WASTE STREAM 5C52 Processed Remote Handled ILW

SITE Harwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	219.2 m^3
Total future arisings:		0 m^3
Total waste volume:		219.2 m^3

Comment on volumes: This waste stream represents wastes that have been packaged into 500 litre drums awaiting cement encapsulation. Once encapsulated, the waste drums will be stored at Harwell until such time as a GDF is available, when they will be exported to GDF. Volume updated to account for all 548 drums held at a nominal 0.4m3 per drum

Uncertainty factors on volumes:

Stock (upper):	x 1.1	Arisings (upper)	x
Stock (lower):	x 0.9	Arisings (lower)	x

WASTE SOURCE Packaging of RHILW streams: principally 5C30, also 6C32, 5C54, 5G25, and 5C318. Future arisings will also include 5G04 , with possibly (parts of) 5C306, 5C308, and 5C310.

PHYSICAL CHARACTERISTICS

General description: Laboratory/cell wastes, sources, cut-up experimental rigs, glassware and concrete. The RHILW is varied in nature, but has all been size reduced to allow import into the facility; <50 litres and <100kg. Larger items may be disassembled as necessary to facilitate grout infiltration. In future, problem wastes (e.g. bulk particulate) will be separately conditioned in small containers before adding to the waste package; currently these are being retained.

Physical components (%vol): Mild and Stainless Steel Containers (40%), cell waste (30%), filter residues (9%), support structures (8%), pipework (4%), swabs (3%), misc particulate material (2%), electrical equipment (1%), manipulator parts (1%), swarf (1%), tools (1%), sealed sources.

Sealed sources: The waste contains sealed sources. Unknown exact details

Bulk density (t/m^3): ~1

Comment on density: Mass/ volume of stored drums. The density will vary according to the wastes being processed at any particular time. This value is low as some drums are incompletely filled.

CHEMICAL COMPOSITION

General description and components (%wt): Ferrous metal (48.5%), plastics/rubber (18.9%), aluminium (6%), lead (6%), cellulose (8.6%), inert inorganics including glass (2.7%), inorganic chemicals (1%), other metals (~2.3%), concrete/sand/cement (6%).

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Variable
C-14: Activation products
Ra: Variable
Th: Variable
U: Variable
Np: Variable
Pu: Variable

Metals and alloys (%wt): No additional information available.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	21.1	Where grade of stainless is specified, it is 18/8/1.	
Other ferrous metals.....	26.2	Other ferrous metals include 2.2% machine steel.	
Iron.....	1.2		

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Aluminium	6.0	Where specified, Al is BS1471/N4 or BS1470/1050A.
Beryllium		
Cobalt	TR	
Copper	1.6	
Lead	6.0	
Magnox/Magnesium	TR	
Nickel	TR	
Titanium		
Uranium	0.40	
Zinc	<0.10	
Zircaloy/Zirconium	TR	
Other metals	0.30	Traces of Ag, W, Cd, Cr

Organics (%wt): All unspecified plastic is assumed to be halogenated. Where specified, halogenated plastic is PVC. No detail available on rubbers.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	8.6		
Paper, cotton	4.2		
Wood	4.4		
Halogenated plastics	15.4		
Total non-halogenated plastics	2.8		
Condensation polymers	1.3		
Others	1.5		
Organic ion exchange materials	0		
Total rubber	0.70		
Halogenated rubber	0.10		
Non-halogenated rubber	0.60		
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	TR	wax	

Other materials (%wt): Traces of silicon, silicon carbide, magnesium and uranium oxides, carbon, vermiculite, grit all present.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	1.1		
Cementitious material	6.0		

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Sand.....		
Glass/Ceramics.....	2.5	
Graphite.....	0.04	
Desiccants/Catalysts.....		
Asbestos.....	0	Exact data unavailable
Non/low friable.....		
Moderately friable.....		
Highly friable.....		
Free aqueous liquids.....	0	
Free non-aqueous liquids.....	0	
Powder/Ash.....	<2.0	

Inorganic anions (%wt): Sulphate present as calcium sulphate, and other anions as consituents of cementitious materials

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

Materials of interest for waste acceptance criteria: Particulates <3mm limited to 3 litres per drum. Some drums currently contain >3 litres in separate cans, which will be removed for separate immobilisation prior to drum encapsulation.

	(%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.....		
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....		

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Soluble solids as bulk chemical compounds.....

Hazardous substances / non hazardous pollutants: Cadmium is present and it is yet to be assessed if this will cause some of the waste to be designated as hazardous. Lead is present, but is believed to be bulk metal only.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		

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Total complexing agents..... 0

Potential for the waste to contain discrete items: No. In & of itself not a DI; waste stream may include DIs as defined elsewhere (notably any stainless steel components)

PACKAGING AND CONDITIONING

Conditioning method: The stream represents waste that has been retrieved from storage tubes and is packaged in 500-litre enhanced drums. Some drums currently contain cans of particulate that will require removal and separate pretreatment (encapsulation) prior to bulk encapsulation.

