

WASTE STREAM	5B01/C	Cemented PFR Raffinate
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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		= 62.5	71.4
Future arisings:	1.4.2026 - 31.3.2027		= 182.2	208.1
	1.4.2027 - 31.3.2028		= 182.2	208.1
Total future arisings:			364.5	416.2
Total waste volume:			427.0	487.6

Number of waste packages in stock: At 1.4.2025..... 125 packages

Comment on arising rates: Programme is from NRS Dounreay's LTP24 as at December 2023. Arisings reflects that of 5B01 but is a conditioned volume, rather than raw Waste.

Additional information on quantities: Tank washouts will be undertaken but have not been quantified as yet. This may produce more arisings.

Uncertainty factors on volumes: Stock (upper): x 1.00 Arisings (upper): x 1.05
Stock (lower): x 1.00 Arisings (lower): x 0.95

WASTE SOURCE The source of this waste is from the reprocessing of Prototype Fast Reactor (PFR) fuel.

PHYSICAL CHARACTERISTICS

General description: The waste is a raffinate from fuel reprocessing immobilised in a 1:2 PFA:OPC grout matrix within 500L drums. There are no large items in the waste.

Changes since waste generated: The waste has been cemented into 500 litre drums.

Bulk density (t/m³): ~ 1.8

Comment on density: The density of the conditioned raffinate is about 1.77 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): The raffinate is a nitric acid solution containing fission products and trace quantities of uranium and plutonium. Nitric acid (96.6%) and metals in solution (copper, sodium, iron, cadmium, nickel and zinc) (3.4%). This has since been neutralised with caustic soda (NaOH) and immobilised in a cemented matrix

Chemical state: Alkali

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	P	-	
Iron.....	P	-	
Aluminium.....	-	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	P	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	P	-	
Titanium.....	= 0	-	
Uranium.....	= 0	-	
Zinc.....	P	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 3.4	Covers a range of metallic species which are in the immobilised solution including sodium, cadmium and nickel.	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	= 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.....	= 0	-	
Oil or grease.....	= 0	-	
Fuel.....	= 0	-	
Asphalt/Tarmac (cont.coal tar).....	= 0	-	
Asphalt/Tarmac (no coal tar).....	= 0	-	
Bitumen.....	= 0	-	
Others.....	= 0	-	
Other organics.....	= 0	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	= 0	-	
Inorganic sludges and flocs.....	= 0	-	
Soil.....	= 0	-	
Brick/Stone/Rubble.....	= 0	-	
Cementitious material.....	= 96.6	-	
Sand.....	= 0	-	
Glass/Ceramics.....	= 0	-	
Graphite.....	= 0	-	
Desiccants/Catalysts.....	= 0	-	
Asbestos.....	= 0	-	
Non/low friable.....	= 0	-	
Moderately friable.....	= 0	-	
Highly friable.....	= 0	-	
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.....	P	-
Iodide.....	= 0	-
Cyanide.....	= 0	-
Carbonate.....	= 0	-
Nitrate.....	= 30.0	-
Nitrite.....	= 0	-
Phosphate.....	TR	-
Sulphate.....	P	-
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.....	= 0	-
Soluble solids as bulk chemical compounds.....	= 0	-

Hazardous substances / non hazardous pollutants:

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

Complexing agents (%wt):

Yes		
	(%wt)	Type(s) and comment
EDTA.....	= 0	-
DPTA.....	= 0	-
NTA.....	= 0	-
Polycarboxylic acids.....	= 0	-
Other organic complexants.....	TR	Traces of organic complexing agents (MDP, DBP, TBP) may be present.
Total complexing agents.....	TR	-

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:

Waste already conditioned.

Conditioning method:

Waste already conditioned.

Conditioning plants:

Plant Name	Location
Dounreay Cementation Plant	Dounreay

Likely conditioning matrix:

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Further information on the conditioning matrix:

-

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 (paddle)	100.0	0.50	0.50	854	2026

Range in container waste loading: The target loading is 0.228 m³ of raw raffinate per drum, but is dependent on composition of the raffinate in the tank. A final volume of 328 l of neutralised liquor will be dispensed to each drum.

Other information on packaging and conditioning: Waste is already conditioned.

Conditioned density (t/m³): ~ 1.8

Conditioned density comment: The density of the conditioned waste will probably be about 1.8 t/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: No

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

RADIOACTIVITY

Source: Activity arises mainly from the fission products separated from the irradiated Prototype Fast Reactor fuel at reprocessing.

Uncertainty: The activity accuracy is within a factor of 3.
Radionuclides have been re-assessed.

Measurement of radioactivities: Samples were taken from the tanks and subsequently analysed. These results gave specific activities for the principle radionuclides. Other specific activities were estimated from earlier results and Fispin calculations.

