

<b>WASTE STREAM</b>	<b>7A41</b>	<b>Cemented Sludges</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.....	166.1 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2080.....	0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		166.1 m <sup>3</sup>

Comment on volumes: This code contains AWE's cemented sludges. It had been previously agreed that these would be disposed as LLW under 7A27 (agreement with LLWR), but LLWR has not accepted these items since the introduction of discrete items in the LLWR WAC. Stock volumes are recorded in a database and are considered to be accurate. The total volume of arisings will depend on the BAT route for processing the sludge drums, which is subject to change.

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

**WASTE SOURCE** Effluent treatment using ferric floc precipitation process to remove radioactivity from aqueous waste streams, which have originated from uranium and plutonium operations, and been cemented.

**PHYSICAL CHARACTERISTICS**

General description: The waste consists of uranium and plutonium bearing sludges resulting from legacy operations. The waste contains no items that require special handling. Solid component of the sludge has been concentrated by aqueous waste treatment processes. The sludge has been mixed with cement to solidify inside 205 litre lost paddle steel drums.

Physical components (%wt): The solid content is 100%.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m<sup>3</sup>): 1.87

Comment on density: The figure has been reviewed and slightly adjusted for the 2022 UKRWI, and is an average of all in-stock containers.

**CHEMICAL COMPOSITION**

General description and components (%wt): Contains trace metals, other ferrous metal (12%) and cemented flocculant sludge (88%). This is an accurate description (2022) taken from an analysis report. The last RWI also identified the waste as being made up of uranium and plutonium bearing ferric hydroxide sludges. The waste contains silica as SiO<sub>2</sub> (1.2%), iron as Fe<sub>2</sub>O<sub>3</sub> (1.6%), calcium as CaO (2.4%), sodium as Na<sub>2</sub>O (0.2%), carbonate as CO<sub>2</sub> (1.9%), chloride as Cl (0.1%), plutonium as oxide (<0.1%), uranium as oxide (<0.1%), heavy metals as oxides (<0.1%), potassium as sulphate (<0.1%), magnesium as hydroxide (<0.1%). As in the 2019 UKRWI, this data has been assumed to be correct and not reviewed for the 2022 UKRWI.

Chemical state: Alkali

Chemical form of radionuclides: H-3: HT and HTO diffused present in waste stream. Small amount of organically bound tritium may be present in solid form  
 C-14: Not present in the waste stream  
 Cl-36: Not present in the waste stream  
 Se-79: Not present in the waste stream  
 Tc-99: Not present in the waste stream  
 I-129: Not present in the 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 the waste stream in oxide form  
 Np: Np-237 present in waste stream as oxide form from daughter product of Am-241 alpha decay  
 Pu: Present in the waste stream in oxide form

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Metals and alloys (%wt):            No sheet metal.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	12.0	Includes drum and lost paddle (both mild steel)	
Iron.....	0		
Aluminium.....	0		
Beryllium.....	TR		
Cobalt.....	TR		
Copper.....	TR		
Lead.....	TR		
Magnox/Magnesium.....	TR		
Nickel.....	TR		
Titanium.....	TR		
Uranium.....	TR		
Zinc.....	TR		
Zircaloy/Zirconium.....	TR		
Other metals.....	TR		

Organics (%wt):                            There are no organic materials (other than traces of complexing agents)

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	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.....	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		

Other materials (%wt):                    The waste stream is a sludge

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	TR		
Inorganic sludges and flocs.....	63.0		
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	25.0	Cement	
Sand.....	0		
Glass/Ceramics.....	0		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....	0		
Moderately friable.....	0		
Highly friable.....	0		
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt):      The waste contains sulphates, chlorides, carbonates and phosphates with traces of nitrate, fluoride and sulphide. Chloride is estimated as 350 to 1100 ppm of total sludge.

	(%wt)	Type(s) and comment
Fluoride.....	TR	
Chloride.....	0.10	350 to 1100 ppm
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	1.9	
Nitrate.....	TR	
Nitrite.....	0	
Phosphate.....	TR	
Sulphate.....	<0.10	
Sulphide.....	TR	

Materials of interest for waste acceptance criteria:      There are no hazardous materials present in the walls.

