

WASTE STREAM	5B354	PFR Ion Exchange Columns
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025 = 3.8			
Future arisings:	1.4.2027 - 31.3.2028 = 0.1			
	1.4.2028 - 31.3.2029 = 0.1			
	1.4.2029 - 31.3.2030 < 0.1			
	1.4.2030 - 31.3.2031 = 0.2			
	1.4.2031 - 31.3.2032 = 0.2			
	1.4.2032 - 31.3.2033 < 0.1			
	1.4.2048 - 31.3.2049 = 0.4			
	1.4.2049 - 31.3.2050 = 0.8			
	1.4.2050 - 31.3.2051 = 0.4			
Total future arisings:	2.2			
Total waste volume:	6.0			

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

Comment on arising rates: Programme data is based on NRS Dounreay Life Time Plan 2024 dataset generated in December 2023.

Additional information on quantities: Each 200 litre drum has an internal volume of 0.2 m³ hosting within it a carbon steel ion exchange column filled with approximately 57 litres of ion exchange media.

Uncertainty factors on volumes: Stock (upper): x 1.02 Arisings (upper): x 1.02
Stock (lower): x 0.98 Arisings (lower): x 0.98

WASTE SOURCE The Sodium Disposal Plant (SDP) was used to dispose of bulk sodium from the PFR primary and secondary circuits. Initially sodium was reacted with water to produce NaOH that was treated with HCl to produce NaCl. The caesium removal plant removed radioactive contaminants from the brine by passing the solution through ion exchange columns. Ion Exchange Columns will also be used for cleaning of PFR pond water and for cleaning the effluent discharge from sodium cleaning operations within the Size Reduction Facility (PFRSRF).

PHYSICAL CHARACTERISTICS

General description: The carbon steel and lead, forming the actual physical structure of the ion exchange columns, will form the bulk of the waste. Steel from the Z6033 drum. The resin used makes up the balance.

Changes since waste generated: -

Bulk density (t/m³): = 2.5

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 (14.45%), Lead (8.27%), Mild Steel (6.73%), Other (5.09%), Plastic (2.73%), Stainless steel (62.73%),

Chemical state: Neutral

Sheet metal proportion / thickness: Waste is not suitable for further treatment. Therefore, the proportion of sheet metal has not been assessed.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 62.7	Probably M316.	
Other ferrous metals.....	= 6.7	-	
Iron.....	= 0	-	
Aluminium.....	= 0	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	= 8.3	-	
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 cellulotics.....	= 0	-	
Paper, cotton.....	= 0	-	
Wood.....	= 0	-	
Halogenated plastics.....	= 1.4	-	
Total non-halogenated plastics.....	= 1.4	-	
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.....	= 5.1	Other 5.09%,	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	= 14.5	-	
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):

Not yet determined

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

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

Comments on planned treatments:

The preferred strategy is to immobilise the Ion exchange columns into 500L drums using cement.

Conditioning method:

The waste will be conditioned using a grout matrix into 500l drums for long term storage, this will be done through a 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 (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
500 l drum (basket for waste)	100.0	0.20	0.40	30	-

Range in container waste loading: Container loading is likely to be 1 x Z6033 drum into 1 x 500 L drum

Other information on packaging and conditioning:

-

Conditioned density (t/m³):

~ 2.0

Conditioned density comment:

The conditioned waste density is expected to be about 2 te/m³.

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	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 this waste stream during repackaging of ILW into 500l drum. However, details of this will be confirmed through the design process of the repackaging facility

RADIOACTIVITY

Source: The activity of the ion exchange columns is based on the entire inventory of the PFR primary coolant assuming that it is completely absorbed onto the ion exchanger. The radionuclide inventory for the PFR sodium coolant has been derived from sampling of the PFR coolant. Radiation measurements and Microshield calculations have been used for Consignors records.

Uncertainty: Within a factor of three.

Measurement of radioactivities: Consignors records for all the drums were used to generate a specific activity.

Chemical form of radionuclides:

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

WASTE STREAM 5B354 PFR Ion Exchange Columns									
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		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	= 8.15E-04	B B 2	= 8.15E-04	B B 2	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					Ti 204				
Mn 54	= 2.05E-13	B B 2	= 2.05E-13	B B 2	Pb 205				
Fe 55					Pb 210				
Co 60	= 1.46E-03	B B 2	= 1.46E-03	B B 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65	= 1.50E-08	B B 2	= 1.50E-08	B B 2	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					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	= 4.24E-12	B B 2	= 4.24E-12	B B 2	U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m	= 6.86E-18	B B 2	= 6.86E-18	B B 2	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	= 1.57E-05	B B 2	= 1.57E-05	B B 2	Pu 241				
Sb 126					Pu 242				
Te 125m	= 3.70E-06	B B 2	= 3.70E-06	B B 2	Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134	= 4.43E-06	B B 2	= 4.43E-06	B B 2	Cm 242				
Cs 135					Cm 243				
Cs 137	= 2.94E-01	B B 2	= 2.94E-01	B B 2	Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	= 3.49E-15	B B 2	= 3.49E-15	B B 2	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	2.96E-01	*	2.96E-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