

WASTE STREAM	5B302	Prototype Fast Reactor ILW
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SITE Dounreay
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Dounreay Site Restoration Limited
WASTE TYPE ILW
 Is the waste subject to Scottish Policy: Yes

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	11.8 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	21.0 m ³
	1.4.2023 - 31.3.2024.....	0.2 m ³
	1.4.2024 - 31.3.2025.....	0.2 m ³
	1.4.2025 - 31.3.2026.....	0.2 m ³
	1.4.2026 - 31.3.2027.....	0.2 m ³
	1.4.2027 - 31.3.2028.....	0.2 m ³
	1.4.2028 - 31.3.2029.....	4.5 m ³
	1.4.2029 - 31.3.2030.....	8.7 m ³
	1.4.2030 - 31.3.2031.....	41.7 m ³
	1.4.2031 - 31.3.2032.....	81.5 m ³
	1.4.2032 - 31.3.2033.....	39.4 m ³
	1.4.2033 - 31.3.2034.....	3.1 m ³
1.4.2034 - 31.3.2035.....	3.3 m ³	
1.4.2035 - 31.3.2036.....	1.2 m ³	
Total future arisings:		205.4 m ³
Total waste volume:		217.2 m ³

Comment on volumes: It should be noted that the DSRL is currently using a provisional site programme and that arisings dates are subject to change. Waste arisings have been revised following a plant waste inventory walk round exercise. The stocks volumes are 'as stored' in 200 litre drums. The stocks are contained in 160 litre waste crates within the drums. Further characterisation work is on-going to confirm if a proportion of the waste is dominated by tritium which may then impact on waste treatment options. Some wastes will continue to be consigned through existing waste drums until full scale reactor dismantling, which will then package directly into the final waste packages.

Uncertainty factors on volumes:	Stock (upper):	x 1.02	Arisings (upper)	x 1.2
	Stock (lower):	x 0.98	Arisings (lower)	x 0.8

WASTE SOURCE Reactor decommissioning.

PHYSICAL CHARACTERISTICS

General description: The future arisings comprise reactor components and construction materials; All components will be size reduced during decommissioning operations.
 Physical components (%vol): Asphalt (0.12%), Cementitious material (e.g. concrete) (17.17%), Glass (1.52%), Graphite (31.46%), Lead (0.99%), Mild Steel (3.39%), Plastic (0.02%), Stainless steel (45.31%),
 Sealed sources: Not yet determined.
 Bulk density (t/m³): 1.49
 Comment on density: The bulk density is based on Consignor's records

CHEMICAL COMPOSITION

General description and components (%wt): Asphalt (0.05%), Brass (0.02%), Cementitious material (e.g. concrete) (8.07%), Glass (0.74%), Graphite (13.96%), Lead (2.20%), Mild Steel (5.22%), Stainless steel (69.74%),

WASTE STREAM	5B302	Prototype Fast Reactor ILW
---------------------	--------------	-----------------------------------

Chemical state: Neutral

Chemical form of radionuclides: H-3: Present in tritiated steel.
 C-14: Likely to be present.
 Cl-36: Likely to be present at low levels.
 I-129: Likely to be present at low levels.
 Ra: Probably not present.
 Th: Likely to be present at low levels.
 U: Present as uranium metal in the form of shielding.
 Np: Likely to be present at low levels.
 Pu: Likely to be present as contamination at very low levels.

Metals and alloys (%wt): The waste is variable and will contain both bulk and sheet metals, proportions not specified.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	69.7	Stainless steel grade 316L assumed.	69.7
Other ferrous metals.....	5.2		5.2
Iron.....			
Aluminium.....			
Beryllium.....			
Cobalt.....	TR		
Copper.....	0.02	Brass	0.0
Lead.....	2.2		2.2
Magnox/Magnesium.....	0		
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....			

Organics (%wt): Asphalt from pond structure

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	TR		
Paper, cotton.....	TR		
Wood.....	TR		
Halogenated plastics	TR		
Total non-halogenated plastics.....	TR		
Condensation polymers.....	0		
Others.....	0		
Organic ion exchange materials....	0		
Total rubber.....	0		
Halogenated rubber	TR		
Non-halogenated rubber.....	0		
Hydrocarbons.....	0.05		0.1
Oil or grease			
Fuel.....			
Asphalt/Tarmac (cont.coal tar)...	0.05		
Asphalt/Tarmac (no coal tar)....			

