WASTE STREAM	2D74	Pile Fuel Storage Pond Ion Exchange Material

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Ltd

WASTE TYPE ILW

WASTE VOLUMES

		Reported (m^3)
Stocks:	At 1.4.2025	= 0.5
Future arisings:	1.4.2026 - 31.3.2027	= 0.5
Total future arisings:		**0.5**
Total waste volume:		**1.0**

OR

Conditioned (m^3)	Packaged (m^3)

Number of waste packages in stock: At 1.4.2025…… - packages

Comment on arising rates: Local Effluent Treatment Plant commenced operation in July 2007 and from this date began to remove beta activity from the pond water on to Ionsiv cartridges. Dewatering date yet to be confirmed, therefore further arisings may occur.

Additional information on quantities: 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 Ionsiv cartridge was designed to fit into a 250 litre liner for export in the plant 12te flask.

Uncertainty factors on volumes:

Stock (upper):	x 1.00	Arisings (upper):	x 1.30
Stock (lower):	x 1.00	Arisings (lower):	x 0.70

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.

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.

Changes since waste generated: 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.

Bulk density (t/m^3): ~ 2.0

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): Cartridge (67%) is iron with small amounts of carbon, Cr. The Ionsiv (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: Neutral

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	~ 67.0	-	
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 activity
Total cellulosics		-	
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):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	~ 33.0	Ionsiv IE- 911.	
Inorganic sludges and flocs		-	
Soil		-	
Brick/Stone/Rubble		-	
Cementitious material		-	
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		-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride		-
Chloride		-
Iodide		-
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	= 0	-
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 substances / non hazardous 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)	= 0	-
Boron (non-Boral)	= 0	-
Cadmium	= 0	-
Caesium		-
Selenium	= 0	-
Chromium	= 0	-
Molybdenum	= 0	-
Thallium		-
Tin	= 0	-
Vanadium	= 0	-
Mercury compounds		-
Others	= 0	-

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA		-
DPTA		-
NTA		-
Polycarboxylic acids	= 0	-
Other organic complexants	= 0	-
Total complexing agents	= 0	-

Physical components:

	Number	Type(s) and comment
Sources		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1		-
EEE Type 2		-
EEE Type 3		-
EEE Type 4		-
EEE Type 5		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration Drying/dewatering/liquid separation Tie down/fixatives/strippable coating/painting application Decontamination Metal treatment Recycling / reuse Thermal treatment, including vitrification Encapsulation Polymer encapsulation Other physical treatment Other chemical treatment Containerisation Treatment not yet determined None	On-site	= 100.0

Comments on planned treatments: IonSiv cartridges are drained prior to export to WEP.

Conditioning method: The designated route for the used IonSiv cartridges is to be conditioned in WEP for grouting to immobilise the ion exchange material inside the cartridge, and then 4 cartridges within product drums would be placed in a stillage and sent to EPS3 for storage until a repository is available. Transfers to WEP commenced in Q4 2018/19.

Conditioning plants:

Plant Name	Location
Wastes Encapsulation Plant (WEP)	Sellafield

Likely conditioning matrix: -

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m^3)	Payload (m^3)	Number of packages	Estimated start date for packaging
500 l drum	100.0	0.47	0.47	3	-

Range in container waste loading:

Other information on packaging and conditioning: -

Conditioned density (t/m^3): -
Conditioned density comment: -

Management Routes:

Disposal Route	Stream volume %	Raw density t/m^3	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland) Expected to be Non-NSD HAW managed under Scottish Government's policy Expected to be disposed to LLW Vaults NRS Dounreay Expected to be consigned to the Geological Disposal Facility Expected to be consigned to a Near Surface Disposal Facility Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be disposed On-Site Expected to be managed by In-Situ Disposal Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be Out of Scope Expected to be recycled / reused Disposal route not known	= 100.0		

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The activity originates from the corrosion of fuel and is predominantly 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 Ionsiv contained in a purpose built cartridge.

Uncertainty: Having been operational for over 10 years, the Ionsivs are proving highly effective in absorbing beta activity from the pond water. The radionuclides removed are predominantly Cs and Sr. Each cartridge will be 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 Ionsivs 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 Cs137 is preferentially removed over Sr90 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, for arisings this has been changed to 50:50.

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 beta per pair of cartridges.

Chemical form of radionuclides:

H-3: -
C-14: -
Cl-36: -
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM	2D74	Pile Fuel Storage Pond Ion Exchange Material							
	Mean radioactivity, TBq/m³					Mean radioactivity, TBq/m³			
Nuclide	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Waste at 1.4.2025	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					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	4.82E+00	A A 1	5.40E+00	A A 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m					U 236				
Cd 109					U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
Sn 126					Pu 240				
Sb 125					Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	4.99E+00	A A 1	5.40E+00	A A 2	Cm 244				
Ba 133					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					Unsp a				
Eu 152					Unsp b/g				
Eu 154					**Total a**	**0**	*	**0**	*
Eu 155					**Total b/g**	**9.81E+00**	*	**1.08E+01**	*

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 the 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
* Total calculated from the 114 declared radionuclides