WASTE STREAM 5B03 Operational 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.....	142.4 m³
Total future arisings:		0 m³
Total waste volume:		142.4 m³

Comment on volumes: All other future solid RHILW arisings will be consigned under UKRWI decommissioning waste streams. All drums have been overpacked in 330 litre drums and in the Dounreay Cementation Plant Store. The additional volume attributable to these overpacks is not included as it is undecided if the will remain part of the waste stream.Minor change to stocks volume from 2016 as the historic waste drums waste streams were re-evaluated based on a different set of assumptions.

Uncertainty factors on volumes:				
	Stock (upper):	x 1.02	Arisings (upper)	x
	Stock (lower):	x 0.98	Arisings (lower)	x

WASTE SOURCE The waste arises from PFR fuel cycle, including operations and support. It consists of both irradiated and contaminated items. The earliest waste has been in storage since 1980, the start of PFR fuel reprocessing.

PHYSICAL CHARACTERISTICS

General description:	The waste consists of items such as hulls, centrifuge bowls, plenums, wrappers and other assorted scrap such as redundant equipment and tools. It arises from both reactor fuel breakdown and post irradiation examination support work. All waste is in 200 litre stainless steel drums. All drums have been overpacked in 330 litre drums.
Physical components (%vol):	Hulls (9.7%), centrifuge bowls (12.1%), plenums, wrappers, spikes, heads, filters (33.8%), residues (3.4%), filters with aluminium (2.4%), other equipment, tools, glassware and soft waste etc. (38.6%).
Sealed sources:	Not yet determined.
Bulk density (t/m³):	1.31
Comment on density:	The raw density of 1.315 te/m³ is based on a sample of 859 drums (171.8 m³) with a total weight of 225.911 te.

CHEMICAL COMPOSITION

General description and components (%wt):	Stainless steel (79.64%), mild steel (12.51%), glass (0.4%), residues (1.4%), lead (0.64%), copper (0.21%), paper (0.8%), plastic (3.5%), PVC (<0.1%) rubber (<0.1%), other material (<0.9%).
Chemical state:	Neutral
Chemical form of radionuclides:	H-3: Likely to be present, form uncertain. C-14: Likely to be present, form uncertain. Cl-36: Likely to be present, form uncertain. Se-79: Likely to be present, form uncertain. Tc-99: Likely to be present, form uncertain. I-129: Likely to be present, form uncertain. Ra: Likely to be present, form uncertain. Th: Likely to be present, form uncertain. U: Likely to be present as oxide. Np: Likely to be present, form uncertain. Pu: Likely to be present as oxide.
Metals and alloys (%wt):	Both sheet (e.g. drum, hulls) and bulk (e.g. tools) metals are likely to be present. Proportions not estimated.

WASTE STREAM 5B03 Operational RHILW

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	79.6	Assumed to be mainly 316	79.6
Other ferrous metals	12.5		12.5
Iron			
Aluminium	TR		
Beryllium	0		
Cobalt	0		
Copper	0.21		0.2
Lead	0.64		0.6
Magnox/Magnesium	0		
Nickel			
Titanium			
Uranium	0		
Zinc	0		
Zirconium	0		
Other metals	0		

Organics (%wt): Paper content arises mainly from swabs. Plastic and rubber are associated with items of equipment, hoses, cables as well as manipulator gaitors, posting bags and sample bottles. PVC is present. Likely to be degraded through radiation.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	0.80		0.8
Paper, cotton	0.80		0.8
Wood	0		
Halogenated plastics	3.5		3.5
Total non-halogenated plastics	<0.10		0.1
Condensation polymers	NE		
Others	NE		
Organic ion exchange materials	NE		
Total rubber	<0.10		0.1
Halogenated rubber	P		
Non-halogenated rubber	P		
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	<2.3	Residues + other material - no further breakdown available	2.3

Other materials (%wt): -

WASTE STREAM 5B03 Operational RHILW

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	NE		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	0		
Sand.....	0		
Glass/Ceramics.....	0.40		0.4
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): The waste may contain trace quantities of inorganic anions.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	TR	
Iodide.....	NE	
Cyanide.....	NE	
Carbonate.....	NE	
Nitrate.....	TR	
Nitrite.....	0	
Phosphate.....	NE	
Sulphate.....	TR	
Sulphide.....	NE	

Materials of interest for waste acceptance criteria: An examination of plant records has shown that no pyrophoric materials or free liquids are present. No other hazardous materials are expected to be present in significant quantities.

	(%wt)	Type(s) and comment
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	

WASTE STREAM 5B03 Operational RHILW

Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0
Higher activity particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances / non hazardous pollutants: Lead is present in the waste. No other hazardous materials are expected to be present in significant quantities.

	(%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.....		

WASTE STREAM 5B03 Operational RHILW

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		There may be trace quantities of complexing agents present.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Conditioning method: The waste is currently stored in 160 litre crates within 200 litre drums. Waste will be repackaged into 500L drums.

