

WASTE STREAM	7A27	Operational LLW - Plutonium
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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.....	226.0 m ³
Future arisings -	1.4.2022 - 31.3.2024.....	104.0 m ³
	1.4.2025 - 31.3.2027.....	244.0 m ³
	1.4.2028 - 31.3.2030.....	241.0 m ³
	1.4.2031 - 31.3.2033.....	221.0 m ³
	1.4.2034 - 31.3.2036.....	113.0 m ³
	1.4.2037 - 31.3.2039.....	60.0 m ³
	1.4.2040 - 31.3.2042.....	63.0 m ³
	1.4.2043 - 31.3.2045.....	49.0 m ³
	1.4.2046 - 31.3.2048.....	49.0 m ³
	1.4.2049 - 31.3.2051.....	70.0 m ³
	1.4.2052 - 31.3.2054.....	57.0 m ³
	1.4.2055 - 31.3.2057.....	62.0 m ³
	1.4.2058 - 31.3.2060.....	86.0 m ³
	1.4.2061 - 31.3.2063.....	50.0 m ³
	1.4.2064 - 31.3.2080.....	0 m ³
Total future arisings:		1469.0 m ³
Total waste volume:		1695.0 m ³

Comment on volumes: Owing to frequent disposals, the stock has decreased since 2019. Future arisings have been taken from the AWE Site Decommissioning/Liabilities Plan. In stock volumes are considered to be accurate. The total volume of arisings shall depend on the longevity of the AWE site, with esimated based on a 2080 site closure date.

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 Waste arising from plutonium operations.

PHYSICAL CHARACTERISTICS

General description: The waste contains metals, plastics and cellulosic materials. Encapsulated oils and sludges are no longer part of this waste stream.

Physical components (%wt): Metals (59.61%), cellulosic material (9.16%), plastics (23.05%), rubber (2.84%) and other (5.34%)

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~0.56

Comment on density: This figure has been derived using stock data from 2022 (total stream mass divided by the total stream volume). Identical to the 2019 figure.

CHEMICAL COMPOSITION

General description and components (%wt): Metals (59.61%), cellulosic material (9.16%), plastics (23.05%), rubber (2.84%) and other (5.34%)

Chemical state: Neutral

Chemical form of radionuclides: H-3: May be present in the waste stream in very small specific activities in HTO, HT and organically bound forms
 C-14: May be present in the waste stream in very small specific activities
 Cl-36: May be present in the waste stream in very small specific activities
 Se-79: Not present in Waste Stream
 Tc-99: Not present in Waste Stream
 I-129: Not present in Waste Stream

WASTE STREAM	7A27	Operational LLW - Plutonium
---------------------	-------------	------------------------------------

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):

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	7.6		
Other ferrous metals.....	34.4		
Iron.....	0		
Aluminium.....	2.8		
Beryllium.....	<0.05		
Cobalt.....	0		
Copper.....	0.86		
Lead.....	0.19		
Magnox/Magnesium.....	0		
Nickel.....	0		
Titanium.....	0		
Uranium.....	0		
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	13.7	Includes filters	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	9.2		
Paper, cotton.....	5.4	Includes hoover bags and contents	
Wood.....	3.7		
Halogenated plastics	17.0	PVC	
Total non-halogenated plastics.....	6.1		
Condensation polymers.....	6.1		
Others.....	0		
Organic ion exchange materials....	0		
Total rubber.....	2.8		
Halogenated rubber	2.8		
Non-halogenated rubber.....	0		
Hydrocarbons.....	0		
Oil or grease	0		
Fuel.....	0		
Asphalt/Tarmac (cont.coal tar)...	0		
Asphalt/Tarmac (no coal tar)....	0		
Bitumen.....	0		
Others.....	0		
Other organics.....	0		

WASTE STREAM	7A27	Operational LLW - Plutonium
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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.....	4.6		
Cementitious material.....	0		
Sand.....	0.05		
Glass/Ceramics.....	0.40		
Graphite.....	0.21		
Desiccants/Catalysts.....	0		
Asbestos.....	<0.10		
Non/low friable.....	<0.10		
Moderately friable.....	<0.10		
Highly friable.....	<0.10		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): -

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	<0.70	
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	<0.50	
Nitrate.....	<0.50	
Nitrite.....	0	
Phosphate.....	<0.50	
Sulphate.....	<0.70	
Sulphide.....	0	

Materials of interest for waste acceptance criteria: Asbestos, lead and beryllium are present in this waste stream.

	(%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.....	0	

WASTE STREAM	7A27	Operational LLW - Plutonium
---------------------	-------------	------------------------------------

Non-putrescible wastes.....	P	Wood, paper and cotton
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, lead and beryllium are present in this waste stream.

