

WASTE STREAM	5B301	Prototype Fast Reactor LLW
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SITE Dounreay
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Dounreay Site Restoration Limited
WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m ³
Future arisings -	1.4.2019 - 31.3.2028.....	3581.0 m ³
Total future arisings:		3581.0 m ³
Total waste volume:		3581.0 m ³

Comment on volumes: Arisings are based on PWI data. Stocks have been removed. These will be captured under 5B15 and 5B16. It should be noted that DSRL site programme is currently under review and future arisings dates are subject to change. DSRL are undertaking further sampling to improve understanding of tritium content of reactor items to confirm if they are LLW or ILW

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

WASTE SOURCE Reactor decommissioning.

PHYSICAL CHARACTERISTICS

General description: Building materials from decommissioning, and redundant equipment; reactor components; reaction products from treatment of alkali metals

Physical components (%wt): Alkali Metal (0.03%), Aluminium (0.02%), Brass (0.02%), Cementitious material (e.g. concrete) (10.08%), Copper (0.29%), Fibreglass (0.07%), Glass (0.01%), Graphite (0.03%), Iron (0.32%), Lead (6.21%), Mild Steel (69.06%), Other (0.69%), Paper (0.62%), Plastic (1.63%), Rubber (0.45%), Sodium (0.09%), Stainless steel (8.61%), Uranium (0.01%), WEEE not containing hazardous components (1.57%), Wood/ Wood composite (0.19%),

Sealed sources: Not yet determined.

Bulk density (t/m³): 0.73

Comment on density: The density quoted is based on consignor's data.

CHEMICAL COMPOSITION

General description and components (%wt): Alkali Metal (0.03%), Aluminium (0.02%), Brass (0.02%), Cementitious material (e.g. concrete) (10.08%), Copper (0.29%), Fibreglass (0.07%), Glass (0.01%), Graphite (0.03%), Iron (0.32%), Lead (6.21%), Mild Steel (69.06%), Other (0.69%), Paper (0.62%), Plastic (1.63%), Rubber (0.45%), Sodium (0.09%), Stainless steel (8.61%), Uranium (0.01%), WEEE not containing hazardous components (1.57%), Wood/ Wood composite (0.19%),

Chemical state: Neutral

Chemical form of radionuclides: H-3: Tritiated steel will be present.
C-14: Possibly present at low concentrations.
Cl-36: Likely to be present at low levels.
I-129: Likely to be present at low levels.
Ra: Not known to be present.
Th: Not known to be present.
U: Likely to be present at low levels.
Np: Likely to be present at low levels.
Pu: Likely to be present at low levels.

Metals and alloys (%wt): Both bulk and sheet metals will be present, proportions not specified.

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Stainless steel.....	8.6	
Other ferrous metals.....	69.1	
Iron.....	0.32	
Aluminium.....	0.02	
Beryllium.....		
Cobalt.....	NE	
Copper.....	0.29	
Lead.....	6.2	
Magnox/Magnesium.....	NE	
Nickel.....	NE	
Titanium.....		
Uranium.....		
Zinc.....		
Zircaloy/Zirconium.....	NE	
Other metals.....	0.03	Others (0.03%) are alloys of unknown type and mercury and barium.

Organics (%wt):

The waste contains halogenated and non-halogenated plastics and rubber (2.1% in total). Wood may be present as a construction material but only in very small amounts. PVC is likely to be the major constituent of halogenated plastics.

Total cellulose.....	0.81	
Paper, cotton.....	0.62	
Wood.....	NE	
Halogenated plastics	0.82	PVC
Total non-halogenated plastics.....	0.82	
Condensation polymers.....	NE	
Others.....	<	
Organic ion exchange materials....	0	
Total rubber.....	0.45	
Halogenated rubber	0.23	
Non-halogenated rubber.....	0.23	
Hydrocarbons.....		
Oil or grease		
Fuel.....		
Asphalt/Tarmac (cont.coal tar)...		
Asphalt/Tarmac (no coal tar)....		
Bitumen.....		
Others.....		
Other organics.....	TR	

Other materials (%wt):

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Inorganic ion exchange materials. 0
 Inorganic sludges and flocs..... 0
 Soil..... 0
 Brick/Stone/Rubble..... P
 Cementitious material..... 10.1
 Sand.....
 Glass/Ceramics..... 0.08
 Graphite..... 0.03
 Desiccants/Catalysts..... NE
 Asbestos..... P
 Non/low friable.....
 Moderately friable.....
 Highly friable.....
 Free aqueous liquids..... 0
 Free non-aqueous liquids..... 0
 Powder/Ash..... 0

Inorganic anions (%wt):

Inorganic anions (about 3%) are probably present.