WASTE STREAM	5B302	Prototype Fast Reactor ILW
---------------------	--------------	-----------------------------------

Bitumen.....
 Others.....
 Other organics..... 0

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	TR		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	8.1		8.1
Sand.....			
Glass/Ceramics.....	0.74		0.7
Graphite.....	14.0		14.0
Desiccants/Catalysts.....			
Asbestos.....	TR		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): There are no inorganic anions present.

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

Materials of interest for waste acceptance criteria: Asbestos is possibly present. Sodium residues may also be present - risk of hydrogen evolution and potential explosions from reactions with water/water vapour, and corrosive effects of caustic sodium hydroxide reaction product.

	(%wt)	Type(s) and comment
Combustible metals.....	0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	

WASTE STREAM	5B302	Prototype Fast Reactor ILW
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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.....	
Higher activity particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances / non hazardous pollutants: Lead is present.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....	NE	
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....	NE	
Styrene.....		
Tri-butyl phosphate.....	NE	
Other organophosphates.....		
Vinyl chloride.....	NE	
Arsenic.....	NE	
Barium.....		
Boron.....	NE	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....	NE	
Caesium.....		
Selenium.....	NE	
Chromium.....	NE	
Molybdenum.....	NE	
Thallium.....		
Tin.....	NE	
Vanadium.....	NE	
Mercury compounds.....		
Others.....	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		

WASTE STREAM 5B302 Prototype Fast Reactor ILW

EEE Type 3.....
 EEE Type 4.....
 EEE Type 5.....

Complexing agents (%wt): No

(%wt) Type(s) and comment

EDTA.....
 DPTA.....
 NTA.....
 Polycarboxylic acids.....
 Other organic complexants.....
 Total complexing agents..... 0

Potential for the waste to contain discrete items: Yes. The waste has the potential to contain durable engineered steel structures.

PACKAGING AND CONDITIONING

Conditioning method: Waste will either be packaged into Z6033 drums with later overpacking into 500L drums, or (when the size reduction facility is available) direct loading into 500L drums and 6m3 boxes. No conditioning is required for decay storage of tritiated waste.

Plant Name: ILW Size Reduction Facility (ILWSRF) & RHILW Repack Facility

Location: Dounreay

Plant startup date: 2028 & 2028

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: 2028

Throughput for this stream (m³/y incoming waste): ~81.5

Other information: Repackaging Plant and ILWSRF are still in design phase.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
	500 l drum	38.9	~0.2	0.5	423
	6m³ concrete box (HD)	14.9	~3.021	5.76	11
	Other(Other container type = HHISO as interim decay storage for tritiated CHILW. Displacement volume for HHISO Is 19.5m3.)	46.2	~3.89	18.27	26

Likely container type comment: -

Range in container waste volume: The 6 m3 concrete box loading may range from 0.34m3 to 3.72m3.

Other information on containers: If some of the waste is identified for decay storage, these will be packaged in HHISO containers.

Likely conditioning matrix: Cement
 Other information: HD grout for 6 m3 concrete boxes.

Conditioned density (t/m³): >2.5
 Conditioned density comment: The density is likely to be around 2.6 - 4.1 t/m³ for 6 m3 concrete boxes.

Other information on conditioning: For waste loaded directly into 500L Drums at ILWSRF, the strategy is for non encapsulation.

WASTE STREAM	5B302	Prototype Fast Reactor ILW
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Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Near Surface / Near Site Disposal Facility	Metal treatment	~46.0	2023	High	There is an opportunity that further characterisation may show that it is possible to decay store the tritiated steel waste in this stream until activity levels are such that items can be sent for Metal treatment.

RADIOACTIVITY

Source: Main sources are activated and contaminated reactor components, equipment, tools and structure.

Uncertainty: There is on-going work to confirm if a proportion of the waste is dominated by tritium which then may impact on waste treatment options.

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

Measurement of radioactivities: The activity in both the stocks and the arisings is derived from LoC information.

Other information: Radionuclides have been re-assessed. Assume C14 contamination is homogeneous across all the waste.