Plant Name: RHILW Repackaging Facility

Location: Dounreay

Plant startup date: 2028

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

Target start date for packaging this stream: 2028

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

Other information: RHILW Repackaging Plant is currently in the design phase

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	100.0	~0.3	0.5	475

Likely container type comment: -

Range in container waste volume: Waste loading will be variable and dependant on nuclear material content of the wastes.Assume 3:2 Z6033 to 500L drum ratio. Assume Z6033 loading @ 0.2m3 =0.6m3 in 2 500L drums (1m3) = 0.3m3 per 500L drum.

Other information on containers: -

Likely conditioning matrix: Cement

Other information: -

Conditioned density (t/m^3): ~2.5

Conditioned density comment: Density is if waste is grouted directly into 500 litre drums. Assume density similar to CHILW repack.

Other information on conditioning: -

Opportunities for alternative disposal routing: Not yet determined

WASTE STREAM 5B03 Operational RHILW

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 and contaminated fuel element debris and cladding and contaminated redundant equipment and tools.
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:	The specific activity data has been derived from LoC data.
Other information:	Specific Activity uses UKRWI 2019 data decayed to 2022.

WASTE STREAM 5B03 Operational RHILW

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	9.45E-02	B B 2			Gd 153				
Be 10	5.48E-07	B B 2			Ho 163				
C 14	1.02E-02	B B 2			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	1.44E-05	B B 2			Pt 193				
Mn 53	8.76E-03	B B 2			Tl 204				
Mn 54	6.64E-09	B B 2			Pb 205				
Fe 55	8.90E-02	B B 2			Pb 210	6.17E-13	B B 2		
Co 60	8.05E+00	B B 2			Bi 208				
Ni 59	3.41E-02	B B 2			Bi 210m				
Ni 63	9.04E+00	B B 2			Po 210	5.67E-13	B B 2		
Zn 65	6.58E-14	B B 2			Ra 223	4.69E-11	B B 2		
Se 79	1.84E-05	B B 2			Ra 225	3.61E-09	B B 2		
Kr 81					Ra 226	3.77E-12	B B 2		
Kr 85					Ra 228	5.97E-17	B B 2		
Rb 87					Ac 227	4.74E-11	B B 2		
Sr 90	1.09E+00	B B 2			Th 227	4.64E-11	B B 2		
Zr 93	1.68E-04	B B 2			Th 228	1.02E-09	B B 2		
Nb 91					Th 229	3.62E-09	B B 2		
Nb 92					Th 230	1.02E-09	B B 2		
Nb 93m	4.06E-02	B B 2			Th 232	1.22E-16	B B 2		
Nb 94	3.17E-03	B B 2			Th 234	1.04E-05	B B 2		
Mo 93	1.89E-02	B B 2			Pa 231	1.95E-10	B B 2		
Tc 97					Pa 233	5.98E-06	B B 2		
Tc 99	9.09E-04	B B 2			U 232				
Ru 106	1.13E-06	B B 2			U 233	1.82E-06	B B 2		
Pd 107					U 234	7.98E-06	B B 2		
Ag 108m	1.47E-04	B B 2			U 235	4.99E-07	B B 2		
Ag 110m	2.40E-13	B B 2			U 236	2.4E-07	B B 2		
Cd 109					U 238	1.04E-05	B B 2		
Cd 113m	1.31E-03	B B 2			Np 237	6.00E-06	B B 2		
Sn 119m					Pu 236				
Sn 121m					Pu 238	8.87E-02	B B 2		
Sn 123					Pu 239	4.19E-01	B B 2		
Sn 126	3.32E-05	B B 2			Pu 240	3.89E-01	B B 2		
Sb 125	7.66E-04	B B 2			Pu 241	6.17E+00	B B 2		
Sb 126	4.64E-06	B B 2			Pu 242	3.38E-04	B B 2		
Te 125m	1.92E-04	B B 2			Am 241	6.27E-01	B B 2		
Te 127m					Am 242m	5.84E-02	B B 2		
I 129	1.55E-06	B B 2			Am 243	5.69E-04	B B 2		
Cs 134	3.20E-04	B B 2			Cm 242	4.81E-02	B B 2		
Cs 135	2.90E-05	B B 2			Cm 243	2.88E-03	B B 2		
Cs 137	3.17E+00	B B 2			Cm 244	2.26E-01	B B 2		
Ba 133					Cm 245	7.95E-06	B B 2		
La 137					Cm 246	7.94E-07	B B 2		
La 138					Cm 248				
Ce 144	3.49E-10	B B 2			Cf 249				
Pm 145					Cf 250				
Pm 147	5.70E-03	B B 2			Cf 251				
Sm 147	1.64E-11	B B 2			Cf 252				
Sm 151	1.23E-01	B B 2			Other a				
Eu 152	8.14E-02	B B 2			Other b/g				
Eu 154	3.71E-02	B B 2			**Total a**	**1.80E+00**	**B B 2**	**0**	
Eu 155	1.58E-02	B B 2			**Total b/g**	**2.81E+01**	**B B 2**	**0**	

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