WASTE STREAM 5B302 Prototype Fast Reactor ILW

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

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	7.0 m³
Future arisings -	1.4.2019 - 31.3.2028.....	206.0 m³
Total future arisings:		206.0 m³
Total waste volume:		213.0 m³

Comment on volumes: It should be noted that the DSRL site programme is under review and 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.

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) (17.04%), Glass (1.51%), Graphite (31.23%), Lead (0.98%), Mild Steel (3.37%), Other (0.31%), Plastic (0.02%), Stainless steel (45.41%),

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) (8.01%), Glass (0.74%), Graphite (13.86%), Lead (2.18%), Mild Steel (5.18%), Other (0.06%), Stainless steel (69.89%),

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.

Stainless steel.....	69.9	Stainless steel grade 316L assumed.
Other ferrous metals.....	5.2	
Iron.....		
Aluminium.....		
Beryllium.....		
Cobalt.....	TR	
Copper.....	0.02	Brass

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	Lead	2.2	
	Magnox/Magnesium	0	
	Nickel		
	Titanium		
	Uranium		
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals	0.08	Molybdenum used as a coating of the Ta discs and as a disc below absorber stacks.
Organics (%wt):	Asphalt from pond structure		
	Total cellulosics	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	
	Oil or grease		
	Fuel		
	Asphalt/Tarmac (cont.coal tar)	0.05	
	Asphalt/Tarmac (no coal tar)		
	Bitumen		
	Others		
	Other organics	0	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	TR	
	Inorganic sludges and flocs	0	
	Soil	0	
	Brick/Stone/Rubble	0	
	Cementitious material	8.0	
	Sand		
	Glass/Ceramics	0.74	
	Graphite	13.9	
	Desiccants/Catalysts		
	Asbestos	TR	
	Non/low friable		
	Moderately friable		

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Highly friable	
Free aqueous liquids	0
Free non-aqueous liquids	0
Powder/Ash	0

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

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.

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	
Active particles	NE
Soluble solids as bulk chemical compounds	0

Hazardous substances / non hazardous pollutants: Lead is present

Acrylamide	
Benzene	NE
Chlorinated solvents	
Formaldehyde	
Organometallics	
Phenol	NE
Styrene	
Tri-butyl phosphate	NE

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	Other organophosphates.....	
	Vinyl chloride.....	NE
	Arsenic.....	NE
	Barium.....	
	Boron.....	NE
	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.....	
	EEE Type 3.....	
	EEE Type 4.....	
	EEE Type 5.....	
Complexing agents (%wt):	No	
	EDTA.....	
	DPTA.....	
	NTA.....	
	Polycarboxylic acids……	
	Other organic complexants.....	
	Total complexing agents.....	0

PACKAGING AND CONDITIONING

Conditioning method:	Depending on dose rate, waste will either be grouted into 6 m3 concrete boxes or packaged into Z6033 drums with later overpacking into 500L drums.
Plant Name:	PFR
Location:	Dounreay
Plant startup date:	2020
Total capacity (m^3/y incoming waste):	NE
Target start date for packaging this stream:	2020
Throughput for this stream (m^3/y incoming waste):	NE
Other information:	Packaging will happen over 3 years, no exact throughput defined.

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Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	28.0	0.1	0.5	597
6m^3 concrete box (HD)	72.0	1.8	5.76	86

Likely container type comment:	Site ILW container strategy is under review
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, then they may be packaged in HHISO containers
Likely conditioning matrix:	Cement
Other information:	HD grout for 6 m3 concrete boxes.
Conditioned density (t/m^3):	>2.5
Conditioned density comment:	The density is likely to be around 2.6 - 4.1 t/m^3 for 6 m3 concrete boxes.
Other information on conditioning:	Work is still to be done to determine whether 500L drum should be grouted or void filled.
Opportunities for alternative disposal routing:	No

Treatment	Stream volume (%)	Comment
-	-	-

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 the stocks is derived from LoC information. Future arisings data is based upon consignor's records.
Other information:	Specific Activities have been re-evaluated since the 2016 UK Inventory.

