

<b>WASTE STREAM</b>	<b>5B339</b>	<b>PIE Facility LLW</b>
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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 <sup>3</sup>
Future arisings -	1.4.2019 - 31.3.2020.....	694.0 m <sup>3</sup>
Total future arisings:		694.0 m <sup>3</sup>
Total waste volume:		694.0 m <sup>3</sup>

Comment on volumes: Arisings are dependent on the decommissioning programme and have been revised in line with the Predictive Waste Inventory walk round exercise. 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.

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

**WASTE SOURCE** Decommissioning of PIE facility.

**PHYSICAL CHARACTERISTICS**

General description: Metallic cell waste, concrete and rubble. Items will be size reduced where practicable during decommissioning.

Physical components (%wt): Aluminium (0.02%), Asbestos (1.47%), Asphalt (2.50%), Cementitious material (e.g. concrete) (31.37%), Copper (6.01%), Fibreglass (4.50%), Glass (0.10%), Gypsum Plasterboard/ Fibreboard (0.28%), Iron (0.56%), Lead (0.39%), Mild Steel (49.62%), Other (0.10%), Other organics (0.03%), Paper (0.36%), Plastic (1.98%), Rubber (0.28%), Wood/ Wood composite (0.43%),

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 0.6

Comment on density: The Bulk Density is based on consignor's records.

**CHEMICAL COMPOSITION**

General description and components (%wt): Aluminium (0.02%), Asbestos (1.47%), Asphalt (2.50%), Cementitious material (e.g. concrete) (31.37%), Copper (6.01%), Fibreglass (4.50%), Glass (0.10%), Gypsum Plasterboard/ Fibreboard (0.28%), Iron (0.56%), Lead (0.39%), Mild Steel (49.62%), Other metals (0.10%), Other organics (0.03%), Paper (0.36%), Plastic (1.98%), Rubber (0.28%), Wood/ Wood composite (0.43%),

Chemical state: Neutral

Chemical form of radionuclides: Cl-36: Not likely to be present.  
 I-129: Not likely to be present.  
 U: Likely to be present as oxides.  
 Pu: Likely to be present as oxides.

Metals and alloys (%wt): Metals are likely to be mostly present as sheet metal.

Stainless steel.....		assumed M316
Other ferrous metals.....	49.6	
Iron.....	0.56	
Aluminium.....	0.02	
Beryllium.....	NE	
Cobalt.....	NE	
Copper.....	6.0	
Lead.....	0.39	
Magnox/Magnesium.....	NE	

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	Nickel.....	NE	
	Titanium.....		
	Uranium.....	P	
	Zinc.....	NE	
	Zircaloy/Zirconium.....	NE	
	Other metals.....	0.10	others
Organics (%wt):	Organic materials may be present in small quantities.		
	Total cellulose.....	0.79	
	Paper, cotton.....	0.36	
	Wood.....	0.43	
	Halogenated plastics .....	2.0	
	Total non-halogenated plastics.....	NE	
	Condensation polymers.....	NE	
	Others.....	NE	
	Organic ion exchange materials....	0	
	Total rubber.....	0.28	
	Halogenated rubber .....	0.14	
	Non-halogenated rubber.....	0.14	
	Hydrocarbons.....	2.5	
	Oil or grease .....		
	Fuel.....		
	Asphalt/Tarmac (cont.coal tar)...	2.5	
	Asphalt/Tarmac (no coal tar)....		
	Bitumen.....		
	Others.....		
	Other organics.....	0.31	Plasterboard + others
Other materials (%wt):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs.....	0	
	Soil.....	0	
	Brick/Stone/Rubble.....	NE	
	Cementitious material.....	31.4	
	Sand.....		
	Glass/Ceramics.....	4.6	Fibreglass + glass
	Graphite.....	0	
	Desiccants/Catalysts.....	0	
	Asbestos.....	1.5	
	Non/low friable.....		
	Moderately friable.....		
	Highly friable.....		
	Free aqueous liquids.....	0	
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	

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Inorganic anions (%wt):

Inorganic anions may be present in trace quantities.

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

Materials of interest for waste acceptance criteria:

Hazardous materials unlikely to be present in significant quantities.

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.....	0
Active particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances / non hazardous pollutants:

Toxic metals unlikely to be present in significant quantities.

Acrylamide.....	
Benzene.....	NE
Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	NE
Styrene.....	
Tri-butyl phosphate.....	NE
Other organophosphates.....	
Vinyl chloride.....	NE
Arsenic.....	NE
Barium.....	

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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..... ~40.0  
     EEE Type 2.....  
     EEE Type 3.....  
     EEE Type 4.....  
     EEE Type 5.....  
 Complexing agents (%wt): Not yet determined  
 EDTA.....  
 DPTA.....  
 NTA.....  
 Polycarboxylic acids.....  
 Other organic complexants.....  
 Total complexing agents..... NE

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	20.0
Supercompaction (HFC)		
Incineration	On-site	100.0
Solidification		
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 but no decision has been made on their use yet.

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**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 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	100.0

**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 <sup>3</sup>	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 2m box (no shielding) 4m box (no shielding) Other	100.0	10	70

**Other information:**

There is an opportunity that when the facility's cell blocks are decommissioned their waste category may change to Demolition LLW and as such, would not be disposed in containers, but as blocks. 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.

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

- 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: -

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Other information:

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**RADIOACTIVITY**

Source:

The north cell has handled PFR wrapper sections and other materials which contain cobalt 60 from irradiation in PFR. Analysis of samples from the cells in 2005 indicated a low percentage of a activity and significant quantities of europium radionuclides. These europium radionuclides are the result of destructive examination of capsules containing europium hexaboride after irradiation in DFR. The south cell has handled DFR breeder elements with the dominant beta/gamma radionuclides being caesium 137 and strontium 90. All other radionuclides are expected to be negligible by comparison.

Uncertainty:

The estimates are within a factor of ten.

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 is taken from 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 <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					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					Pb 205				
Fe 55					Pb 210				
Co 60			1.80E-05	CC 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			7.42E-05	CC 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		3.2E-08	CC 2	
Ag 108m					U 235		1.27E-09	CC 2	
Ag 110m					U 236		6.43E-10	CC 2	
Cd 109					U 238		4.21E-09	CC 2	
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		1.82E-08	CC 2	
Sn 123					Pu 239		1.79E-06	CC 2	
Sn 126					Pu 240		2.48E-07	CC 2	
Sb 125					Pu 241		5.09E-07	CC 2	
Sb 126					Pu 242				
Te 125m					Am 241		3.48E-08	CC 2	
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242		1.03E-09	CC 2	
Cs 135					Cm 243				
Cs 137			5.69E-05	CC 2	Cm 244				
Ba 133					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			2.05E-05	CC 2	Other b/g		7.27E-10	CC 2	
Eu 154			1.84E-05	CC 2	<b>Total a</b>	<b>0</b>	<b>2.13E-06</b>	<b>CC 2</b>	
Eu 155			1.72E-07	CC 2	<b>Total b/g</b>	<b>0</b>	<b>1.89E-04</b>	<b>CC 2</b>	

**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