WASTE STREAM 5C308 PLUTO 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.....	47.0 m³
Total future arisings:		47.0 m³
Total waste volume:		47.0 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 26 MW(T) reactor in steel containment building with heavy water moderator.

PHYSICAL CHARACTERISTICS

General description: Graphite reflector, aluminium tanks and pipework, steel tanks and pipework, iron-shot concrete, cadmium sheet and lead. Large items will be broken down during decommissioning.

Physical components (%vol): Biological shield (54%), reactor aluminium tanks (7%), graphite reflector (20%), iron shot concrete (16%), steels 4%.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~3.4

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 including steel (54%), graphite (~10%), aluminium (5%), steel/other metals (9%) and iron shot concrete (22%).

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 and concrete.
Cl-36: Cl-36 is present as an activation product of impurities in the graphite and concrete

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~5.0		
Other ferrous metals.....	~4.0		
Iron.....			
Aluminium.....	<5.0		
Beryllium.....			
Cobalt.....			
Copper.....	NE		
Lead.....	P		
Magnox/Magnesium.....	NE		
Nickel.....			

WASTE STREAM 5C308 PLUTO Reactor Decommissioning ILW

Titanium		
Uranium		
Zinc	NE	
Zircaloy/Zirconium	NE	
Other metals	P	Other metals include cadmium.

Organics (%wt): -

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

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	NE		
Inorganic sludges and flocs	NE		
Soil	NE		
Brick/Stone/Rubble	NE		
Cementitious material	~76.0	Barytes concrete including steel (54%), iron shot concrete (22%).	
Sand			
Glass/Ceramics	NE		
Graphite	~10.0		
Desiccants/Catalysts			
Asbestos	NE		
Non/low friable			
Moderately friable			
Highly friable			

WASTE STREAM 5C308 PLUTO Reactor Decommissioning ILW

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

Inorganic anions (%wt): -

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

Materials of interest for waste acceptance criteria: Lead is present in an unspecified amount in the waste. There is 0.1 t of cadmium sheet. Cadmium (<<1%).

	(%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: -

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

WASTE STREAM 5C308 PLUTO Reactor Decommissioning ILW

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):

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

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:	Waste will be encapsulated into 6m3 boxes and placed in long-term storage in the Harwell ILW Store
Plant Name:	Pluto ILW Processing Plant
Location:	Harwell

WASTE STREAM 5C308 PLUTO Reactor Decommissioning ILW

Plant startup date: 2040

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	2.36	5.8	20

Likely container type comment: -

Range in container waste volume: 0.7 to 5.5 m3

Other information on containers: Stainless steel and concrete.

Likely conditioning matrix: Pulverised Fly Ash / Ordinary Portland Cement

Other information: Expected to range from 1.7 to 2.7 t/m3

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, including Fe-55 and Co-60 from irradiated steel.

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: Specific activity for the future arising was calculated based on the original inventory for the structural components of Pluto and on the known operational history and the flux rates of the reactors. Specific activities were calculated from values given in 2013 CLOC submission.

Other information: -

WASTE STREAM 5C308 PLUTO Reactor Decommissioning ILW

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			4.54E-02	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			2.11E-03	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			9.52E-05	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			1.68E-04	C C 2	Pb 210				8
Co 60			2.62E-02	C C 2	Bi 208				8
Ni 59			4.15E-04	C C 2	Bi 210m				8
Ni 63			1.51E+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			3.44E-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			1.59E-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			2.12E-06	C C 2	Other a				
Eu 152			2.03E-03	C C 2	Other b/g				
Eu 154			1.66E-04	C C 2	**Total a**	**0**		**0**	
Eu 155				8	**Total b/g**	**0**		**1.59E+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