WASTE STREAM 5B02 Low Alpha RHILW

SITE	Dounreay
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Dounreay Site Restoration Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	Yes

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m³
Future arisings -	1.4.2028 - 31.3.2029.....	148.7 m³
	1.4.2029 - 31.3.2030.....	242.4 m³
	1.4.2030 - 31.3.2031.....	89.0 m³
Total future arisings:		480.1 m³
Total waste volume:		480.1 m³

Comment on volumes: The waste will be retrieved from a former storage facility for packaging and interim storage at about 137 m3/year. Programme is from DSRL's provisional Lifetime Plan. The volume quoted is the recorded disposal volume of the solid waste plus an assessment of the sludge volume.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 1.05
Stock (lower):	x	Arisings (lower)	x 0.95

WASTE SOURCE Redundant and waste items from various cell operations including PIE, analytical, defuelling, POCO as well as routine operations.

PHYSICAL CHARACTERISTICS

General description: A range of solid wastes is included in the stream. These are redundant metallic reactor components, metallic fuel element debris and cladding, redundant equipment and tools, discarded plastics from bag posting operations and wrappings on undrummed components and gaiters, and metallic components from plant decommissioning and refurbishment work. Small items include manipulator jaws and tools etc. Sludge is thought to be present from direct consignments and from degradation of some of the solid wastes. A number of items were contained in steel drums or cans. Large items and heavy items are known to have been consigned to the Silo. The solid wastes will normally be shredded prior to radiological characterisation. The waste will have undergone changes in the water filled silo, the current form of much of it is unknown.

Physical components (%vol): PVC (39.7%), Polythene (2.8%), Paper (6.0%), Aluminium (5.6%), Mild Steel (22.1%), Stainless Steel (18.0%), Glass (2.4%), Sludge (1.7%), Lead (0.8%), Concrete/rubble (0.8%), Copper/niobium/rubber/other (0.1%). All percentages are by volume. Sludge figure is based on recorded disposals.

Sealed sources: Not yet determined.

Bulk density (t/m³): <3.4

Comment on density: The density has been determined from the volume of waste, broken down into constituent materials.

CHEMICAL COMPOSITION

General description and components (%wt): Glass (1.5%), PVC (13.1%), Polythene (0.6%), Paper (1.5%), Aluminium (3.5%), Mild Steel (41.8%), Stainless Steel (35.4%), Lead (2.2%), Concrete/rubble (0.4%). Composition of solid waste only.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Likely to be present in corrosion resistant stainless steel from reactor operations.
C-14: Possibly present in steels, PVC and polythene. Unlikely to be present in significant quantities.
Ra: Possibly present in sources.
Th: Likely to be present.
U: Likely to be present as metal, alloyed with Cr, Mo and possibly Al, oxides and also within the sludge.
Pu: Likely to be associated with uranium and in cemented liquors.

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

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	35.4		
Other ferrous metals	41.8		
Iron			
Aluminium	3.5		
Beryllium	P		
Cobalt	TR		
Copper	TR		
Lead	2.2		
Magnox/Magnesium	0		
Nickel	NE		
Titanium			
Uranium	P		
Zinc	NE		
Zircaloy/Zirconium	P		
Other metals	TR	The waste is known to contain approximately 95 kg of niobium.	

Organics (%wt): The waste contains PVC and ion-exchange resins, with smaller amounts of polythene, paper and rubber. PVC is present and halogenated rubbers are likely to be present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	~1.5		
Paper, cotton	~1.5		
Wood	NE		
Halogenated plastics	~13.1		
Total non-halogenated plastics	~0.60		
Condensation polymers	0		
Others	~0.60		
Organic ion exchange materials	P		
Total rubber	NE		
Halogenated rubber	NE		
Non-halogenated rubber	NE		
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	TR		

Other materials (%wt): A large volume of this waste will be in the form of sludge, though this cannot be quantified exactly at present.

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	P		
Inorganic sludges and flocs.....	P		
Soil.....	0		
Brick/Stone/Rubble.....	P		
Cementitious material.....	~0.40		
Sand.....			
Glass/Ceramics.....	~1.5		
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	NE		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	NE		
Free non-aqueous liquids.....	NE		
Powder/Ash.....	NE		

Inorganic anions (%wt): Borated glass was routinely consigned to the silo. Ion-exchange material will also be present.

	(%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: It is possible that there are traces of sodium or sodium/potassium alloy in the waste. There may also be traces of pyrophoric uranium hydride in any canned waste. Also, zircaloy metal is known to be present fixed in resin.

	(%wt)	Type(s) and comment
Combustible metals.....	NE	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	NE	
Biological etc. materials.....	0	
Biodegradable materials.....	P	
Putrescible wastes.....	NE	

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Non-putrescible wastes.....	NE	
Corrosive materials.....	NE	
Pyrophoric materials.....	P	May be trace quantities
Generating toxic gases.....	0	
Reacting with water.....	NE	
Higher activity particles.....	P	Active swarf known to have been disposed - quantity not determined
Soluble solids as bulk chemical compounds.....	NE	

Hazardous substances / non hazardous pollutants: Toxic metals may be present as sources. Beryllium is present as two Be rods. Lead is present (2.2%).

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....	NE	
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....	NE	
Styrene.....		
Tri-butyl phosphate.....	NE	
Other organophosphates.....		
Vinyl chloride.....	NE	
Arsenic.....	NE	
Barium.....		
Boron.....	NE	
Boron (in Boral).....		
Boron (non-Boral).....		
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.....		

