

WASTE STREAM	5C308	PLUTO Reactor Decommissioning ILW
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SITE Harwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m ³
Future arisings -	1.4.2023 - 31.3.2024.....	47.0 m ³
Total future arisings:		47.0 m ³
Total waste volume:		47.0 m ³

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: -

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):

Stainless steel.....	~5.0
Other ferrous metals.....	~4.0
Iron.....	
Aluminium.....	<5.0
Beryllium.....	
Cobalt.....	
Copper.....	NE
Lead.....	P
Magnox/Magnesium.....	NE
Nickel.....	
Titanium.....	
Uranium.....	
Zinc.....	NE

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	Zircaloy/Zirconium.....	NE	
	Other metals.....	P	Other metals include cadmium.
Organics (%wt):	-		
	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):	-		
	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.....		
	Free aqueous liquids.....	0	
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	
Inorganic anions (%wt):	-		

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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%).

Combustible metals.....	*0
Low flash point liquids.....	*0
Explosive materials.....	*0
Phosphorus.....	*0
Hydrides.....	*0
Biological etc. materials.....	*0
Biodegradable materials.....	
Putrescible wastes.....	*0
Non-putrescible wastes.....	
Corrosive materials.....	*0
Pyrophoric materials.....	*0
Generating toxic gases.....	*0
Reacting with water.....	*0
Active particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants:

-
Acrylamide.....
Benzene.....
Chlorinated solvents.....
Formaldehyde.....
Organometallics.....
Phenol.....
Styrene.....
Tri-butyl phosphate.....
Other organophosphates.....
Vinyl chloride.....
Arsenic.....
Barium.....
Boron.....

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- 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):

- EDTA.....
- DPTA.....
- NTA.....
- Polycarboxylic acids.....
- Other organic complexants.....
- Total complexing agents..... NE

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

Plant startup date: 2023

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: 2023

Throughput for this stream (m³/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

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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/m³): ~2.6

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	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: -

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			1.18E-01	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			1.25E-02	C C 2	Pb 210				8
Co 60			2.45E-01	C C 2	Bi 208				8
Ni 59			4.15E-04	C C 2	Bi 210m				8
Ni 63			1.7E+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			8.13E-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			4.84E-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			2.42E-06	C C 2	Other a				
Eu 152			4.86E-03	C C 2	Other b/g				
Eu 154			6.53E-04	C C 2	Total a	0	0		
Eu 155				8	Total b/g	0	2.09E+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