WASTE STREAM 5C52/C Encapsulated 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

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	11.2 m³	16.0 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		11.2 m³	16.0 m³
Number of waste packages in stock:	At 1.4.2022.....	28 package(s)	

Comment on volumes: This waste stream represents wastes that have been packaged into 500 litre drums and have been cement 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 28 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

Bulk density (t/m³): ~2

Comment on density: Conditioned density

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.

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	(%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	2.2% machine steel.	
Iron	1.2		
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.

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	(%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		
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	

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Non-putrescible wastes.....	
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0
Higher activity particles.....	
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.....		

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. Grouted drums are considered to be DIs

PACKAGING AND CONDITIONING

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	28

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.

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: -

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