

WASTE STREAM	5B356	PFR Absorbers
--------------	-------	---------------

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			
Future arisings:				
Total future arisings:				
Total waste volume:				

Total future arisings: 0.0

Total waste volume: 4.8

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

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

Additional information on quantities: Stated volumes align with LoC.

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

WASTE SOURCE Reactor Component.

PHYSICAL CHARACTERISTICS

General description: This waste stream consists of 46 Absorber rods (28 Control Rods; 18 Shut off Rods) used during PFR operations to control the reactivity of the core during normal operation.

Changes since waste generated: -

Bulk density (t/m³): = 1.0

Comment on density: Based on 24 consignments ~5te of waste in 2.91m³ UKRWI vol.

CHEMICAL COMPOSITION

General description and components (%wt): Boron Carbide (8.5%); Stainless Steel (40.74%); Nimonic PE16 (22.92%); Copper (1.49%); Molybdenum (0.07%); GEC Heavy Alloy (26.28%).

Chemical state: Neutral

Sheet metal proportion / thickness: Metal is present as steel rods and swarf.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 40.7	-	
Other ferrous metals.....	NE	-	
Iron.....	NE	-	
Aluminium.....	NE	-	
Beryllium.....	NE	-	
Cobalt.....	NE	-	
Copper.....	= 1.5	-	
Lead.....	NE	-	
Magnox/Magnesium.....	NE	-	
Nickel.....	= 22.9	Nimonic PE16 (Nickel/Iron/Chromium alloy)	
Titanium.....	NE	-	
Uranium.....	NE	-	
Zinc.....	NE	-	
Zircaloy/Zirconium.....	NE	-	
Other metals.....	= 26.4	26.3% GeC Heavy Alloy (Tungsten alloy); 0.05% Molybdenum. Sodium Hydroxide will be present.	

Organics (%wt):

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

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials.....	NE	-	
Inorganic sludges and flocs.....	NE	-	
Soil.....	NE	-	
Brick/Stone/Rubble.....	NE	-	
Cementitious material.....	P	within packing	
Sand.....			
Glass/Ceramics.....	= 8.5	8.5% Boron Carbide	
Graphite.....	NE	-	
Desiccants/Catalysts.....	NE	-	
Asbestos.....	NE	-	
Non/low friable.....	NE	-	
Moderately friable.....	NE	-	
Highly friable.....	NE	-	
Free aqueous liquids.....	NE	-	
Free non-aqueous liquids.....	NE	-	
Powder/Ash.....	NE	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride.....	NE	-
Chloride.....	NE	-
Iodide.....	NE	-
Cyanide.....	NE	-
Carbonate.....	NE	-
Nitrate.....	NE	-
Nitrite.....	NE	-
Phosphate.....	NE	-
Sulphate.....	NE	-
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.....	NE	-
Putrescible wastes.....	NE	-
Non-putrescible wastes.....	NE	-
Corrosive materials.....	NE	-
Pyrophoric materials.....	NE	-
Generating toxic gases.....	NE	-
Reacting with water.....	TR	Absorbers contaminated with sodium. They have been treated and sodium removed however trace amounts (either embedded in material or as a hydroxide) will remain.
Higher activity particles.....	NE	-
Soluble solids as bulk chemical compounds.....	NE	-

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.....	= 8.5	Boron Carbide
Boron (in Boral).....	= 0	-
Boron (non-Boral).....	= 8.5	-
Cadmium.....	NE	-
Caesium.....	NE	-
Selenium.....	NE	-
Chromium.....	NE	-
Molybdenum.....	= 0.07	As a low density disc
Thallium.....	NE	-
Tin.....	NE	-
Vanadium.....	NE	-
Mercury compounds.....	NE	-
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	On-site	= 100.0
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation	On-site	= 100.0
Treatment not yet determined		
None		

Comments on planned treatments:

A recent assessment of this wastestream now outlines for this waste to be encapsulated into 500L drums through the ILW repack facility. However, this will remain at 1 200L drum: 1 500L drum ratio.

Conditioning method:

A recent assessment of this wastestream now outlines for this waste to be encapsulated into 500L drums through the ILW repack facility. However, this will remain at 1 200L drum: 1 500L drum ratio (2 absorbers per drum).

Conditioning plants:

Plant Name	Location
Combined ILW Repackaging Facility	Dounreay

Likely conditioning matrix:

Non-standard

Further information on the conditioning matrix:

Dounreay will use: Cement PFA 3:1 OPC.

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	100.0	0.20	0.50	24	-

Range in container waste loading: Based on 2 absorber rods per 200L drum and 1 200L drum per 500L drum.

Other information on packaging and conditioning: For optimal waste management, this stream may be co-packaged with other streams in the future.

Conditioned density (t/m³): = 1.3

Conditioned density comment: Rough calculated estimate. See doc: 5B356 absorbers consignmnets_weights_volumes.

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: PFR Operations. Rods were used to control the reactivity in the reactor core.

Uncertainty: -

Measurement of radioactivities: Based on LoC data.