Fluoride..... NE
 Chloride..... NE
 Iodide..... NE
 Cyanide..... 0
 Carbonate..... NE
 Nitrate..... NE
 Nitrite..... 0
 Phosphate..... NE
 Sulphate..... NE
 Sulphide..... NE

Materials of interest for waste acceptance criteria:

Asbestos is present. Trace quantities of sodium may also be present.

Combustible metals.....
 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.....
 Corrosive materials..... 0
 Pyrophoric materials..... 0
 Generating toxic gases..... 0
 Reacting with water..... 0
 Active particles..... NE

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	Soluble solids as bulk chemical compounds.....	NE	
Hazardous substances / non hazardous pollutants:	Lead and mercury are present. Barium is present in Barytes concrete. Asbestos is also present.		
	Acrylamide.....		
	Benzene.....	NE	
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....	NE	
	Styrene.....		
	Tri-butyl phosphate.....	NE	
	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.....	P	
	Others.....	NE	
	Electronic Electrical Equipment (EEE)		
	EEE Type 1.....		
	EEE Type 2.....	~1.6	Electrical panels, cooling system; vacuums
	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	

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)		23.0
Incineration		
Solidification		100.0
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		

Comment on planned treatments:

Uncompacted drums will be supercompacted before being placed in HHISOs. The waste will be encapsulated before final disposal. DSRL is investigating the feasibility of alternative waste treatment routes in particular Metal Treatment for Tritiated steel but no decision has been made on their use yet.

Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	
Expected to be consigned to a Landfill Facility	
Expected to be consigned to an On-Site Disposal Facility	23.0
Expected to be consigned to an Incineration Facility	
Expected to be consigned to a Metal Treatment Facility	
Expected to be consigned as Out of Scope	
Expected to be recycled / reused	
Disposal route not known	77.0

Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m ³	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO			
1/2 Height IP-2 Disposal/Re-usable ISO	100.0	10	359
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information:

The waste will consist of large uncompactable items and 200 litre drums that have already been compacted. DSRL is investigating the feasibility of alternative LLW Disposal Container.

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Container voidage: -

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

Potential for the waste to contain discrete items: -

Non-Containerised Waste for In-Vault Grouting: (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

RADIOACTIVITY

Source: The radioactivity arises from contamination of reactor building construction materials.

Uncertainty: Within a factor of 10 for arisings.

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: From modelling results and waste consignor's declarations.

Other information: Specific Activities have been re-evaluated since the 2016 UK Inventory.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			1.56E-04	C C 2	Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22			1.53E-07	C C 2	Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54			2.10E-11	C C 2	Pb 205				
Fe 55					Pb 210				
Co 60			2.49E-05	C C 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90			2.34E-06	C C 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235		5.61E-13	C C 2	
Ag 110m					U 236				
Cd 109			9.64E-12	C C 2	U 238		4.82E-12	C C 2	
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		1.13E-07	C C 2	
Sn 123					Pu 239		8.08E-08	C C 2	
Sn 126					Pu 240		1.20E-07	C C 2	
Sb 125					Pu 241		5.83E-06	C C 2	
Sb 126					Pu 242				
Te 125m					Am 241		1.12E-07	C C 2	
Te 127m					Am 242m				
I 129					Am 243				
Cs 134			9.36E-12	C C 2	Cm 242		6.01E-10	C C 2	
Cs 135					Cm 243				
Cs 137			1.25E-04	C C 2	Cm 244		3.64E-09	C C 2	
Ba 133			7.46E-10	C C 2	Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g		5.63E-12	C C 2	
Eu 154					Total a	0	4.30E-07	C C 2	
Eu 155			4.65E-10	C C 2	Total b/g	0	3.14E-04	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