WASTE STREAM 5C306 DIDO Reactor Decommissioning 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.....	0 m³
Future arisings -	1.4.2040 - 31.3.2054.....	60.0 m³
Total future arisings:		60.0 m³
Total waste volume:		60.0 m³

Comment on volumes:	Volumes updated for 2016 RWI to reflect SMART Inventory review			
Uncertainty factors on volumes:	Stock (upper):	x	Arisings (upper)	x 1.2
	Stock (lower):	x	Arisings (lower)	x 0.8

WASTE SOURCE Decommissioning of a 26MW(T) reactor in steel containment building with heavy water moderator.

PHYSICAL CHARACTERISTICS

General description:	Graphite reflector, steel tanks and pipework, iron-shot concrete and cadmium sheet. Large items will be broken down during decommissioning.
Physical components (%vol):	Graphite reflector (32%), top shield plug (7%), reactor aluminium tanks RATS (1%), reflector steel tank (3%), annular shield (7%) and concrete biological shield (50%).
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m³):	3.1
Comment on density:	Estimated density for material types

CHEMICAL COMPOSITION

General description and components (%wt):	The waste will be dominated by the biological shield. Barytes concrete (54% including steel), other steel (6%), graphite (16%), aluminium (4%), iron shot concrete (19%), cast iron (1%) and cadmium (~0.1%)
Chemical state:	Neutral
Chemical form of radionuclides:	H-3: Tritium is present as an activation product in the graphite and concrete. C-14: C-14 is present as an activation product in the graphite. Cl-36: Cl-36 activation product in the graphite and concrete
Metals and alloys (%wt):	Metal is present in a large range of thicknesses.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~6.0		
Other ferrous metals.....			
Iron.....	~1.0	Cast iron	
Aluminium.....	~4.0		
Beryllium.....			
Cobalt.....			
Copper.....			
Lead.....	NE		
Magnox/Magnesium.....	0		
Nickel.....			
Titanium.....			

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Uranium	
Zinc	
Zircaloy/Zirconium	0
Other metals	

Organics (%wt): -

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

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	~73.0	Barytes concrete (54% including steel), iron shot concrete (19%),	
Sand			
Glass/Ceramics	0		
Graphite	16.0		
Desiccants/Catalysts			
Asbestos	NE		
Non/low friable			
Moderately friable			
Highly friable			
Free aqueous liquids	0		

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Free non-aqueous liquids.....	0
Powder/Ash.....	0

Inorganic anions (%wt): -

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

Materials of interest for waste acceptance criteria: Asbestos may be present.

	(%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.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: Cadmium (< 1%).

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		

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Styrene.....	
Tri-butyl phosphate.....	
Other organophosphates.....	
Vinyl chloride.....	
Arsenic.....	
Barium.....	
Boron.....	0
Boron (in Boral).....	
Boron (non-Boral).....	
Cadmium.....	~0.10
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.....		
Total complexing agents.....		

Potential for the waste to contain discrete items: Yes. Graphite Bricks/Tiles assumed to be DIs; may also include some HDRIs (e.g. steel pins)Large Concrete Items (LCIs) may be DIs; drummed (ungrouted)/"rubbleised" wastes assumed Not DIs. Note - LCIs with embedded metals may also be DIs within DIs, depends on specific circumstances/waste form.Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs; Stainless items assumed DIs

PACKAGING AND CONDITIONING

Conditioning method:	The waste will be packaged into 6m3 boxes and placed in long-term storage in the Harwell ILW Store
Plant Name:	Dido ILW Processing Plant
Location:	Harwell
Plant startup date:	2040

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

Target start date for packaging this stream: 2040

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

Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
6m^3 concrete box (SD)	100.0	2.06	5.8	30

Likely container type comment: -

Range in container waste volume: Average waste volume will be ~2 m3, but could range from 0.7 to 2.8 m3.

Other information on containers: The components of Dido have different activities and densities which effects the number of packages required. The aluminium tanks, steel tank and top shield plug are restricted by activity and the graphite, annular shield and concrete bio-shield by volume or weight.

Likely conditioning matrix: Pulverised Fly Ash / Ordinary Portland Cement

Other information: -

Conditioned density (t/m^3): ~2.6

Conditioned density comment: -

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 reactor structure and components. Co-60 from irradiated steel.

Uncertainty: Expected that waste will comprise primarily of beta/gamma emitting radionuclides. Alpha emitting radionuclides may be present but they are expected to be in small quantities.

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: -

Other information: -

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3			4.72E-02	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			3.84E-03	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			1.68E-04	C C 2	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41				8	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55			2.01E-04	C C 2	Pb 210				8
Co 60			2.26E-02	C C 2	Bi 208				8
Ni 59				8	Bi 210m				8
Ni 63			1.06E+00	C C 2	Po 210				8
Zn 65				8	Ra 223				8
Se 79				8	Ra 225				8
Kr 81				8	Ra 226				8
Kr 85				8	Ra 228				8
Rb 87				8	Ac 227				8
Sr 90				8	Th 227				8
Zr 93				8	Th 228				8
Nb 91				8	Th 229				8
Nb 92				8	Th 230				8
Nb 93m				8	Th 232				8
Nb 94				8	Th 234				8
Mo 93				8	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99				8	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m				8	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				8
Cd 113m			3.29E-04	C C 2	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m				8	Pu 238				8
Sn 123				8	Pu 239				8
Sn 126				8	Pu 240				8
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				8	Cm 244				8
Ba 133			1.51E-03	C C 2	Cm 245				8
La 137				8	Cm 246				8
La 138				8	Cm 248				8
Ce 144				8	Cf 249				8
Pm 145				8	Cf 250				8
Pm 147				8	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151			3.55E-06	C C 2	Other a				
Eu 152			2.18E-03	C C 2	Other b/g				
Eu 154			2.62E-04	C C 2	**Total a**	**0**		**0**	
Eu 155				8	**Total b/g**	**0**		**1.14E+00**	**C C 2**

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