WASTE STREAM 5B356 PFR Absorbers

SITE	Dounreay
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Dounreay Site Restoration Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2019 - 31.3.2028.....	1.3 m³
Total future arisings:		1.3 m³
Total waste volume:		1.3 m³

Comment on volumes: It should be noted that the DSRL site programme is under review and that arisings dates are subject to change. Arisings figure based on PWI figures which have been assessed against the LoC.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 1.02
Stock (lower):	x	Arisings (lower)	x 0.98

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.

Physical components (%wt): Boron Carbide (8.5%); Stainless Steel (40.75%); Nimonic PE16(22.92%); Copper (1.47%); Molybendum (0.03%); GEC Heavy Alloy(26.29%)

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.17

Comment on density: Based on the ILoC submission for PFR absorbers

CHEMICAL COMPOSITION

General description and components (%wt): Boron Carbide (8.5%); Stainless Steel (40.75%); Nimonic PE16(22.92%); Copper (1.47%); Molybendum (0.07%); GEC Heavy Alloy(26.29%)

Chemical state: Neutral

Chemical form of radionuclides: -

Metals and alloys (%wt): Metal is present as steel rods

Stainless steel.....	40.8	
Other ferrous metals.....		
Iron.....		
Aluminium.....		
Beryllium.....		
Cobalt.....		
Copper.....	1.5	
Lead.....		
Magnox/Magnesium.....		
Nickel.....	22.9	Nimonic PE16 (Nickel/Iron/Chromium alloy)
Titanium.....		
Uranium.....		
Zinc.....		
Zircaloy/Zirconium.....		

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	Other metals.....	26.4	26.29% GeC Heavy Alloy (Tungsten alloy); 0.07% Molybdenum
Organics (%wt):	-		
	Total cellulosics.....		
	Paper, cotton.....		
	Wood.....		
	Halogenated plastics		
	Total non-halogenated plastics.....		
	Condensation polymers.....		
	Others.....		
	Organic ion exchange materials....		
	Total rubber.....		
	Halogenated rubber		
	Non-halogenated rubber.....		
	Hydrocarbons.....		
	Oil or grease		
	Fuel.....		
	Asphalt/Tarmac (cont.coal tar)...		
	Asphalt/Tarmac (no coal tar).....		
	Bitumen.....		
	Others.....		
	Other organics.....		
Other materials (%wt):	Lithium and tritium are also associated with this waste stream. These are produced by the irradiation of boron.		
	Inorganic ion exchange materials.		
	Inorganic sludges and flocs.....		
	Soil.....		
	Brick/Stone/Rubble.....		
	Cementitious material.....		
	Sand.....		
	Glass/Ceramics.....	8.5	8.5% Boron Carbide
	Graphite.....		
	Desiccants/Catalysts.....		
	Asbestos.....		
	Non/low friable.....		
	Moderately friable.....		
	Highly friable.....		
	Free aqueous liquids.....		
	Free non-aqueous liquids.....		
	Powder/Ash.....		
Inorganic anions (%wt):	-		

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Fluoride.....

Chloride.....

Iodide.....

Cyanide.....

Carbonate.....

Nitrate.....

Nitrite.....

Phosphate.....

Sulphate.....

Sulphide.....

Materials of interest for waste acceptance criteria: -

Combustible metals.....

Low flash point liquids.....

Explosive materials.....

Phosphorus.....

Hydrides.....

Biological etc. materials.....

Biodegradable materials.....

Putrescible wastes.....

Non-putrescible wastes.....

Corrosive materials.....

Pyrophoric materials.....

Generating toxic gases.....

Reacting with water.....

Active particles.....

Soluble solids as bulk chemical compounds.....

Hazardous substances / non hazardous pollutants: Absorber pins will be wiped clean to remove any residual alkli metal residue.

Acrylamide.....

Benzene.....

Chlorinated solvents.....

Formaldehyde.....

Organometallics.....

Phenol.....

Styrene.....

Tri-butyl phosphate.....

Other organophosphates.....

Vinyl chloride.....

Arsenic.....

Barium.....

Boron..... 8.5 Boron Carbide

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Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....	0.07	As a low density disc
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

Complexing agents (%wt):

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

PACKAGING AND CONDITIONING

Conditioning method:	The waste will be placed in Z6033 drums, overpacked in 330 litre drums and packaged in 500 litre drums for long term storage.
Plant Name:	-
Location:	To Be Confirmed
Plant startup date:	To Be Confirmed
Total capacity (m^3/y incoming waste):	-
Target start date for packaging this stream:	-
Throughput for this stream (m^3/y incoming waste):	-
Other information:	-

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	100.0	0.04	0.5	32

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Likely container type comment:	Conditioning factor of 12.4
Range in container waste volume:	Based on 2 absorber rods per 500L drum.
Other information on containers:	-
Likely conditioning matrix:	None
Other information:	As per the LoC it is currently proposed that no encapsulation of this waste is required.
Conditioned density (t/m³):	1.17
Conditioned density comment:	No encapsulation or immobilisation is required for this waste. Therefore conditioned density = bulk density.
Other information on conditioning:	-
Opportunities for alternative disposal routing:	

