WASTE STREAM 5C30 Harwell 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.....	40.1 m^3
Total future arisings:		0 m^3
Total waste volume:		40.1 m^3

Comment on volumes: Some processing carried out which has resulted in a change in waste volume since UK RWI 2013. An additional 12m3 has been added for new waste found in the form of water/sludge which will be retrieved and processed along with the legacy waste. Volume is that of the waste cans outer containers, which by default are part of the waste stream. Voidage within is variable and difficult to estimate. The waste is contained in steel or stainless steel containers. Wherever possible the empty containers are size reduced and consigned as LLW. Any cans whose contents and dose rates have decayed to levels commensurate with LLW disposal may also be diverted to that route. The overall percentage of diverted wastes is small and it is not practicable to reliably estimate the volume of waste diverted in this way.

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

WASTE SOURCE Operational solid wastes from research reactors and active cells performing a wide variety of tasks, including fuel examination, source production and others. Redundant sources, notably Co60, Am/Be and Pu238. This waste represents legacy ILW in storage tubes. In addition there has been water/sludge found inside some of the tubes.

PHYSICAL CHARACTERISTICS

General description:	Laboratory/ cell wastes, sources, cut-up experimental rigs, glassware and concrete. Most wastes in cans (max 50 litres). Once retrieved the waste is re-classified as either stream 5C52 or 5C318 as appropriate. Some acids/ alkalis/ oxidants/reductants may be present, but bulk of waste is inert. Some wastes (including liquids) have been cemented or encapsulated in polymer. Some solids have been subject to low-force compaction.
Physical components (%vol):	Miscellaneous canned wastes (95%), bulk items (5%).
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m^3):	~0.8
Comment on density:	Estimate- mass data not available for many items.

CHEMICAL COMPOSITION

General description and components (%wt):	Ferrous metal (>21%), other metals (<38%), plastics (<16%), cellulose(<12%) and others. Note that this does not include the steel containers, most of which are diverted to LLW.
Chemical state:	Neutral
Chemical form of radionuclides:	H-3: H3 is principally present as a metal activation product with some absorption from D2O/H3 gas C-14: C-14 is associated with labelled organic compounds and activation of metals Ra: Radium may be present in a variety of forms, principally oxide, nitrate and sulphate. Th: Thorium is principally present as metal or oxide and in irradiated fuel. U: Uranium may be present in a variety of forms, principally oxide, metal and fuel. Pu: Plutonium may be present in a variety of forms, principally oxide and metal fuel.
Metals and alloys (%wt):	Metal is present in a large range of thicknesses.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	P	The identity of steels/other alloys is unknown.	
Other ferrous metals	~21.0		
Iron			
Aluminium	~33.0		
Beryllium			
Cobalt			
Copper	~0.40		
Lead	~0.60		
Magnox/Magnesium	TR		
Nickel			
Titanium			
Uranium	<0.01		
Zinc	TR		
Zircaloy/Zirconium	~0.50		
Other metals	~4.0	Other metals include uranium, europium, cobalt, magnesium, tin, nickel and trace mercury.	

Organics (%wt): Other organics comprise wax and bitumen. Halogenated plastics present are PVC and PTFE, and the rubbers are neoprene and hypalon. No detail is available on percentages

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	~12.0		
Paper, cotton	~11.8		
Wood	~0.20		
Halogenated plastics	<13.0		
Total non-halogenated plastics	<9.9		
Condensation polymers	~0.40		
Others	<9.5		
Organic ion exchange materials	~0.03		
Total rubber	<0.50		
Halogenated rubber	<0.25		
Non-halogenated rubber	<0.25		
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	<0.10		

Other materials (%wt): Other inert inorganics present include vermiculite and Mor-dri (~.4%)

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	P		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	~2.0		
Sand.....			
Glass/Ceramics.....	~1.7		
Graphite.....	~1.0		
Desiccants/Catalysts.....			
Asbestos.....	~0	Exact data unavailable	
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	<0.01		
Free non-aqueous liquids.....	<0.01		
Powder/Ash.....	P		

Inorganic anions (%wt): Chlorides are present as eutectic powder.

	(%wt)	Type(s) and comment
Fluoride.....	<0.01	
Chloride.....	<1.0	
Iodide.....	<0.01	
Cyanide.....	NE	
Carbonate.....	<0.10	
Nitrate.....	<0.10	
Nitrite.....	<0.10	
Phosphate.....	<0.10	
Sulphate.....	<0.10	
Sulphide.....	<0.10	

Materials of interest for waste acceptance criteria: Combustible/ pyrophoric metals comprise finely divided metals, possibly reactive ones. Free liquids will be immobilised in cement before packaging. There are trace levels of asbestos present in the waste. Powders are present principally from degradation of plastics and corrosion of mild steel. Cans retrieved to date contain <<1% on average.

	(%wt)	Type(s) and comment
Combustible metals.....	<0.10	
Low flash point liquids.....	<0.01	
Explosive materials.....	<0.01	
Phosphorus.....	<0.01	
Hydrides.....	<0.01	
Biological etc. materials.....	<0.01	
Biodegradable materials.....	0.01	
Putrescible wastes.....	<0.01	

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Non-putrescible wastes.....	
Corrosive materials.....	<0.01
Pyrophoric materials.....	<0.01
Generating toxic gases.....	<0.01
Reacting with water.....	<0.01
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: Cadmium (0.02vol%)and beryllium (0.003vol%) are present in massive form or part of other materials. Mercury/ mercuric compounds are present in <5 cans. Lead is thought only to be present as bulk metal, in which form it does not require consideration as special waste.

