

<b>WASTE STREAM</b>	<b>7A115</b>	<b>Decommissioning LLW - Plutonium</b>
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**SITE** AWE Aldermaston

**SITE OWNER** Ministry of Defence

**WASTE CUSTODIAN** AWE plc

**WASTE TYPE** LLW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	404.0 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2024.....	635.0 m <sup>3</sup>
	1.4.2025 - 31.3.2027.....	1453.0 m <sup>3</sup>
	1.4.2028 - 31.3.2030.....	1662.0 m <sup>3</sup>
	1.4.2031 - 31.3.2033.....	1279.0 m <sup>3</sup>
	1.4.2034 - 31.3.2036.....	1038.0 m <sup>3</sup>
	1.4.2037 - 31.3.2039.....	1125.0 m <sup>3</sup>
	1.4.2040 - 31.3.2052.....	0 m <sup>3</sup>
	1.4.2053 - 31.3.2055.....	168.0 m <sup>3</sup>
	1.4.2056 - 31.3.2058.....	172.0 m <sup>3</sup>
	1.4.2059 - 31.3.2062.....	0 m <sup>3</sup>
	1.4.2063 - 31.3.2065.....	155.0 m <sup>3</sup>
	1.4.2066 - 31.3.2068.....	155.0 m <sup>3</sup>
	1.4.2069 - 31.3.2071.....	218.0 m <sup>3</sup>
	1.4.2072 - 31.3.2074.....	344.0 m <sup>3</sup>
	1.4.2075 - 31.3.2077.....	344.0 m <sup>3</sup>
	1.4.2078 - 31.3.2080.....	0 m <sup>3</sup>
Total future arisings:		8748.0 m <sup>3</sup>
Total waste volume:		9152.0 m <sup>3</sup>

Comment on volumes: Future arisings are estimated based on the latest decommissioning plans for facilities on site. The total volume of arisings will depend on the longevity of the AWE site with estimates being based on a site closure date of 2080. The stock volumes are considered to be accurate. The total volume of waste from this waste stream is dependent on the longevity of the AWE site, with estimates based upon existing buildings and a site closure date of 2080.

Uncertainty factors on volumes: Stock (upper): x 1.0 Arisings (upper) x 5.0  
 Stock (lower): x 1.0 Arisings (lower) x 0.2

**WASTE SOURCE** The waste arises from plutonium decommissioning operations.

**PHYSICAL CHARACTERISTICS**

General description: Metal (64.93%), rubble (11.12%), plastics (11.15%), rubber (1.15%) cellulose (10.39%) and other (1.26%).

Physical components (%wt): Metal (64.93%), rubble (11.12%), plastics (11.15%), rubber (1.15%) cellulose (10.39%) and other (1.26%). Data reviewed in 2022.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 0.62

Comment on density: This figure has been derived using stock data from 2022 (total stream mass divided by the total stream volume).

**CHEMICAL COMPOSITION**

General description and components (%wt): Metal (64.93%), rubble (11.12%), plastics (11.15%), rubber (1.15%) cellulose (10.39%) and other (1.26%).

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Chemical state: Neutral

Chemical form of radionuclides: H-3: Not present in Waste Stream  
 C-14: Not present in Waste Stream  
 Cl-36: Not present in Waste Stream  
 Se-79: Not present in Waste Stream  
 Tc-99: Not present in Waste Stream  
 I-129: Not present in Waste Stream  
 Ra: Only daughter products present from uranium in this waste stream. Oxide form.  
 Th: Only daughter products present from uranium in this waste stream. Oxide form.  
 U: Present in Waste Stream as oxide form  
 Np: Np-237 likely to be present in waste stream in oxide form as daughter product of Am-241 alpha decay.  
 Pu: Present in Waste Stream as oxide form

Metals and alloys (%wt): The majority of decommissioning metal is sheets and pipes typically 4mm in thickness.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	11.2		
Other ferrous metals.....	49.4		
Iron.....	0		
Aluminium.....	2.6		
Beryllium.....	0		
Cobalt.....	0		
Copper.....	1.4	Includes cables	
Lead.....	0.26		
Magnox/Magnesium.....	0		
Nickel.....	0		
Titanium.....	0		
Uranium.....	0		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	0.16	Brass	

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	10.4		
Paper, cotton.....	2.8	Paper	
Wood.....	7.6		
Halogenated plastics .....	7.3	PVC	
Total non-halogenated plastics.....	3.9		
Condensation polymers.....	3.9		
Others.....	0		
Organic ion exchange materials....	0		
Total rubber.....	1.2		
Halogenated rubber .....	1.2		
Non-halogenated rubber.....	0		
Hydrocarbons.....	0		
Oil or grease .....	0		
Fuel.....	0		

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Asphalt/Tarmac (cont.coal tar)...	0
Asphalt/Tarmac (no coal tar).....	0
Bitumen.....	0
Others.....	0
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.....	0.07		
Brick/Stone/Rubble.....	11.1		
Cementitious material.....	0		
Sand.....	0		
Glass/Ceramics.....	1.0		
Graphite.....	0.07		
Desiccants/Catalysts.....	0		
Asbestos.....	<0.10	Form of asbestos is likely to be moderately / highly friable.	
Non/low friable.....	NE		
Moderately friable.....	NE		
Highly friable.....	NE		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): None

	(%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 is present in this waste stream

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	(%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.....	P	
Putrescible wastes.....	P	Potential for dead animals, but likely to have dried out.
Non-putrescible wastes.....	P	Paper and wood,
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....	0	
Soluble solids as bulk chemical compounds.....	0	