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	PFR Operations. Rods were used to control the reactivity in reactor core.
Uncertainty:	-
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:	Based on LoC data for PFR Decommissioning.
Other information:	Due to high tritium content, the absorbers are limited to two per package

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			1.63E-02	C C 2	Gd 153			1.25E-06	C C 2
Be 10			1.08E-07	C C 2	Ho 163			2.67E-25	C C 2
C 14			3.59E-03	C C 2	Ho 166m			1.38E-05	C C 2
Na 22					Tm 170			7.21E-06	C C 2
Al 26					Tm 171				
Cl 36			6.20E-07	C C 2	Lu 174			1.67E-10	C C 2
Ar 39			1.49E-04	C C 2	Lu 176			1.85E-10	C C 2
Ar 42			4.20E-10	C C 2	Hf 178n			9.29E-06	C C 2
K 40			1.55E-09	C C 2	Hf 182			6.49E-06	C C 2
Ca 41			2.19E-05	C C 2	Pt 193			1.26E-04	C C 2
Mn 53			4.24E-08	C C 2	Tl 204			1.05E-05	C C 2
Mn 54			5.73E-17	C C 2	Pb 205			1.45E-05	C C 2
Fe 55			4.10E-04	C C 2	Pb 210			1.83E-13	C C 2
Co 60			2.84E-01	C C 2	Bi 208			1.22E-09	C C 2
Ni 59			5.69E-03	C C 2	Bi 210m			5.56E-07	C C 2
Ni 63			4.21E-01	C C 2	Po 210			7.67E-10	C C 2
Zn 65			7.98E-22	C C 2	Ra 223			1.27E-10	C C 2
Se 79			2.39E-07	C C 2	Ra 225			3.77E-09	C C 2
Kr 81			2.41E-06	C C 2	Ra 226			1.05E-09	C C 2
Kr 85			6.54E-05	C C 2	Ra 228			1.19E-09	C C 2
Rb 87			7.43E-09	C C 2	Ac 227			1.18E-10	C C 2
Sr 90			1.82E-05	C C 2	Th 227			1.16E-09	C C 2
Zr 93			5.32E-08	C C 2	Th 228			8.28E-09	C C 2
Nb 91					Th 229			2.48E-07	C C 2
Nb 92			2.43E-10	C C 2	Th 230			3.85E-09	C C 2
Nb 93m			2.61E-03	C C 2	Th 232			1.27E-09	C C 2
Nb 94			1.13E-03	C C 2	Th 234			3.83E-09	C C 2
Mo 93			1.94E-03	C C 2	Pa 231			2.09E-10	C C 2
Tc 97			2.94E-11	C C 2	Pa 233			2.09E-10	C C 2
Tc 99			1.88E-04	C C 2	U 232			7.20E-09	C C 2
Ru 106			1.91E-17	C C 2	U 233			8.82E-07	C C 2
Pd 107			1.17E-09	C C 2	U 234			8.11E-07	C C 2
Ag 108m			2.65E-05	C C 2	U 235			6.21E-08	C C 2
Ag 110m			1.15E-22	C C 2	U 236			8.13E-11	C C 2
Cd 109			7.21E-13	C C 2	U 238			3.06E-09	C C 2
Cd 113m			3.15E-05	C C 2	Np 237			5.84E-10	C C 2
Sn 119m			2.62E-20	C C 2	Pu 236			8.61E-10	C C 2
Sn 121m			1.68E-05	C C 2	Pu 238			8.31E-06	C C 2
Sn 123					Pu 239			4.34E-05	C C 2
Sn 126			2.93E-09	C C 2	Pu 240			9.31E-06	C C 2
Sb 125			1.05E-07	C C 2	Pu 241			8.99E-05	C C 2
Sb 126			4.10E-10	C C 2	Pu 242			4.82E-06	C C 2
Te 125m			2.63E-08	C C 2	Am 241			2.90E-05	C C 2
Te 127m					Am 242m			1.77E-04	C C 2
I 129			3.65E-11	C C 2	Am 243			5.48E-05	C C 2
Cs 134			2.22E-10	C C 2	Cm 242			5.64E-07	C C 2
Cs 135			3.75E-07	C C 2	Cm 243			4.82E-07	C C 2
Cs 137			3.99E-05	C C 2	Cm 244			1.05E-06	C C 2
Ba 133			4.57E-05	C C 2	Cm 245			1.67E-05	C C 2
La 137					Cm 246			4.52E-08	C C 2
La 138			9.74E-05	C C 2	Cm 248				
Ce 144			7.42E-13	C C 2	Cf 249			7.98E-09	C C 2
Pm 145			3.70E-07	C C 2	Cf 250			1.69E-11	C C 2
Pm 147			5.53E-21	C C 2	Cf 251			9.44E-12	C C 2
Sm 147			1.38E-12	C C 2	Cf 252			8.83E-13	C C 2
Sm 151			1.55E-05	C C 2	Other a				
Eu 152			1.71E-04	C C 2	Other b/g				
Eu 154			7.05E-05	C C 2	**Total a**	**0**		**1.72E-04**	**C C 2**
Eu 155			2.23E-05	C C 2	**Total b/g**	**0**		**7.37E-01**	**C C 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