WASTE STREAM	5B357	DFR Pond Ion Exchange Columns

SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

		Reported (m^3)
Stocks:	At 1.4.2025	= 1.2
Future arisings:	1.4.2042 - 31.3.2043	< 0.1
	1.4.2043 - 31.3.2044	< 0.1
	1.4.2044 - 31.3.2045	< 0.1
	1.4.2045 - 31.3.2046	< 0.1
	1.4.2046 - 31.3.2047	< 0.1
	1.4.2047 - 31.3.2048	< 0.1
	1.4.2048 - 31.3.2049	< 0.1
Total future arisings:		**0.2**
Total waste volume:		**1.4**

OR

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

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

Comment on arising rates: Forecasting data is based on NRS Dounreay's Lifetime Plan 2024 as generated in December 2023.

Additional information on quantities: 2IXC left to remove. 1 IXC left to remove as ILW. There is an opportunity for the other 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.

Changes since waste generated: -

Bulk density (t/m^3): = 1.4

Comment on density: Based on actuals data from Dounreay's waste consignment system. Data considered acceptable for 2025 submission

CHEMICAL COMPOSITION

General description and components (%wt): Inorganic ion exchange materials (80.00%), Lead (2.00%), Stainless Steel (18.00%),

Chemical state: Neutral

Sheet metal proportion / thickness: The stainless steel will be in the form of ion exchange column bodies.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel……	= 18.0	316L	
Other ferrous metals……		-	
Iron……	= 0	-	
Aluminium……	= 0	-	
Beryllium……	= 0	-	
Cobalt……	= 0	-	
Copper……	= 0	-	
Lead……	= 2.0	-	
Magnox/Magnesium……	= 0	-	
Nickel……	= 0	-	
Titanium……	= 0	-	
Uranium……	= 0	-	
Zinc……	= 0	-	
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	NE	-	
Others	NE	-	
Organic ion exchange materials	= 0	-	
Total rubber	= 0	-	
Halogenated rubber	NE	-	
Non-halogenated rubber	NE	-	
Hydrocarbons	= 0	-	
Oil or grease	= 0	-	
Fuel	NE	-	
Asphalt/Tarmac (cont.coal tar)	= 0	-	
Asphalt/Tarmac (no coal tar)	= 0	-	
Bitumen	= 0	-	
Others	NE	-	
Other organics	= 0	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	= 80.0	-	
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	-	
Non/low friable	NE	-	
Moderately friable	NE	-	
Highly friable	NE	-	
Free aqueous liquids	= 0	-	
Free non-aqueous liquids	= 0	-	
Powder/Ash	= 0	-	

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

Inorganic anions (%wt):

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

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals	NE	-
Low flash point liquids	NE	-
Explosive materials	NE	-
Phosphorus	NE	-
Hydrides	NE	-
Biological etc. materials	NE	-
Biodegradable materials	= 0	-
Putrescible wastes	NE	-
Non-putrescible wastes	NE	-
Corrosive materials	NE	-
Pyrophoric materials	NE	-
Generating toxic gases	NE	-
Reacting with water	= 0	-
Higher activity particles	NE	-
Soluble solids as bulk chemical compounds	NE	-

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide	NE	-
Benzene	= 0	-
Chlorinated solvents	NE	-
Formaldehyde	NE	-
Organometallics	NE	-
Phenol	NE	-
Styrene	NE	-
Tri-butyl phosphate	NE	-
Other organophosphates	NE	-
Vinyl chloride	NE	-
Arsenic	= 0	-
Barium	NE	-
Boron	= 0	-
Boron (in Boral)	NE	-
Boron (non-Boral)	NE	-
Cadmium	= 0	-
Caesium	NE	-
Selenium	= 0	-
Chromium	= 0	-
Molybdenum	= 0	-
Thallium	NE	-
Tin	= 0	-
Vanadium	= 0	-
Mercury compounds	= 0	-
Others	NE	-

Complexing agents (%wt): No

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

Physical components:

	Number	Type(s) and comment
Sources	= 0	-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1	= 0	-
EEE Type 2	= 0	-
EEE Type 3	= 0	-
EEE Type 4	= 0	-
EEE Type 5	= 0	-

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	On-site	= 100.0
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments: The prefered option is to cement the IX Columns into 500 litre drums, with the outer drum potentially being consignned a different route.

Conditioning method: Waste will be conditioned using a grout matrix into 500l drums. This will be done through dedicated ILW repackaging facility, which will handle both RHILW and CHILW 200l drums. The facility will produce conditioned 500l drums

Conditioning plants:

Plant Name	Location
Combined ILW Repackaging Facility	Dounreay

Likely conditioning matrix: Non-standard

Further information on the conditioning matrix: Dounreay uses 1:3 OPC:PFA, 42% water.

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 (basket for waste)	100.0	0.20	0.40	7	-

Range in container waste loading: Waste loading will be 1 x Z6033 into 1 x 500L drum

Other information on packaging and conditioning: -

Conditioned density (t/m^3): ~ 2.5
Conditioned density comment: Density is if waste is grouted directly into 500l drums. Assume density similar to CHILW repack.

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)	= 100.0		
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			

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

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
Near-site NSDF	Dounreay LLWDV	NE	RED	There is potential for LLW to be diverted out of the waste stream during repackaging of ILW into 500l drums. However, details of this will be confirmed through the design processs of the repackaging facility

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 m^3 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.

Measurement of radioactivities: Based on waste consignment data. Consignment data was derived using sample analysis of the pond water.

Chemical form of radionuclides:

H-3: -
C-14: -
Cl-36: Not likely to be present
Se-79: -
Tc-99: -
I-129: Not likely to be present
Ra: -
Th: -
U: May be present at low levels, probably small particles in metallic form.
Np: -
Pu: May be present at low levels, probably small particles in metallic form.

WASTE STREAM **5B357** **DFR Pond Ion Exchange Columns**

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ 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	= 3.54E-04	B B 2	= 3.54E-04	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	= 7.46E-02	B B 2	= 7.46E-02	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					Unsp a				
Eu 152					Unsp b/g				
Eu 154					**Total a**	**0**	*	**0**	*
Eu 155					**Total b/g**	**7.50E-02**	*	**7.50E-02**	*

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