	(%wt)	Type(s) and comment
Acrylamide.....	0	
Benzene.....	0	
Chlorinated solvents.....	0	
Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	0	
Styrene.....	0	
Tri-butyl phosphate.....	0	
Other organophosphates.....	0	
Vinyl chloride.....	P	PVC
Arsenic.....	NE	
Barium.....	0	
Boron.....	NE	
Boron (in Boral).....	NE	
Boron (non-Boral).....		
Cadmium.....	NE	
Caesium.....	0	
Selenium.....	0	
Chromium.....	0	
Molybdenum.....	0	
Thallium.....	0	
Tin.....	0	
Vanadium.....	0	
Mercury compounds.....	0	
Others.....	0	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	0	
EEE Type 2.....	0	
EEE Type 3.....	0	
EEE Type 4.....	0	
EEE Type 5.....	0	

WASTE STREAM 7A27 Operational LLW - Plutonium

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	0	
Other organic complexants.....	0	Complexing agents are not present in the waste stream
Total complexing agents.....	0	

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	~3.0
Incineration	Off-site	~2.0
Solidification		
Decontamination		
Metal treatment	Off-site	~55.0
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		~40.0

Comment on planned treatments: -

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~3.0	~0.56
Expected to be consigned to a Landfill Facility	~40.0	~0.56
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	~2.0	<0.56
Expected to be consigned to a Metal Treatment Facility	~55.0	~0.56
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: 170605, 150202, 150203, 200140, 200301

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			

WASTE STREAM	7A27	Operational LLW - Plutonium
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Opportunities for alternative disposal routing: No

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 ³	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 2m box (no shielding) 4m box (no shielding) Other	~3.0	17	3

Other information: Wastes destined for LLWR are likely to go via supercompaction.

Waste Planned for Disposal at the LLW Repository:

Container voidage: Voidage will be minimal as wastes will be supercompacted prior to being sent to LLWR for burial.

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: -

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: Plutonium (principally) and uranium contaminated material.

Uncertainty: The gross alpha and gross beta activities for the in-stock wastes are accurate. The radionuclide breakdown has been estimated. Predicted waste activities are based on recent disposal data.

Definition of total alpha and total beta/gamma: Where totals are shown on the table of radionuclides activities, they are the sums of the listed alpha and beta/gamma emitting radionuclides.

Measurement of radioactivities: Typically this waste is measured using high resolution gamma-ray spectroscopy.

Other information: -

WASTE STREAM 7A27 Operational LLW - Plutonium

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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		5		5	Gd 153				
Be 10		5			Ho 163				
C 14		5			Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36		5			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		5		5	Pb 210		5		5
Co 60	1.61E-09	BB 2	7.21E-12	CC 2	Bi 208				
Ni 59					Bi 210m				
Ni 63		5		5	Po 210		5		5
Zn 65		5			Ra 223		5		5
Se 79					Ra 225		5		5
Kr 81					Ra 226		5		5
Kr 85					Ra 228		5		5
Rb 87					Ac 227		5		5
Sr 90		5			Th 227		5		5
Zr 93					Th 228		5		5
Nb 91					Th 229		5		5
Nb 92					Th 230		5		5
Nb 93m					Th 232		5		5
Nb 94		5			Th 234		5		5
Mo 93					Pa 231		5		5
Tc 97					Pa 233		5		5
Tc 99					U 232	5.51E-10	BB 2		
Ru 106		5			U 233		5		5
Pd 107					U 234	6.23E-05	BB 2	1.65E-06	CC 2
Ag 108m					U 235	2.04E-06	BB 2	5.51E-08	CC 2
Ag 110m		5			U 236	3.15E-07	BB 2	4.28E-09	CC 2
Cd 109					U 238	5.86E-06	BB 2	1.32E-06	CC 2
Cd 113m					Np 237		5		5
Sn 119m					Pu 236				
Sn 121m					Pu 238	1.26E-05	BB 2	1.6E-07	CC 2
Sn 123					Pu 239	4E-04	BB 2	5.21E-06	CC 2
Sn 126					Pu 240	9.49E-05	BB 2	1.15E-06	CC 2
Sb 125		5			Pu 241	3.89E-04	BB 2	4.02E-06	CC 2
Sb 126					Pu 242	1.04E-08	BB 2	1.37E-10	CC 2
Te 125m					Am 241	1.18E-04	BB 2	7.1E-07	CC 2
Te 127m					Am 242m				
I 129		5			Am 243				
Cs 134		5			Cm 242				
Cs 135					Cm 243				
Cs 137	1.05E-07	BB 2			Cm 244				
Ba 133		5			Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144		5			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					Total a	6.96E-04	BB 2	1.03E-05	CC 2
Eu 155					Total b/g	3.89E-04	BB 2	4.02E-06	CC 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