning:

-

RADIOACTIVITY

Source: The activity originates from the corrosion of fuel and is predominately the soluble fission

products Cs and Sr, which are transferred to the pond water. The pond water is then treated by passing through the Local Effluent Treatment Plant (LETP) which removes the

Cs and Sr on to the lonsiv contained in a purpose built cartridge.

Uncertainty: Having been operational for over 10 years, the IonSiv's are proving highly effective in

absorbing beta activity from the pond water. The radionuclides removed are predominately Cs and Sr. Each cartridge will changed once the overall activity of each pair is analysed to be around 7-8TBq. under certain operational circumstances this may be higher with the possibility of activity levels of 20TBq however it is more likely to be 11-12TBq as the lonsivs will be "blinded" prior to reaching this activity level. Early removal of fuel from the pond has led to a revised downward estimation of lifetime cartridge requirements from previous submissions. As caesium 137 is prefentially removed over strontium 90 and the cartridges will always be changed on total activity, there will be a change in the Cs to Sr

ratio over time. For stocks the ratio is 60:40.

Definition of total alpha and total beta/gamma:

The nature and radiological fingerprint of the sludge differs with the pond areas, for instance, within the bays there is a higher fuel content within the sludge than there is within the pond, as activities in the bays is disturbed we may note different ratios of radionuclides on the cartridges. Sampling of these areas is an ongoing actitivity and this data will be utilised to ascertain the radiological fingerprint on the cartridges for disposal.

Measurement of radioactivities:

The loading of activity onto the Ionsiv cartridge will be calculated by sampling and flow measurements. The samples will be analysed for total beta and alpha and other radionuclides and by spreadsheet calculations the quantities of radioactivity absorbed on to the Ionsiv cartridges will be calculated and monitored to ensure it remains below 7TBq

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beta per pair of cartridges.

Other information:

The activity loaded on to the lonsiv cartridges will be estimated from sampling and volume calculation (from flow meters). The calculated radionuclide inventory will be from analysis data comprising of total alpha, total beta and the individual isotopes Cs and Sr (the main nuclides involved).

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	N	Mean radioactivity, TBq/m³			Mean radioactivity, TBq/m³				
Nuclide	Waste at	Bands and	Future	Bands and	Nuclide	Waste at	Bands and	Future	Bands and
-	1.4.2022	Code	arisings	Code		1.4.2022	Code	arisings	Code
H 3 Be 10					Gd 153 Ho 163				
C 14	1.31E-05	AA 2			Ho 166m				
Na 22	1.512-05	AA 2			Tm 170				
Al 26					Tm 171				
CI 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					TI 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60	4.27E-05	AA 2			Bi 208				
Ni 59	6.06E-06	AA 2			Bi 210m				
Ni 63	4.86E-04	AA 2			Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	2.42E+00	AA 2			Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m Nb 94					Th 232 Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99	4.62E-06	AA 2			U 232				
Ru 106		=			U 233	6.54E-12	AA 2		
Pd 107					U 234	3.10E-06	AA 2		
Ag 108m					U 235	8.80E-08	AA 2		
Ag 110m					U 236	9.18E-08	AA 2		
Cd 109					U 238	2.70E-06	AA 2		
Cd 113m					Np 237	2.27E-08	AA 2		
Sn 119m					Pu 236	9.67E-16	AA 2		
Sn 121m					Pu 238	1.10E-05	AA 2		
Sn 123					Pu 239	7.02E-06	AA 2		
Sn 126					Pu 240	2.62E-04	AA 2		
Sb 125					Pu 241	6.70E-04	AA 2		
Sb 126					Pu 242	2.38E-08	AA 2		
Te 125m					Am 241	6.74E-04	AA 2		
Te 127m	0.405.00				Am 242m				
I 129	9.16E-09	AA 2			Am 243				
Cs 134	1.07E-03	AA 2			Cm 242				
Cs 135	8.02E-05 3.08E+00	AA 2 AA 2			Cm 243 Cm 244				
Cs 137 Ba 133	3.00E+00	AA 2			Cm 244 Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151	2.01E-04	AA 2			Other a				
Eu 152					Other b/g				
Eu 154	1.33E-06	AA 2			Total a	9.60E-04	AA 2	0	
Eu 155					Total b/g	5.50E+00	AA 2	0	
	<u>I</u>				<u> </u>			i	

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

- Measured activity
 Derived activity (best estimate)
 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