WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

SITE	Dounreay
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Dounreay Site Restoration Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	Yes

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	1.2 m^3
Future arisings -	1.4.2028 - 31.3.2029.....	0.2 m^3
Total future arisings:		0.2 m^3
Total waste volume:		1.4 m^3

Comment on volumes: Forecasting the past 2IXC left to remove. 1 IXC left to remove as ILW. The other is expected to go as LLW.

Uncertainty factors on volumes:

Stock (upper):	x 1.05	Arisings (upper)	x 1.05
Stock (lower):	x 0.95	Arisings (lower)	x 0.95

WASTE SOURCE The DFR pond facility was used for the storage of canned fuel pins and breeder fuel following their removal from DFR prior to reprocessing or post irradiation examination. Cs-137 contamination has been removed from the pond water using ion exchange columns containing IONSIVTM IE-96 ion exchanger. Additionally, a further 2 ion exchange columns were used containing an IONSIV Series A zeolite to increase strontium retention.

PHYSICAL CHARACTERISTICS

General description:	The waste will consist of stainless steel ion exchange columns, filled with resin.
Physical components (%vol):	Stainless steel (18%), Lead (2%), inorganic ion exchange resin (80%).
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m^3):	1.5
Comment on density:	Based on the 6 IXC waste consignments from DFR Pond

CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel (73%), Lead (17%), inorganic ion exchange resin (10%).

Chemical state: -

Chemical form of radionuclides:
Cl-36: Not likely to be present
I-129: Not likely to be present
U: May be present at low levels, probably small particles in metallic form.
Pu: May be present at low levels, probably small particles in metallic form.

Metals and alloys (%wt): The stainless steel will be in the form of ion exchange column bodies.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	73.0	316L	
Other ferrous metals.....	0		
Iron.....			
Aluminium.....	0		
Beryllium.....	0		
Cobalt.....	0		
Copper.....			
Lead.....	17.0		
Magnox/Magnesium.....	0		

WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

Nickel	0
Titanium	
Uranium	P
Zinc	
Zircaloy/Zirconium	0
Other metals	0

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
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		

Other materials (%wt): IONSIVTM IE-96 zeolite is an inorganic, alkali metal alumino-silicate. This resin does not contain a binder or organic resin. The chemical formula is:(Na2O, MgO, CaO).Al2O3.4-6SiO2.H2O.IONSIV Series A zeolites are inorganic alkali metal alumino-silicates. The ion exchange material does not contain a binder of organic resin. The chemical formula is:Na2O.Al2O3.2 SiO2. 4.5 H2O

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	10.0		
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand	0		
Glass/Ceramics	0		
Graphite	0		
Desiccants/Catalysts	0		
Asbestos	0		

WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

Non/low friable	
Moderately friable	
Highly friable	
Free aqueous liquids	0
Free non-aqueous liquids	0
Powder/Ash	0

Inorganic anions (%wt): -

	(%wt)	Type(s) and comment
Fluoride	0	
Chloride	0	
Iodide	0	
Cyanide	0	
Carbonate	0	
Nitrate	0	
Nitrite	0	
Phosphate	0	
Sulphate	0	
Sulphide	0	

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	NE	
Soluble solids as bulk chemical compounds	0	

Hazardous substances / non hazardous pollutants: Lead may be present in the waste if the shielding cannot be removed from the columns.

	(%wt)	Type(s) and comment
Acrylamide		
Benzene	NE	

WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	NE
Styrene.....	
Tri-butyl phosphate.....	NE
Other organophosphates.....	
Vinyl chloride.....	NE
Arsenic.....	NE
Barium.....	
Boron.....	NE
Boron (in Boral).....	
Boron (non-Boral).....	
Cadmium.....	NE
Caesium.....	
Selenium.....	NE
Chromium.....	NE
Molybdenum.....	NE
Thallium.....	
Tin.....	NE
Vanadium.....	NE
Mercury compounds.....	
Others.....	NE
Electronic Electrical Equipment (EEE)	
EEE Type 1.....	
EEE Type 2.....	
EEE Type 3.....	
EEE Type 4.....	
EEE Type 5.....	

Complexing agents (%wt):

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

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Conditioning method: The waste is currently stored in 160 litre crates within 200 litre drums. Waste will be repackaged into 500L drums.

Plant Name: RHILW Repackaging Facility

WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

Location:	Dounreay
Plant startup date:	2028
Total capacity (m³/y incoming waste):	-
Target start date for packaging this stream:	2028
Throughput for this stream (m³/y incoming waste):	-
Other information:	RHILW Repacking plant is currently in design phase

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
500 l drum	100.0	~0.3	0.5	5

Likely container type comment:	The conditioning factor will be 1.67 if a single column is grouted into each 500 litre drum.
Range in container waste volume:	Waste loading will be variable and dependant on nuclear material content of the wastes.Assume 3:2 Z6033 to 500L drum ratio. Assume Z6033 loading @ 0.2m3 =0.6m3 in 2 500L drums (1m3) = 0.3m3 per 500L drum.
Other information on containers:	-
Likely conditioning matrix:	Cement
Other information:	-
Conditioned density (t/m³):	~2.5
Conditioned density comment:	-
Other information on conditioning:	-
Opportunities for alternative disposal routing:	No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	The Dounreay Fast Reactor was provided with a pond facility and in the 1990's, an ion exchange facility was constructed adjacent to the pond. The pond was used for the storage of canned fuel pins and breeder fuel following removal from the reactor and prior to reprocessing, or Post Irradiation Examination (PIE). The ponds were filled to approximately the operating depth and contains about 1000 m³ of contaminated water. This water is known to be contaminated with radioactive material, predominantly Cs-137 and contains suspended particles.
Uncertainty:	Within a factor of three.
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:	Based on waste consignment data. Consignment data was derived using sample analysis of the pond water.
Other information:	There are no unlisted radionuclides present at significant concentrations. Specific Activity uses UKRWI 2019 data decayed to 2022

WASTE STREAM 5B357 DFR Pond Ion Exchange Columns

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	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	2.23E-03	B B 2	2.67E-03	B B 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	4.40E-01	B B 2	5.22E-01	B B 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					Other a				
Eu 152					Other b/g			4.95E-01	B B 2
Eu 154					**Total a**	**0**		**0**	
Eu 155					**Total b/g**	**4.43E-01**	**B B 2**	**1.02E+00**	**B B 2**

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