Chemical form of radionuclides:

- H-3: Likely to be present as water.
- C-14: Unknown - possibly present as traces of dissolved solvent.
- Cl-36: Likely to be present, form unknown.
- Se-79: Likely to be present, form unknown.
- Tc-99: Likely to be present, form unknown.
- I-129: Likely to be present, form unknown.
- Ra: Likely to be present as nitrate.
- Th: Present as nitrate.
- U: Present as nitrate.
- Np: Likely to be present, form unknown.
- Pu: Present as nitrate.

WASTE STREAM				5B01/C		Cemented PFR Raffinate			
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	= 2.31E-03	B B 1	= 2.31E-03	B B 1	Gd 153	= 1.78E-19	B B 2	= 1.78E-19	B B 2
Be 10	= 9.22E-10	B B 2	= 9.22E-10	B B 2	Ho 163	= 2.74E-10	B B 2	= 2.74E-10	B B 2
C 14	= 3.78E-05	B B 2	= 3.78E-05	B B 2	Ho 166m	= 2.91E-08	B B 2	= 2.91E-08	B B 2
Na 22					Tm 170	= 5.47E-30	B B 2	= 5.47E-30	B B 2
Al 26					Tm 171	= 1.22E-09	B B 2	= 1.22E-09	B B 2
Cl 36	= 1.88E-09	B B 2	= 1.88E-09	B B 2	Lu 174	= 8.47E-10	B B 2	= 8.47E-10	B B 2
Ar 39					Lu 176	= 1.27E-14	B B 2	= 1.27E-14	B B 2
Ar 42					Hf 178n	= 1.85E-07	B B 2	= 1.85E-07	B B 2
K 40	= 1.39E-10	B B 2	= 1.39E-10	B B 2	Hf 182	= 2.36E-13	B B 2	= 2.36E-13	B B 2
Ca 41	= 1.56E-07	B B 2	= 1.56E-07	B B 2	Pt 193				
Mn 53	= 1.19E-09	B B 2	= 1.19E-09	B B 2	Tl 204	= 3.21E-06	B B 2	= 3.21E-06	B B 2
Mn 54	= 6.38E-12	B B 2	= 6.38E-12	B B 2	Pb 205	= 6.85E-11	B B 2	= 6.85E-11	B B 2
Fe 55	= 2.79E-04	B B 2	= 2.79E-04	B B 2	Pb 210	= 3.47E-11	B B 2	= 3.47E-11	B B 2
Co 60	= 4.54E-03	B B 1	= 4.54E-03	B B 2	Bi 208	= 5.10E-11	B B 2	= 5.10E-11	B B 2
Ni 59	= 2.81E-04	B B 2	= 2.81E-04	B B 2	Bi 210m	= 1.73E-11	B B 2	= 1.73E-11	B B 2
Ni 63	= 1.18E-02	B B 2	= 1.18E-02	B B 2	Po 210	= 3.38E-11	B B 2	= 3.38E-11	B B 2
Zn 65	= 6.32E-16	B B 2	= 6.32E-16	B B 2	Ra 223	= 1.03E-09	B B 2	= 1.03E-09	B B 2
Se 79	= 4.98E-04	B B 2	= 4.98E-04	B B 2	Ra 225	= 1.26E-06	B B 2	= 1.26E-06	B B 2
Kr 81					Ra 226	= 8.72E-11	B B 2	= 8.72E-11	B B 2
Kr 85					Ra 228	= 2.32E-08	B B 2	= 2.32E-08	B B 2
Rb 87	= 1.74E-08	B B 2	= 1.74E-08	B B 2	Ac 227	= 1.04E-09	B B 2	= 1.04E-09	B B 2
Sr 90	= 2.45E+01	B B 1	= 2.45E+01	B B 2	Th 227	= 1.02E-09	B B 2	= 1.02E-09	B B 2
Zr 93	= 1.88E-03	B B 2	= 1.88E-03	B B 2	Th 228	= 9.60E-08	B B 2	= 9.60E-08	B B 2
Nb 91					Th 229	= 1.26E-06	B B 2	= 1.26E-06	B B 2
Nb 92	= 6.89E-11	B B 2	= 6.89E-11	B B 2	Th 230	= 5.46E-09	B B 2	= 5.46E-09	B B 2
Nb 93m	= 2.15E-03	B B 2	= 2.15E-03	B B 2	Th 232	= 2.55E-08	B B 2	= 2.55E-08	B B 2
Nb 94	= 2.22E-05	B B 2	= 2.22E-05	B B 2	Th 234	= 1.75E-06	B B 2	= 1.75E-06	B B 2