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Complexing agents (%wt): Not yet determined

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....	NE	Decontamination reagents on swabs may be present.
Total complexing agents.....	NE	

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Conditioning method: Waste will be retrieved and segregated into sludge and solid components. The solids will be shredded and packaged into 200l drums. The sludge will be solidified in a 200l annular drum. The 200l drums will be supercompacted and packaged.

Plant Name: Shaft Retrieval and Processing Facility

Location: Dounreay

Plant startup date: 2028

Total capacity (m^3/y incoming waste): 305.0

Target start date for packaging this stream: 2028

Throughput for this stream (m^3/y incoming waste): 137.0

Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	100.0	0.547	0.5	879

Likely container type comment: No change in container strategy is likely.

Range in container waste volume: There will be different waste loadings in the 500 l drums dependant if being used for compacted solids, non-compacted solids or sludge waste. Presented likely container type is for compacted solids.

Other information on containers: -

Likely conditioning matrix: Not Specified

Other information: To be confirmed.

Conditioned density (t/m^3): -

Conditioned density comment: -

Other information on conditioning: Data will be confirmed or amended as necessary as the plant design and process are further developed.

Opportunities for alternative disposal routing: No

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Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	The main sources of activity are activated reactor components, activated and contaminated fuel element debris and cladding, and contaminated redundant equipment and small tools.
Uncertainty:	The specific activity is based on the estimated total activity divided by the bulk volume of the solid waste. This assumes that the sludge occupies the voidage in the solid waste.
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:	Records have been kept for fissile material which have been used to estimate the activity in the waste. Data for Cm246-Cf252 inferred from PFR raffinate data (FISPIN results).
Other information:	No account of leaching from the waste into water historically pumped from the Silo has been considered. Specific Activity uses UKRWI 2019 data decayed to 2022.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3			<2.08E-04	A 3	Gd 153				
Be 10					Ho 163				
C 14			<6.28E-05	A 3	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			<7.13E-13	A 3
Co 60			<5.42E-01	A 3	Bi 208				
Ni 59			<1.55E-02	A 3	Bi 210m				
Ni 63			<4.70E-01	A 3	Po 210			<6.48E-13	A 3
Zn 65					Ra 223			<6.26E-10	A 3
Se 79			<7.12E-08	A 3	Ra 225			<5.90E-10	A 3
Kr 81					Ra 226			<4.60E-12	A 3
Kr 85					Ra 228			<2.38E-16	A 3
Rb 87					Ac 227			<6.51E-10	A 3
Sr 90			<6.93E-02	A 3	Th 227			<6.27E-10	A 3
Zr 93			<4.03E-06	A 3	Th 228			<5.51E-10	A 3
Nb 91					Th 229			<5.92E-10	A 3
Nb 92					Th 230			<1.26E-09	A 3
Nb 93m			<2.37E-06	A 3	Th 232			<4.13E-16	A 3
Nb 94			<1.7E-02	A 3	Th 234			<3.87E-06	A 3
Mo 93					Pa 231			<7.19E-09	A 3
Tc 97					Pa 233			<1.10E-07	A 3
Tc 99			<1.9E-03	A 3	U 232			<5.37E-10	A 3
Ru 106			<4.93E-08	A 3	U 233			<3.69E-07	A 3
Pd 107			<3.27E-07	A 3	U 234			<8.30E-06	A 3
Ag 108m			<5.39E-23	A 3	U 235			<1.4E-06	A 3
Ag 110m					U 236			<4.91E-07	A 3
Cd 109					U 238			<3.88E-06	A 3
Cd 113m			<5.07E-06	A 3	Np 237			<1.10E-07	A 3
Sn 119m					Pu 236				
Sn 121m			<7.40E-05	A 3	Pu 238			<3.80E-03	A 3
Sn 123					Pu 239			<2.54E-03	A 3
Sn 126			<6.57E-07	A 3	Pu 240			<4.25E-03	A 3
Sb 125			<3.68E-05	A 3	Pu 241			<1.06E-01	A 3
Sb 126			<6.57E-07	A 3	Pu 242			<3.73E-06	A 3
Te 125m			<8.7E-06	A 3	Am 241			<7.28E-03	A 3
Te 127m					Am 242m			<1.03E-17	A 3
I 129			<7.8E-08	A 3	Am 243			<1.09E-05	A 3
Cs 134			<1.41E-05	A 3	Cm 242			<8.63E-18	A 3
Cs 135			<3.42E-06	A 3	Cm 243			<3.77E-05	A 3
Cs 137			<8.85E-02	A 3	Cm 244			<3.30E-04	A 3
Ba 133					Cm 245			<4.09E-08	A 3
La 137					Cm 246			<1.96E-09	A 3
La 138					Cm 248			<4.07E-22	A 3
Ce 144					Cf 249			<9.76E-14	A 3
Pm 145					Cf 250			<5.12E-14	A 3
Pm 147			<3.55E-04	A 3	Cf 251			<2.08E-17	A 3
Sm 147			<7.76E-13	A 3	Cf 252			<6.29E-19	A 3
Sm 151			<4.71E-03	A 3	Other a			<5.62E-09	A 3
Eu 152			<3.10E-07	A 3	Other b/g			<1.53E-01	A 3
Eu 154			<5.63E-04	A 3	**Total a**	**0**		**1.83E-02**	**A 3**
Eu 155			<4.42E-04	A 3	**Total b/g**	**0**		**1.47E+00**	**A 3**

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