

WASTE STREAM	5B34	DFR Breeder Fuel Removal Waste
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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 = 14.8			
Future arisings:	1.4.2025 - 31.3.2026 = 0.2			
	1.4.2026 - 31.3.2027 = 0.4			
	1.4.2027 - 31.3.2028 = 0.1			
	1.4.2039 - 31.3.2040 = 1.5			
	1.4.2040 - 31.3.2041 = 1.6			
Total future arisings:	3.7			
Total waste volume:	18.5			

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

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

Additional information on quantities: -

Uncertainty factors on volumes: Stock (upper): x 1.02 Arisings (upper): x 1.20
Stock (lower): x 0.98 Arisings (lower): x 0.80

WASTE SOURCE The waste will consist of breeder fuel cladding and associated operational wastes.

PHYSICAL CHARACTERISTICS

General description: The waste mostly comprises stainless steel and breeder fuel cladding.

Changes since waste generated: -

Bulk density (t/m³): = 2.3

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): Aluminium (0.19%), Beryllium (TR), Boron (TR), Ceramics (0.10%), Copper (3.94%), Glass (0.19%), Nickel (9.17%), Other (TR), Plastic (9.32%), Stainless steel (77.08%), Uranium (TR),

Chemical state: Neutral

Sheet metal proportion / thickness: This waste is unsuitable 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.....	= 77.1	Assumed to be M316.	
Other ferrous metals.....	0	-	
Iron.....	0	-	
Aluminium.....	= 0.19	-	
Beryllium.....	< 0.01	-	
Cobalt.....	0	-	
Copper.....	= 3.9	-	
Lead.....	0	-	
Magnox/Magnesium.....	0	-	
Nickel.....	= 9.2	-	
Titanium.....	0	-	
Uranium.....	< 0.01	-	
Zinc.....	0	-	
Zircaloy/Zirconium.....	0	-	
Other metals.....	0	Antimony, Uranium	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	0	-	
Paper, cotton.....	0	-	
Wood.....	0	-	
Halogenated plastics.....	= 4.7	-	
Total non-halogenated plastics.....	= 4.7	-	
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.....	< 0.01	-	

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.....	0	-	
Sand.....	0	-	
Glass/Ceramics.....	= 0.29	Ceramics 0.10%, Glass 0.19%,	
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.....	< 0.01	Boron 0.00%,	
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.....	< 0.01	-
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.....		-
EEE Type 2.....		-
EEE Type 3.....		-
EEE Type 4.....	= 2	sodium lamps
EEE Type 5.....		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 100.0
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		

Comments on planned treatments:

Waste will be conditioned into 500l drums for long term storage

Conditioning method:

The waste will be conditioned using a grout matrix into 500l drums for long term storage, 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:

42% water, Dounreay uses (1:3 OPC:BFS)

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	0.27	0.40	69	-

Range in container waste loading: 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 packaging and conditioning: -

Conditioned density (t/m³): ~ 2.5

Conditioned density comment: Density is if waste is grouted directly into 500 litre drums. Assume density similar to CHILW repack.

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: The main source of activity is the activated cladding and minor contamination from irradiated breeder fuel debris.

Uncertainty: Specific activities are best estimates on computer modelling. Both stocks and arisings data taken from LoC.

Measurement of radioactivities: Data taken from LoC

Chemical form of radionuclides:

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

WASTE STREAM 5B34 DFR Breeder Fuel Removal Waste									
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	= 2.46E-03	C C 2	= 2.46E-03	C C 2	Gd 153				
Be 10					Ho 163	= 1.79E-07	C C 2	= 1.79E-07	C C 2
C 14	= 1.96E-03	C C 2	= 1.96E-03	C C 2	Ho 166m	= 1.65E-05	C C 2	= 1.65E-05	C C 2
Na 22					Tm 170				
Al 26	= 2.76E-10	C C 2	= 2.76E-10	C C 2	Tm 171	= 2.64E-10	C C 2	= 2.64E-10	C C 2
Cl 36	= 1.85E-07	C C 2	= 1.85E-07	C C 2	Lu 174	= 2.97E-10	C C 2	= 2.97E-10	C C 2
Ar 39	= 4.12E-04	C C 2	= 4.12E-04	C C 2	Lu 176	= 1.80E-11	C C 2	= 1.80E-11	C C 2
Ar 42	= 1.36E-08	C C 2	= 1.36E-08	C C 2	Hf 178n	= 1.91E-12	C C 2	= 1.91E-12	C C 2
K 40	= 1.69E-09	C C 2	= 1.69E-09	C C 2	Hf 182	= 4.95E-13	C C 2	= 4.95E-13	C C 2
Ca 41	= 1.43E-05	C C 2	= 1.43E-05	C C 2	Pt 193	= 1.35E-04	C C 2	= 1.35E-04	C C 2
Mn 53	= 6.60E-10	C C 2	= 6.60E-10	C C 2	Ti 204	= 1.64E-05	C C 2	= 1.64E-05	C C 2
Mn 54					Pb 205	= 1.14E-09	C C 2	= 1.14E-09	C C 2
Fe 55	= 2.02E-04	C C 2	= 2.02E-04	C C 2	Pb 210	= 1.32E-10	C C 2	= 1.32E-10	C C 2
Co 60	= 1.31E-02	C C 2	= 1.31E-02	C C 2	Bi 208	= 9.62E-10	C C 2	= 9.62E-10	C C 2
Ni 59	= 6.51E-03	C C 2	= 6.51E-03	C C 2	Bi 210m	= 1.59E-09	C C 2	= 1.59E-09	C C 2
Ni 63	= 2.39E-01	C C 2	= 2.39E-01	C C 2	Po 210	= 1.34E-10	C C 2	= 1.34E-10	C C 2
Zn 65					Ra 223	= 2.60E-09	C C 2	= 2.60E-09	C C 2
Se 79	= 2.21E-07	C C 2	= 2.21E-07	C C 2	Ra 225	= 7.65E-09	C C 2	= 7.65E-09	C C 2
Kr 81	= 4.47E-08	C C 2	= 4.47E-08	C C 2	Ra 226	= 4.37E-13	C C 2	= 4.37E-13	C C 2
Kr 85	= 9.07E-05	C C 2	= 9.07E-05	C C 2	Ra 228	= 2.06E-09	C C 2	= 2.06E-09	C C 2
Rb 87	= 9.03E-10	C C 2	= 9.03E-10	C C 2	Ac 227	= 2.62E-09	C C 2	= 2.62E-09	C C 2
Sr 90	= 1.41E-03	C C 2	= 1.41E-03	C C 2	Th 227	= 2.57E-09	C C 2	= 2.57E-09	C C 2
Zr 93	= 1.68E-07	C C 2	= 1.68E-07	C C 2	Th 228	= 1.80E-07	C C 2	= 1.80E-07	C C 2
Nb 91	= 8.00E-08	C C 2	= 8.00E-08	C C 2	Th 229	= 7.66E-09	C C 2	= 7.66E-09	C C 2
Nb 92	= 2.60E-09	C C 2	= 2.60E-09	C C 2	Th 230	= 1.31E-10	C C 2	= 1.31E-10	C C 2
Nb 93m	= 6.97E-04	C C 2	= 6.97E-04	C C 3	Th 232	= 2.06E-09	C C 2	= 2.06E-09	C C 2
Nb 94	= 2.50E-02	C C 2	= 2.50E-02	C C 2	Th 234	= 8.74E-07	C C 2	= 8.74E-07	C C 2
Mo 93	= 1.84E-03	C C 2	= 1.84E-03	C C 2	Pa 231	= 7.73E-09	C C 2	= 7.73E-09	C C 2
Tc 97	= 1.60E-10	C C 2	= 1.60E-10	C C 2	Pa 233	= 2.79E-08	C C 2	= 2.79E-08	C C 2
Tc 99	= 1.43E-04	C C 2	= 1.43E-04	C C 2	U 232	= 1.75E-07	C C 2	= 1.75E-07	C C 2
Ru 106					U 233	= 1.73E-06	C C 2	= 1.73E-06	C C 2
Pd 107	= 9.71E-09	C C 2	= 9.71E-09	C C 2	U 234	= 8.84E-07	C C 2	= 8.84E-07	C C 2
Ag 108m	= 1.04E-05	C C 2	= 1.04E-05	C C 2	U 235	= 3.73E-08	C C 2	= 3.73E-08	C C 2
Ag 110m					U 236	= 2.55E-08	C C 2	= 2.55E-08	C C 2
Cd 109					U 238	= 8.74E-07	C C 2	= 8.74E-07	C C 2
Cd 113m	= 4.25E-04	C C 2	= 4.25E-04	C C 2	Np 237	= 2.79E-08	C C 2	= 2.79E-08	C C 2
Sn 119m					Pu 236				
Sn 121m	= 2.33E-05	C C 2	= 2.33E-05	C C 2	Pu 238	= 1.41E-05	C C 2	= 1.41E-05	C C 2
Sn 123					Pu 239	= 1.38E-03	C C 2	= 1.38E-03	C C 2
Sn 126	= 4.90E-08	C C 2	= 4.90E-08	C C 2	Pu 240	= 5.43E-05	C C 2	= 5.43E-05	C C 2
Sb 125	= 3.91E-08	C C 2	= 3.91E-08	C C 2	Pu 241	= 2.20E-05	C C 2	= 2.20E-05	C C 2
Sb 126	= 4.90E-08	C C 2	= 4.90E-08	C C 2	Pu 242	= 4.20E-11	C C 2	= 4.20E-11	C C 2
Te 125m	= 9.24E-09	C C 2	= 9.24E-09	C C 2	Am 241	= 7.57E-06	C C 2	= 7.57E-06	C C 2
Te 127m					Am 242m	= 7.29E-09	C C 2	= 7.29E-09	C C 2
I 129	= 2.66E-09	C C 2	= 2.66E-09	C C 2	Am 243	= 8.20E-12	C C 2	= 8.20E-12	C C 2
Cs 134	= 8.47E-10	C C 2	= 8.47E-10	C C 2	Cm 242	= 6.08E-09	C C 2	= 6.08E-09	C C 2
Cs 135	= 1.16E-07	C C 2	= 1.16E-07	C C 2	Cm 243				
Cs 137	= 2.25E-03	C C 2	= 2.25E-03	C C 2	Cm 244	= 1.09E-11	C C 2	= 1.09E-11	C C 2
Ba 133	= 1.64E-04	C C 2	= 1.64E-04	C C 2	Cm 245				
La 137	= 1.90E-06	C C 2	= 1.90E-06	C C 2	Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145	= 1.35E-06	C C 2	= 1.35E-06	C C 2	Cf 250				
Pm 147	= 6.62E-11	C C 2	= 6.62E-11	C C 2	Cf 251				
Sm 147	= 1.71E-12	C C 2	= 1.71E-12	C C 2	Cf 252				
Sm 151	= 1.90E-04	C C 2	= 1.90E-04	C C 2	Unsp a				
Eu 152	= 6.73E-05	C C 2	= 6.73E-05	C C 2	Unsp b/g				
Eu 154	= 3.45E-05	C C 2	= 3.45E-05	C C 2	Total a	1.46E-03	*	1.46E-03	*
Eu 155	= 7.07E-07	C C 2	= 7.07E-07	C C 2	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