Mo 93	= 1.64E-04	B B 2	= 1.64E-04	B B 2	Pa 231	= 2.22E-09	B B 2	= 2.22E-09	B B 2
Tc 97					Pa 233	= 1.82E-04	B B 2	= 1.82E-04	B B 2
Tc 99	= 1.97E-02	B B 2	= 1.97E-02	B B 2	U 232	= 7.20E-08	B B 2	= 7.20E-08	B B 2
Ru 106	= 7.90E-07	B B 2	= 7.90E-07	B B 2	U 233	= 2.94E-08	B B 2	= 2.94E-08	B B 2
Pd 107	= 4.32E-04	B B 2	= 4.32E-04	B B 2	U 234	= 4.46E-05	B B 1	= 4.46E-05	B B 2
Ag 108m					U 235	= 6.86E-08	B B 1	= 6.86E-08	B B 2
Ag 110m	= 3.19E-14	B B 2	= 3.19E-14	B B 2	U 236	= 1.90E-07	B B 1	= 1.90E-07	B B 2
Cd 109	= 6.72E-11	B B 2	= 6.72E-11	B B 2	U 238	= 1.75E-06	B B 1	= 1.75E-06	B B 2
Cd 113m	= 2.05E-03	B B 2	= 2.05E-03	B B 2	Np 237	= 1.82E-04	B B 2	= 1.82E-04	B B 2
Sn 119m	= 6.94E-14	B B 2	= 6.94E-14	B B 2	Pu 236	= 1.10E-10	B B 2	= 1.10E-10	B B 2
Sn 121m	= 6.14E-02	B B 2	= 6.14E-02	B B 2	Pu 238	= 5.22E-01	B B 1	= 5.22E-01	B B 2
Sn 123	= 1.30E-26	B B 2	= 1.30E-26	B B 2	Pu 239	= 6.19E-02	B B 1	= 6.19E-02	B B 2
Sn 126	= 1.73E-03	B B 2	= 1.73E-03	B B 2	Pu 240	= 6.85E-02	B B 1	= 6.85E-02	B B 2
Sb 125	= 7.98E-03	B B 2	= 7.98E-03	B B 2	Pu 241	= 6.49E-01	B B 1	= 6.49E-01	B B 2
Sb 126	= 1.73E-03	B B 2	= 1.73E-03	B B 2	Pu 242	= 5.22E-05	B B 1	= 5.22E-05	B B 2
Te 125m	= 1.89E-03	B B 2	= 1.89E-03	B B 2	Am 241	= 1.09E+01	B B 1	= 1.09E+01	B B 2
Te 127m	= 2.59E-33	B B 2	= 2.59E-33	B B 2	Am 242m	= 3.01E-01	B B 2	= 3.01E-01	B B 2
I 129	= 4.98E-05	B B 2	= 4.98E-05	B B 2	Am 243	= 2.01E-02	B B 2	= 2.01E-02	B B 2
Cs 134	= 5.96E-04	B B 1	= 5.96E-04	B B 1	Cm 242	= 2.51E-01	B B 2	= 2.51E-01	B B 2
Cs 135	= 2.42E-03	B B 2	= 2.42E-03	B B 2	Cm 243	= 5.17E-02	B B 2	= 5.17E-02	B B 2
Cs 137	= 7.16E+01	B B 1	= 7.16E+01	B B 1	Cm 244	= 4.11E-01	B B 2	= 4.11E-01	B B 2
Ba 133	= 7.16E-06	B B 2	= 7.16E-06	B B 2	Cm 245	= 5.40E-05	B B 2	= 5.40E-05	B B 2
La 137					Cm 246	= 2.14E-06	B B 2	= 2.14E-06	B B 2
La 138	= 8.33E-14	B B 2	= 8.33E-14	B B 2	Cm 248	= 1.29E-20	B B 2	= 1.29E-20	B B 2
Ce 144	= 1.07E-09	B B 2	= 1.07E-09	B B 2	Cf 249	= 5.76E-11	B B 2	= 5.76E-11	B B 2
Pm 145					Cf 250	= 1.55E-11	B B 2	= 1.55E-11	B B 2
Pm 147	= 9.02E-02	B B 2	= 9.02E-02	B B 2	Cf 251	= 1.06E-14	B B 2	= 1.06E-14	B B 2
Sm 147	= 4.38E-10	B B 2	= 4.38E-10	B B 2	Cf 252	= 9.11E-18	B B 2	= 9.11E-18	B B 2
Sm 151	= 4.14E+00	B B 2	= 4.14E+00	B B 2	Unsp a				
Eu 152	= 2.15E-05	B B 2	= 2.15E-05	B B 2	Unsp b/g				
Eu 154	= 2.81E-01	B B 1	= 2.81E-01	B B 1	Total a	1.22E+01	*	1.22E+01	*
Eu 155	= 1.15E-01	B B 1	= 1.15E-01	B B 1	Total b/g	1.02E+02	*	1.02E+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