Hazardous substances / non hazardous pollutants:      Asbestos is present in this waste stream

	(%wt)	Type(s) and comment
Acrylamide.....	0	
Benzene.....	NE	
Chlorinated solvents.....		
Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	NE	
Styrene.....		
Tri-butyl phosphate.....	NE	
Other organophosphates.....	0	
Vinyl chloride.....	P	PVC
Arsenic.....	NE	
Barium.....	0	
Boron.....	NE	
Boron (in Boral).....	NE	
Boron (non-Boral).....	0	
Cadmium.....	NE	
Caesium.....	0	
Selenium.....	NE	
Chromium.....	NE	
Molybdenum.....	NE	
Thallium.....	0	
Tin.....	NE	

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Vanadium.....	NE
Mercury compounds.....	0
Others.....	NE
Electronic Electrical Equipment (EEE)	
EEE Type 1.....	0
EEE Type 2.....	0
EEE Type 3.....	0
EEE Type 4.....	0
EEE Type 5.....	0

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	TR	
Other organic complexants.....	TR	There are likely to be traces of complexing agents in this waste stream
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: No.

**TREATMENT, PACKAGING AND DISPOSAL**

Planned on-site / off-site treatment(s):

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)	Off-site	~5.0
Incineration	Off-site	~5.0
Solidification		
Decontamination		
Metal treatment	Off-site	~50.0
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None	Off-site	~40.0

Comment on planned treatments:

Planned treatment percentages have been estimated based on disposals of this waste stream made since 2019.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~5.0	~0.62
Expected to be consigned to a Landfill Facility	~40.0	~0.62
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	~5.0	<0.62
Expected to be consigned to a Metal Treatment Facility	~50.0	~0.62
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

Classification codes for waste expected to be consigned to a landfill facility:

170601, 170603, 170409, 170204, 170201, 170202, 170203, 170106, 170107

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**Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):**

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

**Opportunities for alternative disposal routing:** Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

**Waste Packaging for Disposal:**

Container	Stream volume %	Waste loading m <sup>3</sup>	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO			
1/2 Height IP-2 Disposal/Re-usable ISO	5.0	17	27
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: Drums would be supercompacted prior to transfer to the repository at LLWR.

**Waste Planned for Disposal at the LLW Repository:**

Container voidage: Voidage would be minimal as the HHISO would contain supercompacted pucks.

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).  
The waste has a current WCH.  
Inventory information is consistent with the current WCH.

Waste consigned for disposal to LLWR in year of generation: Yes.

**Non-Containerised Waste for In-Vault Grouting:** (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

**RADIOACTIVITY**

Source: Principal contamination is from plutonium, with low level uranium contamination present too.

Uncertainty: The gross alpha and gross beta activity of the in-stock waste is accurate. The radionuclide contributions have been generated from disposals undertaken in the last three years.

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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:

Isotopic declarations (fingerprints) are generated from the assay undertaken to pertinent buildings prior to decommissioning commencing. Assay methods include in-situ NDA analysis and sampling/destructive to ascertain relevant fingerprints. The associated fingerprint is used in addition to health physics probe or instrument (high resolution gamma-ray spectroscopy) measurements to derive individual nuclide activities.

Other information:

Decay nuclides with a half-life of less than three months have been omitted.

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210		5	5.68E-15	CC 2
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210		5	5.35E-15	CC 2
Zn 65					Ra 223		5	1.38E-13	CC 2
Se 79					Ra 225		5	1.36E-17	CC 2
Kr 81					Ra 226		5	2.66E-14	CC 2
Kr 85					Ra 228		5	1.6E-19	CC 2
Rb 87					Ac 227		5	1.39E-13	CC 2
Sr 90					Th 227		5	1.36E-13	CC 2
Zr 93					Th 228		5	1.36E-19	CC 2
Nb 91					Th 229		5	1.37E-17	CC 2
Nb 92					Th 230		5	4.94E-12	CC 2
Nb 93m					Th 232		5	2.36E-19	CC 2
Nb 94					Th 234		5	4.38E-09	CC 2
Mo 93					Pa 231		5	4.48E-13	CC 2
Tc 97					Pa 233		5	3.32E-10	CC 2
Tc 99					U 232				
Ru 106					U 233		5	1.77E-14	CC 2
Pd 107					U 234	2.14E-08	BB 2	2.16E-08	CC 2
Ag 108m					U 235	8.44E-10	BB 2	8.46E-10	CC 2
Ag 110m					U 236	1.84E-10	BB 2	2.01E-10	CC 2
Cd 109					U 238	4.38E-09	BB 2	4.38E-09	CC 2
Cd 113m					Np 237		5	3.34E-10	CC 2
Sn 119m					Pu 236				
Sn 121m					Pu 238	3.91E-06	BB 2	3.29E-06	CC 2
Sn 123					Pu 239	9.87E-05	BB 2	9.86E-05	CC 2
Sn 126					Pu 240	2.54E-05	BB 2	2.54E-05	CC 2
Sb 125					Pu 241	2.36E-04	BB 2	8.19E-05	CC 2
Sb 126					Pu 242	5.14E-09	BB 2	5.14E-09	CC 2
Te 125m					Am 241	3.93E-05	BB 2	4.3E-05	CC 2
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137					Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g				
Eu 154					<b>Total a</b>	<b>1.67E-04</b>	<b>BB 2</b>	<b>1.70E-04</b>	<b>CC 2</b>
Eu 155					<b>Total b/g</b>	<b>2.36E-04</b>	<b>BB 2</b>	<b>8.19E-05</b>	<b>CC 2</b>

**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