	(%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	

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Non-putrescible wastes.....	0
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: -

	(%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.....	0	
Arsenic.....	P	0.34ppm
Barium.....	0	
Boron.....	P	0.84ppm
Boron (in Boral).....	P	0.84ppm
Boron (non-Boral).....	0	
Cadmium.....	P	0.51ppm
Caesium.....	TR	
Selenium.....	P	0.51ppm
Chromium.....	P	4.21ppm
Molybdenum.....	P	0.25ppm
Thallium.....	0	
Tin.....	P	0.93ppm
Vanadium.....	P	0.34ppm
Mercury compounds.....	0	
Others.....	P	TR
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	0	
EEE Type 2.....	0	
EEE Type 3.....	0	
EEE Type 4.....	0	
EEE Type 5.....	0	

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	0	
Other organic complexants.....	0	The waste stream does not contain any complexing agents.
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. These items are cemented drums likely to go to LLWR for burial at the repository near Drigg.

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction Supercompaction (HFC) Incineration Solidification Decontamination Metal treatment Size reduction Decay storage Recycling / reuse Other / various None	Off-site	100.0

Comment on planned treatments: AWE is awaiting confirmation from LLWR that this waste cannot be accepted on a variation, as it was acceptable up until June 2014. The average alpha activity is 3800 Bq/g so is LLW, but does not fall under the discrete items' limit.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
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	100.0	1.9

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

**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			

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**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:** (Not applicable to this waste stream)

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			
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: Will only go into a HHISO if the waste is accepted at the LLWR. Some voidage will be filled with small packages from the 7A27 waste stream and there will be no inaccessible voidage.

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

Container voidage: -

Waste Characterisation Form (WCH): The waste does not meet the LLWR's Waste Acceptance Criteria (WAC). The waste does not have a current WCH.

Average alpha activity is 3800 Bq/g, which is classified as LLW but does not meet the discrete items criteria.

Waste consigned for disposal to LLWR in year of generation: No. This waste was being drip fed to the LLWR when AWE had an annual allocation. Most of the cemented drums were generated in 2007.

**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, uranium and tritium. With traces of Cs-137, Fe-55 and Co-60.

Uncertainty: Accurate data based on assay of sludge from water treatment tanks (minimal variation).

Definition of total alpha and total beta/gamma: The total alpha and total beta/gamma figures are the sum of the listed alpha and beta/gamma radionuclides.

Measurement of radioactivities: The activity contained within the sludge is determined by sampling and using destructive assay. Decay nuclides with a half-life of less than 3 months have been omitted.

Other information: -

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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	1.86E-04	AA 1			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	3.92E-07	AA 1			Pb 210		5		
Co 60	1.73E-06	AA 1			Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210		5		
Zn 65					Ra 223		5		
Se 79					Ra 225		5		
Kr 81					Ra 226		5		
Kr 85					Ra 228		5		
Rb 87					Ac 227		5		
Sr 90					Th 227		5		
Zr 93					Th 228		5		
Nb 91					Th 229		5		
Nb 92					Th 230		5		
Nb 93m					Th 232		5		
Nb 94					Th 234		5		
Mo 93					Pa 231		5		
Tc 97					Pa 233		5		
Tc 99					U 232				
Ru 106					U 233		5		
Pd 107					U 234	4.89E-03	AA 1		
Ag 108m					U 235	1.72E-04	AA 1		
Ag 110m					U 236	4.38E-05	AA 1		
Cd 109					U 238	1.72E-03	AA 1		
Cd 113m					Np 237		5		
Sn 119m					Pu 236				
Sn 121m					Pu 238	2.09E-06	AA 1		
Sn 123					Pu 239	4.46E-05	AA 1		
Sn 126					Pu 240	1.05E-05	AA 1		
Sb 125					Pu 241	4.75E-03	AA 1		
Sb 126					Pu 242	2.09E-09	AA 1		
Te 125m					Am 241	6.47E-05	AA 1		
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	6.26E-05	AA 1			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>6.95E-03</b>	<b>AA 1</b>	<b>0</b>	
Eu 155					<b>Total b/g</b>	<b>5.00E-03</b>	<b>AA 1</b>	<b>0</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