

<b>WASTE STREAM</b>	<b>2F15</b>	<b>LWR Pond Furniture (MEBs)</b>
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**SITE** Sellafield  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Sellafield Limited  
**WASTE TYPE** ILW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	0 m <sup>3</sup>
Future arisings -	1.4.2026 - 31.3.2030.....	288.0 m <sup>3</sup>
	1.4.2031 - 31.3.2035.....	576.0 m <sup>3</sup>
	1.4.2036 - 31.3.2040.....	576.0 m <sup>3</sup>
	1.4.2041 - 31.3.2045.....	576.0 m <sup>3</sup>
	1.4.2046 - 31.3.2050.....	411.8 m <sup>3</sup>
Total future arisings:		2427.8 m <sup>3</sup>
Total waste volume:		2427.8 m <sup>3</sup>

**Comment on volumes:** Arisings are a function of removal rate as part of POCO activities. Each MEB is assumed to have a raw volume of 2.88 m<sup>3</sup>. This volume represents the average volume of the types included in the ILW population.

**Uncertainty factors on volumes:** Stock (upper): x Arisings (upper) x 1.05  
 Stock (lower): x Arisings (lower) x 0.95

**WASTE SOURCE** Transport and pond storage containers for LWR fuel prior to reprocessing.

**PHYSICAL CHARACTERISTICS**

**General description:** Multi Element Bottles (MEBs). MEBs vary in size but are generally cylindrical in shape. All MEBs are large (~4.5m x 0.8m diam) and heavy (1.2-4.34t). The waste has not undergone any changes since it was generated.

**Physical components (%vol):** MEBs (100%).

**Sealed sources:** The waste does not contain sealed sources.

**Bulk density (t/m<sup>3</sup>):** ~1

**Comment on density:** The density is based on the average MEB volume of 2.88m<sup>3</sup> divided by the average mass of 2.88te.

**CHEMICAL COMPOSITION**

**General description and components (%wt):** Boronated stainless steel, stainless steel, boral, lead, aluminium. Minor components include metallic crud, copper/bronze, nickel and traces of rubber. The following composition is for a representative MEB design: stainless steel (80%), aluminium bronze (0.3%), boral (<6%, of which 1% is elemental boron), lead (<14%), rubber (TR). The proportions of materials will vary between different designs and may be between the following ranges: stainless steel 80-99% (some of which may be boronated), boral 0.2-10%, lead 0-14%, aluminium bronze 0.1-0.5%, crud 0-2%. Other materials are present in small or trace quantities.

**Chemical state:** -

**Chemical form of radionuclides:** C-14: Oxides.  
 Tc-99: Oxides.  
 U: Oxides.  
 Pu: Oxides

**Metals and alloys (%wt):** 62% sheet metal (thickness approx 1/4 inch), 24% bulk metal (thickness from 1 to 3 inches), 14% lead ballast (1 7/8 inches diam).

Stainless steel.....	80.0
Other ferrous metals.....	0
Iron.....	
Aluminium.....	5.0
Beryllium.....	
Cobalt.....	0

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	Copper.....	TR
	Lead.....	<12.0
	Magnox/Magnesium.....	0
	Nickel.....	
	Titanium.....	
	Uranium.....	
	Zinc.....	0
	Zircaloy/Zirconium.....	0
	Other metals.....	0
Organics (%wt):	Rubber is present as 'O' rings/gaskets. Neoprene 'O' rings, 0.065%.	
	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.....	NE
	Halogenated rubber .....	-0.07
	Non-halogenated rubber.....	NE
	Hydrocarbons.....	
	Oil or grease .....	
	Fuel.....	
	Asphalt/Tarmac (cont.coal tar)...	
	Asphalt/Tarmac (no coal tar)....	
	Bitumen.....	
	Others.....	
	Other organics.....	0
Other materials (%wt):	The waste contains crud consisting of metal oxide corrosion products (either haematite or nickel substituted spinels) dislodged from the fuel previously held in the containers which constitute the waste. The principal constituents are Co-60 and Fe-55.	
	Inorganic ion exchange materials.	0
	Inorganic sludges and flocs.....	<1.9
	Soil.....	0
	Brick/Stone/Rubble.....	0
	Cementitious material.....	0
	Sand.....	
	Glass/Ceramics.....	
	Graphite.....	0
	Desiccants/Catalysts.....	
	Asbestos.....	0
	Non/low friable.....	

