

WASTE STREAM	5B05/C	Cemented DFR Raffinate
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SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	At 1.4.2025	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:				= 439.0	501.3
Future arisings:					0.0
Total future arisings:				0.0	0.0
Total waste volume:				439.0	501.3

Number of waste packages in stock: At 1.4.2025..... 878 packages

Comment on arising rates: There will be no further arisings of raw waste.

Additional information on quantities: -

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

WASTE SOURCE Dounreay Fast Reactor (DFR) fuel reprocessing.

PHYSICAL CHARACTERISTICS

General description: The waste consists of a cemented ferric/aluminium nitrate solution containing fission products and some actinides from reprocessing spent DFR fuel and some plutonium fuel. 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): ~ 1.7

Comment on density: The density is about 1.67 te/m³. The raw waste density has been measured around 1.18 te/m³.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is a cement product containing neutralised DFR raffinate. Cementitious grout - 100 %.

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.....	= 0	-	
Iron.....	~ 0.49	-	
Aluminium.....	P	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	P	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0	-	
Titanium.....		-	
Uranium.....	P	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 0.31	A range of metallic species are present (aluminium, cadmium, chromium, mercury, molybdenum, lead, sodium, phosphorus and uranium) at trace levels in the cemented wasteform.	

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.....		-	
Oil or grease.....		-	
Fuel.....		-	
Asphalt/Tarmac (cont.coal tar).....		-	
Asphalt/Tarmac (no coal tar).....		-	
Bitumen.....		-	
Others.....		-	
Other organics.....	TR	-	

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.....	= 99.2	-	
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.....	TR	-
Chloride.....	< 0.01	-
Iodide.....	= 0	-
Cyanide.....	= 0	-
Carbonate.....	= 0	-
Nitrate.....	= 5.0	-
Nitrite.....	NE	-
Phosphate.....	NE	-
Sulphate.....	< 0.03	-
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.....	NE	-
Chlorinated solvents.....	NE	-
Formaldehyde.....	NE	-
Organometallics.....	NE	-
Phenol.....	NE	-
Styrene.....	NE	-
Tri-butyl phosphate.....	NE	-
Other organophosphates.....	NE	-
Vinyl chloride.....	NE	-
Arsenic.....	NE	-
Barium.....	NE	-
Boron.....	NE	-
Boron (in Boral).....	NE	-
Boron (non-Boral).....	NE	-
Cadmium.....	P	0.002 wt%
Caesium.....	NE	-
Selenium.....	NE	-
Chromium.....	P	-
Molybdenum.....	P	-
Thallium.....	NE	-
Tin.....	NE	-
Vanadium.....	NE	-
Mercury compounds.....	NE	-
Others.....	P	-

Complexing agents (%wt):

Yes		
	(%wt)	Type(s) and comment
EDTA.....	NE	-
DPTA.....	NE	-
NTA.....	NE	-
Polycarboxylic acids.....	NE	-
Other organic complexants.....	TR	The raw waste may have contained trace quantities of odourless kerosene, MBP, DBP and TBP (butyl phosphates).
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 packed and immobilised within 500L drums. They will sit in storage on site until a final disposal location has been made available.

Conditioning method:

Waste already conditioned.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

1:1 PFA/OPC with a W/S ratio of 0.38.

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	878	-

Range in container waste loading:

Other information on packaging and conditioning: -

Conditioned density (t/m³): ~ 1.7

Conditioned density comment: The density is about 1.67t/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 fission products from the reactor fuel.

Uncertainty: Analysis figures are accurate to within a factor of three.

Measurement of radioactivities: All tanks have been sampled and analysed during the transfer process in preparation for cementation. Inventory presented is derived from analysis results, FISPIN data and assumption regarding mixing of raffinates.

Chemical form of radionuclides:

- H-3: Likely to be present, form unknown.
- C-14: Likely to be present, form unknown.
- 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, form unknown.
- Th: Likely to be present, form unknown.
- U: Likely to be present, form unknown.
- Np: Likely to be present, form unknown.
- Pu: Likely to be present, form unknown.