Plant Name: Waste Encapsulation Plant (WEP)

Location: Harwell

Plant startup date: -

Total capacity (m^3/y incoming waste): ~~87.0

Target start date for packaging this stream: -

Throughput for this stream (m^3/y incoming waste): ~~87.0

Other information: The Plant has been constructed, and commissioning is complete. Throughput based upon 1300 drums (0.4m^3 prepared waste) being encapsulated in total plant lifetime. Plant will condition packaged wastes both direct from HEC, and retrieved from storage.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum (pre-cast annular)	100.0	0.4	0.4	548

Likely container type comment: The waste loading varies greatly according to the precise nature of the raw wastes. The above loading is the reference value for planning purposes.

Range in container waste volume: Significant variation in waste loading is expected, based upon the precise nature of the waste being packaged at any time and the limits applying to their contents.

Other information on containers: 316L stainless steel, with cement annulus.

Likely conditioning matrix: Pulverised Fly Ash / Ordinary Portland Cement

Other information: 3:1 PFA:OPC w/s 0.42

Conditioned density (t/m^3): ~2.0

Conditioned density comment: The density will vary according to the nature of individual drum contents

Other information on conditioning: -

Opportunities for alternative disposal routing: -

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

RADIOACTIVITY

Source: Activated and contaminated items from historic R&D activities on the Harwell site including

	standard sources and fuel samples.
Uncertainty:	Activities have been calculated from records in a Harwell waste database.
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:	Combination of consignor's declarations and fissile/ gamma counting on packaging. All inventories enhanced by applying fingerprints according to waste origin.
Other information:	Other beta/gamma not defined.

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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	7.35E-02	B B 2			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	1.96E-04	B B 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	4.68E-06	B B 2			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40	5.19E-05	B B 2			Hf 182		8		
Ca 41	6.3E-05	B B 2			Pt 193		8		
Mn 53		8			Tl 204	1.65E-07	B B 2		
Mn 54		8			Pb 205		8		
Fe 55	8.84E-05	B B 2			Pb 210	3.48E-06	B B 2		
Co 60	6.94E-02	B B 2			Bi 208		8		
Ni 59	8.9E-03	B B 2			Bi 210m		8		
Ni 63	4.46E-01	B B 2			Po 210	3.42E-06	B B 2		
Zn 65		8			Ra 223	2.11E-06	B B 2		
Se 79	1.83E-09	B B 2			Ra 225		8		
Kr 81		8			Ra 226	7.07E-06	B B 2		
Kr 85	1.76E-03	B B 2			Ra 228	2.36E-07	B B 2		
Rb 87		8			Ac 227	2.1E-06	B B 2		
Sr 90	2.36E+00	B B 2			Th 227	2.08E-06	B B 2		
Zr 93	8.46E-04	B B 2			Th 228	4.63E-07	B B 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.51E-05	B B 2		
Nb 93m	2.44E-03	B B 2			Th 232	2.82E-07	B B 2		
Nb 94	1.3E-03	B B 2			Th 234	4.72E-05	B B 2		
Mo 93	4.85E-05	B B 2			Pa 231		8		
Tc 97		8			Pa 233	3.16E-05	B B 2		
Tc 99	2.14E-04	B B 2			U 232	2.44E-07	B B 2		
Ru 106	6.94E-09	B B 2			U 233	8.41E-07	B B 2		
Pd 107		8			U 234	7.95E-05	B B 2		
Ag 108m	2.1E-02	B B 2			U 235	2.04E-06	B B 2		
Ag 110m		8			U 236	3.16E-07	B B 2		
Cd 109		8			U 238	4.72E-05	B B 2		
Cd 113m	5.85E-02	B B 2			Np 237	3.16E-05	B B 2		
Sn 119m		8			Pu 236		8		
Sn 121m	9.92E-03	B B 2			Pu 238	3.54E-01	B B 2		
Sn 123		8			Pu 239	1.12E-02	B B 2		
Sn 126	1.3E-06	B B 2			Pu 240	1.00E-02	B B 2		
Sb 125	1.18E-03	B B 2			Pu 241	2.22E-01	B B 2		
Sb 126	1.82E-07	B B 2			Pu 242	2.17E-05	B B 2		
Te 125m	2.95E-04	B B 2			Am 241	1.56E-01	B B 2		
Te 127m		8			Am 242m	6.61E-05	B B 2		
I 129	1.32E-04	B B 2			Am 243	8.52E-05	B B 2		
Cs 134	1.29E-05	B B 2			Cm 242	5.46E-05	B B 2		
Cs 135	2.01E-03	B B 2			Cm 243	3.06E-06	B B 2		
Cs 137	7.03E-01	B B 2			Cm 244	5.74E-03	B B 2		
Ba 133	8.21E-07	B B 2			Cm 245	1.66E-09	B B 2		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250	4.03E-09	B B 2		
Pm 147	7.15E-05	B B 2			Cf 251		8		
Sm 147		8			Cf 252	6.01E-08	B B 2		
Sm 151	1.20E-02	B B 2			Other a				
Eu 152	8.46E-02	B B 2			Other b/g				
Eu 154	1.66E-02	B B 2			**Total a**	**5.37E-01**	**B B 2**	**0**	
Eu 155	8.46E-03	B B 2			**Total b/g**	**4.11E+00**	**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