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	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	<0.02
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0
Inorganic anions (%wt):	The listed anions are unlikely to be present.	
	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:	-	
	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
	Active particles.....	P
		Activity is present in crud particles (<2wt%).
	Soluble solids as bulk chemical compounds.....	0
Hazardous substances / non hazardous pollutants:	The waste contains lead as ballast in MEB types 1175, 1176, 1190, 1192 & 3321 only. Catalytic recombiners made from platinum/palladium are present in a very small proportion of the MEBs (<1% of waste stream). The weight of this material is negligible compared with the MEB weight.	
	Acrylamide.....	
	Benzene.....	
	Chlorinated solvents.....	
	Formaldehyde.....	
	Organometallics.....	
	Phenol.....	

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Styrene.....  
 Tri-butyl phosphate.....  
 Other organophosphates.....  
 Vinyl chloride.....  
 Arsenic.....  
 Barium.....  
 Boron..... 1.0

1%wt Boron is the value per MEB (for 2F36, 2F15 & 2F41) but the total Boron for all MEBs (1,673) comes to 44.5te noted here to reserve the capacity at LLWR.

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): No  
 EDTA.....  
 DPTA.....  
 NTA.....  
 Polycarboxylic acids.....  
 Other organic complexants.....  
 Total complexing agents.....

**LAW TREATMENT, PACKAGING AND DISPOSAL**

**Waste that is currently ILW:** The waste will be decay stored then decontaminated, if required, prior to disposal. Regularly between 2026 and 2050.

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Planned on-site / off-site treatments(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		100.0

Comment on planned treatments:

The MEBs are likely to be consigned to a metal recycling facility. Current experience suggests that ~40% of the waste may comprise unrecyclable material, and for the purpose of the 2019 UK Inventory this assumption has been used. Unrecyclable material is assumed to be consigned to the LLWR from the MRF, but is reported here to ensure it is captured in the 2019 UK Inventory.

**Disposal Routes:**

Disposal Route	Stream volume %
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	~40.0       ~60.0

**Upcoming (2019/20-2021/22) waste routing (if expected to change from above)**

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
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 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 2m box (no shielding) 4m box (no shielding) Other	~40.0	~10	98

Other information:

The waste loading is the typical value for uncompacted wastes grouted at LLWR.

**Waste Consigned to the LLW Repository:**

Container voidage: -

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Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

Potential for the waste to contain discrete items: -

**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: The activity arises primarily from corrosion products from the reactor primary cooling circuit adhering to fuel then becoming dislodged in the MEB and secondly to contamination from pond water. Much of this wastestream will have decayed to LLW levels by the time removals start. It may be possible to decontaminate remaining higher level waste and reclassify it as LLW.

Uncertainty: The specific activity has been assumed to be three times the activity of the LLW MEBs (reported under 2F36) at the time of arising.

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: The specific activity is based on the average measured internal Co-60 activity of a large number of MEBs already measured divided by the average MEB volume of 2.88m<sup>3</sup>. Activity values for the other isotopes present are derived from the measured Co-60 activity using the fingerprint developed after analysis of fuel crud from several LLW MEBs in combination with external HP&S swab data. The external contamination is very much lower than the internal and the fingerprint is equivalent to that of pond water which contributes only a very small fraction to the overall fingerprint.

Other information: Beta/gamma activity is dominant.

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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			1.97E-06	B C 2	Gd 153				
Be 10					Ho 163				
C 14			4.84E-05	B C 2	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			7.74E-05	B C 2	Pb 210				
Co 60			5.21E-04	AA 1	Bi 208				
Ni 59					Bi 210m				
Ni 63			1.53E-03	B C 2	Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90			4.18E-06	B B 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94			3.44E-06	B B 2	Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m					U 236				
Cd 109					U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238		9.83E-07	B C 2	
Sn 123					Pu 239		4.92E-07	B C 2	
Sn 126					Pu 240		4.92E-07	B C 2	
Sb 125			1.50E-05	B B 2	Pu 241		3.44E-05	B C 2	
Sb 126					Pu 242				
Te 125m					Am 241		2.95E-06	B C 2	
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137			1.92E-04	B C 2	Cm 244		2.46E-07	B C 2	
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147			4.18E-06	B C 2	Cf 251				
Sm 147					Cf 252				
Sm 151			1.62E-05	B C 2	Other a				
Eu 152					Other b/g				
Eu 154					<b>Total a</b>	<b>0</b>	<b>5.16E-06</b>	<b>B C 2</b>	
Eu 155					<b>Total b/g</b>	<b>0</b>	<b>2.45E-03</b>	<b>B C 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