	(%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): Yes

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

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 waste is removed from its storage cans and packaged into enhanced 500 litre drums. At this point it is reclassed as 5C52 and stored pending availability of the conditioning plant. A proportion of the waste stream, including the cans, may be reclassified as CHILW/ LLW and processed accordingly. Wastes not meeting acceptance criteria and requiring additional treatment (WRATs) is re-classified as stream 5C318.

Plant Name: Head End Cells (HEC)

Location: Harwell

Plant startup date: 2002

Total capacity (m^3/y incoming waste): ~24.0

Target start date for packaging this stream: 2002

Throughput for this stream (m^3/y incoming waste): ~24.0

Other information: Reference plans are to complete waste packaging by 2023, increasing throughput annually. See 5C52 for details of conditioning plant.

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	101

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. Drums packed to date have averaged ~0.4m3.

Range in container waste volume: Significant variation in waste loading is expected, based upon the precise nature of the wastes being packaged at any time, and 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: Density will vary according to nature of individual drum contents.

Other information on conditioning: -

Opportunities for alternative disposal routing: -

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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:	Data has been re-evaluated and allows for decay. However, most still relies on the accuracy of original information, dating back as far as 1950s, which often does not include all potentially significant radioisotopes. Thus it is difficult to estimate the level of uncertainty, particularly of minor isotopes.
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:	Variety of techniques according to waste type/ source and time of consignment. Typically based on gamma dose measurements and/ or fuel/ item masses where appropriate.
Other information:	-

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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	6.33E-02	C C 2			Gd 153	3.58E-05	B B 2		
Be 10	1.12E-03	B C 2			Ho 163		8		
C 14	8.26E-06	C C 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	9.63E-05	B B 2			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	1.29E-05	B B 2			Pt 193		8		
Mn 53		8			Tl 204	6.76E-08	B C 2		
Mn 54	3.23E-05	C C 2			Pb 205	<1.31E-06	B 3		
Fe 55	3.15E-01	B B 2			Pb 210	3.83E-03	B C 2		
Co 60	3.25E+01	B B 2			Bi 208		8		
Ni 59	1.05E-01	B B 2			Bi 210m		8		
Ni 63	6.6E+00	B B 2			Po 210	3.8E-03	C C 2		
Zn 65	5.31E-09	B C 2			Ra 223	7.43E-05	C C 2		
Se 79	1.28E-08	C C 2			Ra 225	2.80E-06	C C 2		
Kr 81		8			Ra 226	5.38E-03	C C 2		
Kr 85	1.99E-01	B B 2			Ra 228	2.43E-08	B C 2		
Rb 87	3.57E-08	C C 2			Ac 227	7.40E-05	C C 2		
Sr 90	7.07E+00	B C 2			Th 227	7.31E-05	C C 2		
Zr 93	1.59E-03	B B 2			Th 228	1.36E-05	C C 2		
Nb 91		8			Th 229	2.82E-06	C C 2		
Nb 92		8			Th 230	4.56E-07	B C 2		
Nb 93m	1.30E-03	B B 2			Th 232	3.27E-08	B C 2		
Nb 94	4.46E-03	B B 2			Th 234	3.17E-05	C C 2		
Mo 93	3.22E-04	B C 2			Pa 231	7.70E-09	B C 2		
Tc 97		8			Pa 233	1.52E-06	C C 2		
Tc 99	4.43E-03	B B 2			U 232	1.25E-05	B C 2		
Ru 106	2.38E-06	B B 2			U 233	3.31E-03	B C 2		
Pd 107	2.63E-09	C C 2			U 234	2.02E-04	B C 2		
Ag 108m	3.39E-05	B B 2			U 235	4.73E-06	B C 2		
Ag 110m	2.47E-09	B B 2			U 236	4.47E-07	B C 2		
Cd 109	2.13E-06	B B 2			U 238	3.17E-05	B C 2		
Cd 113m	1.82E+00	B B 2			Np 237	1.53E-06	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	3.00E-01	C C 2			Pu 238	5.47E-02	C C 2		
Sn 123		8			Pu 239	2.03E-02	C C 2		
Sn 126	2.45E-08	B C 2			Pu 240	1.75E-02	C C 2		
Sb 125	<6.02E-03	C 3			Pu 241	5.30E-01	C C 2		
Sb 126	3.43E-09	C C 2			Pu 242	4.53E-04	C C 2		
Te 125m	1.51E-03	C C 2			Am 241	9.90E-02	C C 2		
Te 127m		8			Am 242m	5.15E-07	B C 2		
I 129	7.71E-06	B B 2			Am 243	1.22E-04	C C 2		
Cs 134	6.80E-04	B B 2			Cm 242	4.25E-07	C C 2		
Cs 135	2.45E-04	B C 2			Cm 243	1.63E-05	C C 2		
Cs 137	1.68E+01	B B 2			Cm 244	1.22E-03	C C 2		
Ba 133	2.3E-07	B B 2			Cm 245	7.36E-09	B C 2		
La 137		8			Cm 246	2.01E-09	B C 2		
La 138		8			Cm 248		8		
Ce 144	6.92E-07	B B 2			Cf 249	4.99E-09	B C 2		
Pm 145		8			Cf 250	1.31E-07	B C 2		
Pm 147	1.28E-02	B B 2			Cf 251	1.19E-09	B C 2		
Sm 147		8			Cf 252	1.33E-06	C C 2		
Sm 151	2.82E-04	B B 2			Other a				
Eu 152	6.69E+00	B B 2			Other b/g				
Eu 154	<1.58E+01	C 3			**Total a**	**2.06E-01**	**C C 2**	**0**	
Eu 155	<7.75E-01	C 3			**Total b/g**	**8.96E+01**	**C C 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