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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	1.12E-01	C C 2	1.63E-02	C C 2	Gd 153			1.25E-06	C C 2
Be 10	5.48E-07	C C 2	1.08E-07	C C 2	Ho 163			2.67E-25	C C 2
C 14	1.03E-02	C C 2	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
K 40			1.55E-09	C C 2	Hf 182			6.49E-06	C C 2
Ca 41	1.44E-05	C C 2	2.19E-05	C C 2	Pt 193			1.26E-04	C C 2
Mn 53	8.76E-03	C C 2	4.24E-08	C C 2	Tl 204			1.05E-05	C C 2
Mn 54	7.55E-08	C C 2	5.73E-17	C C 2	Pb 205			1.45E-05	C C 2
Fe 55	1.90E-01	C C 2	4.10E-04	C C 2	Pb 210	3.73E-13	C C 2	1.83E-13	C C 2
Co 60	1.19E+01	C C 2	2.84E-01	C C 2	Bi 208			1.22E-09	C C 2
Ni 59	3.41E-02	C C 2	5.69E-03	C C 2	Bi 210m			5.56E-07	C C 2
Ni 63	9.23E+00	C C 2	4.21E-01	C C 2	Po 210	2.19E-13	C C 2	7.67E-10	C C 2
Zn 65	1.47E-12	C C 2	7.98E-22	C C 2	Ra 223	3.37E-11	C C 2	1.27E-10	C C 2
Se 79	1.84E-05	C C 2	2.39E-07	C C 2	Ra 225	3.09E-09	C C 2	3.77E-09	C C 2
Kr 81			2.41E-06	C C 2	Ra 226	2.59E-12	C C 2	1.05E-09	C C 2
Kr 85			6.54E-05	C C 2	Ra 228	3.95E-17	C C 2	1.19E-09	C C 2
Rb 87			7.43E-09	C C 2	Ac 227	3.42E-11	C C 2	1.18E-10	C C 2
Sr 90	1.17E+00	C C 2	1.82E-05	C C 2	Th 227	3.39E-11	C C 2	1.16E-09	C C 2
Zr 93	1.68E-04	C C 2	5.32E-08	C C 2	Th 228	3.03E-09	C C 2	8.28E-09	C C 2
Nb 91					Th 229	3.10E-09	C C 2	2.48E-07	C C 2
Nb 92			2.43E-10	C C 2	Th 230	8.09E-10	C C 2	3.85E-09	C C 2
Nb 93m	4.40E-02	C C 2	2.61E-03	C C 2	Th 232	8.90E-17	C C 2	1.27E-09	C C 2
Nb 94	3.17E-03	C C 2	1.13E-03	C C 2	Th 234	1.04E-05	C C 2	3.83E-09	C C 2
Mo 93	1.89E-02	C C 2	1.94E-03	C C 2	Pa 231	1.63E-10	C C 2	2.09E-10	C C 2
Tc 97			2.94E-11	C C 2	Pa 233	5.39E-06	C C 2	2.09E-10	C C 2
Tc 99	9.09E-04	C C 2	1.88E-04	C C 2	U 232			7.20E-09	C C 2
Ru 106	8.90E-06	C C 2	1.91E-17	C C 2	U 233	1.82E-06	C C 2	8.82E-07	C C 2
Pd 107			1.17E-09	C C 2	U 234	7.22E-06	C C 2	8.11E-07	C C 2
Ag 108m	1.48E-04	C C 2	2.65E-05	C C 2	U 235	4.97E-07	C C 2	6.21E-08	C C 2
Ag 110m	5.03E-12	C C 2	1.15E-22	C C 2	U 236	2.06E-07	C C 2	8.13E-11	C C 2
Cd 109			7.21E-13	C C 2	U 238	1.04E-05	C C 2	3.06E-09	C C 2
Cd 113m	1.53E-03	C C 2	3.15E-05	C C 2	Np 237	5.41E-06	C C 2	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	8.96E-02	C C 2	8.31E-06	C C 2
Sn 123					Pu 239	4.19E-01	C C 2	4.34E-05	C C 2
Sn 126	3.32E-05	C C 2	2.93E-09	C C 2	Pu 240	3.89E-01	C C 2	9.31E-06	C C 2
Sb 125	1.63E-03	C C 2	1.05E-07	C C 2	Pu 241	7.13E+00	C C 2	8.99E-05	C C 2
Sb 126	4.64E-06	C C 2	4.10E-10	C C 2	Pu 242	3.38E-04	C C 2	4.82E-06	C C 2
Te 125m	3.97E-04	C C 2	2.63E-08	C C 2	Am 241	5.98E-01	C C 2	2.90E-05	C C 2
Te 127m				2	Am 242m	5.92E-02	C C 2	1.77E-04	C C 2
I 129	1.55E-06	C C 2	3.65E-11	C C 2	Am 243	5.69E-04	C C 2	5.48E-05	C C 2
Cs 134	8.76E-04	C C 2	2.22E-10	C C 2	Cm 242	4.94E-02	C C 2	5.64E-07	C C 2
Cs 135	2.90E-05	C C 2	3.75E-07	C C 2	Cm 243	3.09E-03	C C 2	4.82E-07	C C 2
Cs 137	3.39E+00	C C 2	3.99E-05	C C 2	Cm 244	2.53E-01	C C 2	1.05E-06	C C 2
Ba 133			4.57E-05	C C 2	Cm 245	7.95E-06	C C 2	1.67E-05	C C 2
La 137					Cm 246	7.94E-07	C C 2	4.52E-08	C C 2
La 138			9.74E-05	C C 2	Cm 248				
Ce 144	5.02E-09	C C 2	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	1.26E-02	C C 2	5.53E-21	C C 2	Cf 251			9.44E-12	C C 2
Sm 147	1.62E-11	C C 2	1.38E-12	C C 2	Cf 252			8.83E-13	C C 2
Sm 151	1.26E-01	C C 2	1.55E-05	C C 2	Other a				
Eu 152	9.50E-02	C C 2	1.71E-04	C C 2	Other b/g				
Eu 154	4.73E-02	C C 2	7.05E-05	C C 2	**Total a**	**1.80E+00**	**C C 2**	**1.72E-04**	**C C 2**
Eu 155	2.42E-02	C C 2	2.23E-05	C C 2	**Total b/g**	**3.37E+01**	**C C 2**	**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