WASTE STREAM 5B302 Prototype Fast Reactor ILW

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	2.24E-07	CC 2	1.38E-02	CC 2	Gd 153	3.44E-07	CC 2	5.31E-08	CC 2
Be 10	1.48E-07	CC 2	1.08E-07	CC 2	Ho 163	2.42E-25	CC 2	2.67E-25	CC 2
C 14	4.20E-03	CC 2	3.59E-03	CC 2	Ho 166m	1.25E-05	CC 2	1.38E-05	CC 2
Na 22					Tm 170	1.11E-06	CC 2	1.96E-08	CC 2
Al 26					Tm 171				
Cl 36	5.63E-07	CC 2	6.20E-07	CC 2	Lu 174	1.15E-10	CC 2	9.32E-11	CC 2
Ar 39	1.35E-04	CC 2	1.48E-04	CC 2	Lu 176	1.68E-10	CC 2	1.85E-10	CC 2
Ar 42	3.70E-10	CC 2	3.95E-10	CC 2	Hf 178n	8.15E-06	CC 2	8.68E-06	CC 2
K 40	1.40E-09	CC 2	1.55E-09	CC 2	Hf 182	5.89E-06	CC 2	6.49E-06	CC 2
Ca 41	2.12E-05	CC 2	2.19E-05	CC 2	Pt 193	1.12E-04	CC 2	1.21E-04	CC 2
Mn 53	8.11E-04	CC 2	4.23E-08	CC 2	Tl 204	7.32E-06	CC 2	6.05E-06	CC 2
Mn 54	6.14E-10	CC 2	5.03E-18	CC 2	Pb 205	1.32E-05	CC 2	1.45E-05	CC 2
Fe 55	8.49E-03	CC 2	1.92E-04	CC 2	Pb 210	4.28E-11	CC 2	9.36E-11	CC 2
Co 60	9.57E-01	CC 2	1.91E-01	CC 2	Bi 208	1.11E-09	CC 2	1.22E-09	CC 2
Ni 59	8.31E-03	CC 2	5.69E-03	CC 2	Bi 210m	5.05E-07	CC 2	5.56E-07	CC 2
Ni 63	1.21E+00	CC 2	4.12E-01	CC 2	Po 210	1.56E-10	CC 2	7.96E-11	CC 2
Zn 65	6.09E-15	CC 2	3.55E-23	CC 2	Ra 223	1.38E-10	CC 2	1.84E-11	CC 2
Se 79	1.92E-06	CC 2	2.39E-07	CC 2	Ra 225	2.21E-07	CC 2	2.48E-07	CC 2
Kr 81	2.19E-06	CC 2	2.41E-06	CC 2	Ra 226	9.51E-10	CC 2	1.05E-09	CC 2
Kr 85	5.39E-05	CC 2	5.39E-05	CC 2	Ra 228	1.09E-09	CC 2	1.22E-09	CC 2
Rb 87	6.74E-09	CC 2	7.43E-09	CC 2	Ac 227	1.15E-10	CC 2	1.92E-11	CC 2
Sr 90	1.01E-01	CC 2	1.69E-05	CC 2	Th 227	1.37E-10	CC 2	1.85E-11	CC 2
Zr 93	1.56E-05	CC 2	5.31E-08	CC 2	Th 228	7.63E-09	CC 2	8.29E-09	CC 2
Nb 91					Th 229	2.25E-07	CC 2	2.48E-07	CC 2
Nb 92	2.20E-10	CC 2	2.43E-10	CC 2	Th 230	3.60E-09	CC 2	3.87E-09	CC 2
Nb 93m	6.07E-03	CC 2	2.5E-03	CC 2	Th 232	1.15E-09	CC 2	1.27E-09	CC 2
Nb 94	1.32E-03	CC 2	1.13E-03	CC 2	Th 234	9.68E-07	CC 2	3.06E-09	CC 2
Mo 93	3.51E-03	CC 2	1.94E-03	CC 2	Pa 231	2.09E-10	CC 2	2.12E-10	CC 2
Tc 97	2.66E-11	CC 2	2.94E-11	CC 2	Pa 233	5.54E-07	CC 2	6.11E-10	CC 2
Tc 99	2.55E-04	CC 2	1.88E-04	CC 2	U 232	6.45E-09	CC 2	7.01E-09	CC 2