Chemical form of radionuclides: H-3: Present through irradiation of boron carbide + impurities in steel.
C-14: -
Cl-36: -
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: Present as impurities in the steel.
Np: -
Pu: -

WASTE STREAM		5B356		PFR Absorbers					
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	= 5.58E-03	B B 2			Gd 153	= 7.08E-09	B B 2		
Be 10	= 4.73E-08	B B 2			Ho 163	= 1.17E-25	B B 2		
C 14	= 1.58E-03	B B 2			Ho 166m	= 6.06E-06	B B 2		
Na 22					Tm 170	= 1.46E-09	B B 2		
Al 26					Tm 171				
Cl 36	= 2.73E-07	B B 2			Lu 174	= 3.11E-11	B B 2		
Ar 39	= 6.47E-05	B B 2			Lu 176	= 8.15E-11	B B 2		
Ar 42	= 1.68E-10	B B 2			Hf 178n	= 3.69E-06	B B 2		
K 40	= 6.81E-10	B B 2			Hf 182	= 2.86E-06	B B 2		
Ca 41	= 9.64E-06	B B 2			Pt 193	= 5.21E-05	B B 2		
Mn 53	= 1.86E-08	B B 2			Tl 204	= 2.05E-06	B B 2		
Mn 54	= 8.30E-19	B B 2			Pb 205	= 6.39E-06	B B 2		
Fe 55	= 5.90E-05	B B 2			Pb 210	= 6.00E-11	B B 2		
Co 60	= 6.95E-02	B B 2			Bi 208	= 5.39E-10	B B 2		
Ni 59	= 2.50E-03	B B 2			Bi 210m	= 2.45E-07	B B 2		
Ni 63	= 1.79E-01	B B 2			Po 210	= 5.30E-11	B B 2		
Zn 65	= 4.80E-24	B B 2			Ra 223	= 8.19E-12	B B 2		
Se 79	= 1.05E-07	B B 2			Ra 225	= 1.09E-07	B B 2		
Kr 81	= 1.06E-06	B B 2			Ra 226	= 4.62E-10	B B 2		
Kr 85	= 2.15E-05	B B 2			Ra 228	= 5.39E-10	B B 2		
Rb 87	= 3.27E-09	B B 2			Ac 227	= 8.52E-12	B B 2		
Sr 90	= 7.19E-06	B B 2			Th 227	= 8.20E-12	B B 2		
Zr 93	= 2.34E-08	B B 2			Th 228	= 3.62E-09	B B 2		
Nb 91					Th 229	= 1.09E-07	B B 2		
Nb 92	= 1.07E-10	B B 2			Th 230	= 1.71E-09	B B 2		
Nb 93m	= 1.08E-03	B B 2			Th 232	= 5.60E-10	B B 2		
Nb 94	= 4.96E-04	B B 2			Th 234	= 1.35E-09	B B 2		
Mo 93	= 8.54E-04	B B 2			Pa 231	= 9.43E-11	B B 2		
Tc 97	= 1.29E-11	B B 2			Pa 233	= 2.75E-10	B B 2		
Tc 99	= 8.27E-05	B B 2			U 232	= 3.04E-09	B B 2		
Ru 106	= 4.62E-19	B B 2			U 233	= 3.88E-07	B B 2		
Pd 107	= 5.14E-10	B B 2			U 234	= 3.57E-07	B B 2		
Ag 108m	= 1.15E-05	B B 2			U 235	= 2.73E-08	B B 2		
Ag 110m	= 7.59E-25	B B 2			U 236	= 3.63E-11	B B 2		
Cd 109	= 3.01E-14	B B 2			U 238	= 1.35E-09	B B 2		
Cd 113m	= 1.11E-05	B B 2			Np 237	= 2.76E-10	B B 2		
Sn 119m	= 3.08E-22	B B 2			Pu 236	= 1.31E-10	B B 2		
Sn 121m	= 7.00E-06	B B 2			Pu 238	= 5.68E-06	B B 2		
Sn 123					Pu 239	= 1.91E-05	B B 2		
Sn 126	= 1.29E-09	B B 2			Pu 240	= 4.09E-06	B B 2		
Sb 125	= 1.53E-08	B B 2			Pu 241	= 3.33E-05	B B 2		
Sb 126	= 1.29E-09	B B 2			Pu 242	= 2.12E-06	B B 2		
Te 125m	= 3.61E-09	B B 2			Am 241	= 1.29E-05	B B 2		
Te 127m					Am 242m	= 7.60E-05	B B 2		
I 129	= 1.60E-11	B B 2			Am 243	= 2.41E-05	B B 2		
Cs 134	= 2.24E-11	B B 2			Cm 242	= 6.33E-05	B B 2		
Cs 135	= 1.65E-07	B B 2			Cm 243	= 1.91E-07	B B 2		
Cs 137	= 1.58E-05	B B 2			Cm 244	= 3.87E-07	B B 2		
Ba 133	= 1.50E-05	B B 2			Cm 245	= 7.32E-06	B B 2		
La 137					Cm 246	= 1.99E-08	B B 2		
La 138	= 4.28E-05	B B 2			Cm 248	= 1.10E-18	B B 2		
Ce 144	= 7.93E-15	B B 2			Cf 249	= 3.48E-09	B B 2		
Pm 145	= 1.37E-07	B B 2			Cf 250	= 5.86E-12	B B 2		
Pm 147	= 7.60E-22	B B 2			Cf 251	= 4.14E-12	B B 2		
Sm 147	= 6.07E-13	B B 2			Cf 252	= 1.22E-13	B B 2		
Sm 151	= 6.58E-06	B B 2			Unsp a				
Eu 152	= 5.99E-05	B B 2			Unsp b/g				
Eu 154	= 2.16E-05	B B 2			Total a	1.41E-04	*	0	*
Eu 155	= 5.14E-06	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