WASTE STREAM		5B05/C		Cemented DFR 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	= 5.28E-04	B B 2			Gd 153	= 3.58E-29	B B 2		
Be 10	= 1.99E-07	B B 2			Ho 163	= 7.93E-14	B B 2		
C 14	= 7.31E-05	B B 2			Ho 166m	= 5.26E-10	B B 2		
Na 22					Tm 170	= 6.38E-48	B B 2		
Al 26					Tm 171	= 5.88E-13	B B 2		
Cl 36	= 2.88E-05	B B 2			Lu 174	= 2.88E-15	B B 2		
Ar 39					Lu 176	= 2.22E-18	B B 2		
Ar 42					Hf 178n	= 7.46E-19	B B 2		
K 40					Hf 182	= 9.02E-17	B B 2		
Ca 41	= 2.48E-04	B B 2			Pt 193				
Mn 53					Tl 204	= 6.78E-29	B B 2		
Mn 54	= 9.67E-17	B B 2			Pb 205	= 4.30E-27	B B 2		
Fe 55	= 2.40E-04	B B 2			Pb 210	= 2.58E-09	B B 2		
Co 60	= 1.79E-04	B B 2			Bi 208	= 1.75E-23	B B 2		
Ni 59	= 3.95E-04	B B 2			Bi 210m	= 6.78E-24	B B 2		
Ni 63	= 6.86E-02	B B 2			Po 210	= 2.53E-09	B B 2		
Zn 65	= 8.31E-22	B B 2			Ra 223	= 3.34E-09	B B 2		
Se 79	= 8.35E-05	B B 2			Ra 225	= 6.47E-11	B B 2		
Kr 81					Ra 226	= 5.37E-09	B B 2		
Kr 85					Ra 228	= 3.44E-14	B B 2		
Rb 87	= 1.07E-08	B B 2			Ac 227	= 3.47E-09	B B 2		
Sr 90	= 1.17E+01	B B 2			Th 227	= 3.34E-09	B B 2		
Zr 93	= 8.72E-04	B B 2			Th 228	= 1.71E-07	B B 2		
Nb 91	= 3.34E-18	B B 2			Th 229	= 6.47E-11	B B 2		
Nb 92	= 2.25E-17	B B 2			Th 230	= 2.69E-07	B B 2		
Nb 93m	= 1.20E-03	B B 2			Th 232	= 3.48E-14	B B 2		
Nb 94	= 9.10E-05	B B 2			Th 234	= 2.38E-07	B B 2		
Mo 93	= 5.58E-04	B B 2			Pa 231	= 3.81E-08	B B 2		
Tc 97	= 4.21E-16	B B 2			Pa 233	= 1.40E-05	B B 2		
Tc 99	= 6.41E-03	B B 2			U 232	= 1.66E-07	B B 2		
Ru 106	= 9.20E-13	B B 2			U 233	= 3.37E-09	B B 2		
Pd 107	= 1.25E-05	B B 2			U 234	= 6.56E-05	B B 2		
Ag 108m	= 1.25E-11	B B 2			U 235	= 1.65E-06	B B 2		
Ag 110m	= 7.02E-25	B B 2			U 236	= 9.99E-07	B B 2		
Cd 109	= 1.94E-21	B B 2			U 238	= 2.38E-07	B B 2		
Cd 113m	= 6.40E-04	B B 2			Np 237	= 1.40E-05	B B 2		
Sn 119m	= 1.88E-20	B B 2			Pu 236	= 5.55E-11	B B 2		
Sn 121m	= 7.33E-03	B B 2			Pu 238	= 5.07E-02	B B 2		
Sn 123	= 1.27E-42	B B 2			Pu 239	= 8.85E-02	B B 2		
Sn 126	= 9.52E-05	B B 2			Pu 240	= 9.34E-02	B B 2		
Sb 125	= 2.19E-05	B B 2			Pu 241	= 2.70E-01	B B 2		
Sb 126	= 9.52E-05	B B 2			Pu 242	= 6.38E-05	B B 2		
Te 125m	= 5.17E-06	B B 2			Am 241	= 1.83E-01	B B 2		
Te 127m	= 9.01E-49	B B 2			Am 242m	= 2.10E-03	B B 2		
I 129	= 8.25E-07	B B 2			Am 243	= 1.70E-04	B B 2		
Cs 134	= 2.37E-07	B B 2			Cm 242	= 1.76E-03	B B 2		
Cs 135	= 5.49E-04	B B 2			Cm 243	= 1.92E-04	B B 2		
Cs 137	= 1.35E+01	B B 2			Cm 244	= 9.20E-04	B B 2		
Ba 133	= 3.69E-10	B B 2			Cm 245	= 5.12E-07	B B 2		
La 137	= 8.46E-11	B B 2			Cm 246	= 2.19E-08	B B 2		
La 138	= 3.57E-15	B B 2			Cm 248	= 8.89E-14	B B 2		
Ce 144	= 1.96E-16	B B 2			Cf 249	= 7.14E-13	B B 2		
Pm 145	= 2.90E-12	B B 2			Cf 250	= 3.97E-14	B B 2		
Pm 147	= 3.75E-04	B B 2			Cf 251	= 1.34E-16	B B 2		
Sm 147	= 4.10E-09	B B 2			Cf 252	= 5.89E-23	B B 2		
Sm 151	= 6.98E-01	B B 2			Unsp a				
Eu 152	= 3.39E-06	B B 2			Unsp b/g				
Eu 154	= 9.43E-04	B B 2			Total a	4.19E-01	*	0	*
Eu 155	= 1.37E-03	B B 2			Total b/g	2.62E+01	*	0	*

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