Ru 106	1.05E-07	CC 2	2.48E-18	CC 2	U 233	9.69E-07	CC 2	8.82E-07	CC 2
Pd 107	1.06E-09	CC 2	1.17E-09	CC 2	U 234	1.47E-06	CC 2	8.11E-07	CC 2
Ag 108m	3.75E-05	CC 2	2.63E-05	CC 2	U 235	1.02E-07	CC 2	6.21E-08	CC 2
Ag 110m	2.22E-14	CC 2	5.51E-24	CC 2	U 236	2.23E-08	CC 2	8.21E-11	CC 2
Cd 109	3.21E-13	CC 2	1.40E-13	CC 2	U 238	9.68E-07	CC 2	3.06E-09	CC 2
Cd 113m	1.48E-04	CC 2	2.72E-05	CC 2	Np 237	5.56E-07	CC 2	6.12E-10	CC 2
Sn 119m	8.5E-21	CC 2	1.96E-21	CC 2	Pu 236	5.58E-10	CC 2	4.16E-10	CC 2
Sn 121m	1.5E-05	CC 2	1.62E-05	CC 2	Pu 238	8.21E-03	CC 2	1.14E-05	CC 2
Sn 123					Pu 239	3.88E-02	CC 2	4.34E-05	CC 2
Sn 126	3.07E-06	CC 2	2.93E-09	CC 2	Pu 240	3.60E-02	CC 2	9.31E-06	CC 2
Sb 125	7.09E-05	CC 2	4.94E-08	CC 2	Pu 241	5.71E-01	CC 2	8.00E-05	CC 2
Sb 126	4.3E-07	CC 2	2.93E-09	CC 2	Pu 242	3.56E-05	CC 2	4.82E-06	CC 2
Te 125m	1.78E-05	CC 2	1.17E-08	CC 2	Am 241	5.80E-02	CC 2	2.92E-05	CC 2
Te 127m					Am 242m	5.56E-03	CC 2	1.74E-04	CC 2
I 129	1.44E-07	CC 2	3.65E-11	CC 2	Am 243	1.02E-04	CC 2	5.48E-05	CC 2
Cs 134	2.96E-05	CC 2	8.10E-11	CC 2	Cm 242	4.56E-03	CC 2	1.44E-04	CC 2
Cs 135	3.03E-06	CC 2	3.75E-07		Cm 243	2.67E-04	CC 2	4.5E-07	CC 2
Cs 137	2.93E-01	CC 2	3.72E-05	CC 2	Cm 244	2.09E-02	CC 2	9.32E-07	CC 2
Ba 133	3.76E-05	CC 2	3.75E-05	CC 2	Cm 245	1.58E-05	CC 2	1.67E-05	CC 2
La 137					Cm 246	1.14E-07	CC 2	4.52E-08	CC 2
La 138	8.84E-05	CC 2	9.74E-05	CC 2	Cm 248			3.62E-18	CC 2
Ce 144	3.25E-11	CC 2	5.16E-14	CC 2	Cf 249	7.22E-09	CC 2	7.94E-09	CC 2
Pm 145	3.17E-07	CC 2	3.29E-07	CC 2	Cf 250	1.42E-11	CC 2	1.44E-11	CC 2
Pm 147	5.27E-04	CC 2	2.50E-21	CC 2	Cf 251	8.56E-12	CC 2	9.42E-12	CC 2
Sm 147	2.77E-12	CC 2	1.38E-12	CC 2	Cf 252	5.55E-13	CC 2	4.02E-13	CC 2
Sm 151	1.14E-02	CC 2	1.51E-05	CC 2	Other a			1.02E-06	CC 2
Eu 152	7.68E-03	CC 2	1.47E-04	CC 2	Other b/g			3.12E-04	CC 2
Eu 154	3.49E-03	CC 2	5.53E-05	CC 2	Total a	1.67E-01	CC 2	3.19E-04	CC 2
Eu 155	1.48E-03	CC 2	1.44E-05	CC 2	Total b/g	3.22E+00	CC 2	6.34E-01	CC 2

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 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