WASTE STREAM 2F15 LWR Pond Furniture (MEBs)

SITE	Sellafield
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Sellafield Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m³
Future arisings -	1.4.2022 - 31.3.2029.....	0 m³
	1.4.2029 - 31.3.2030.....	56.2 m³
	1.4.2030 - 31.3.2031.....	56.2 m³
	1.4.2031 - 31.3.2032.....	56.2 m³
	1.4.2032 - 31.3.2033.....	112.4 m³
	1.4.2033 - 31.3.2034.....	112.4 m³
	1.4.2034 - 31.3.2035.....	39.3 m³
	1.4.2035 - 31.3.2036.....	117.2 m³
	1.4.2036 - 31.3.2037.....	117.2 m³
	1.4.2037 - 31.3.2038.....	117.2 m³
	1.4.2038 - 31.3.2039.....	117.2 m³
	1.4.2039 - 31.3.2040.....	117.2 m³
	1.4.2040 - 31.3.2041.....	117.2 m³
	1.4.2041 - 31.3.2042.....	117.2 m³
	1.4.2042 - 31.3.2043.....	117.2 m³
	1.4.2043 - 31.3.2044.....	117.2 m³
	1.4.2044 - 31.3.2045.....	117.2 m³
	1.4.2045 - 31.3.2046.....	117.2 m³
	1.4.2046 - 31.3.2047.....	117.2 m³
	1.4.2047 - 31.3.2048.....	117.2 m³
	1.4.2048 - 31.3.2049.....	117.2 m³
	1.4.2049 - 31.3.2050.....	90.8 m³
	1.4.2050 - 31.3.2086.....	0 m³
	1.4.2086 - 31.3.2087.....	73.2 m³
	1.4.2087 - 31.3.2088.....	73.2 m³
	1.4.2088 - 31.3.2089.....	73.2 m³
Total future arisings:		2383.9 m³
Total waste volume:		2383.9 m³

Comment on volumes: Arisings are a function of MEB removal rate from the pond. Initial volumes anticipated from removal from TR&S followed by removal from FGOFSP. Each MEB is assumed to have a raw volume of 2.91 m³. 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/m³):	~1.17
Comment on density:	The density is based on the weighted average MEBs in FGOFSP (1.21 t/m3) and TR&S (1.01 t/m3).

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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).

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	80.0		
Other ferrous metals	0		
Iron			
Aluminium	<6.0	Aluminium content in boral	
Beryllium			
Cobalt	0		
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%.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	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	~0.07		
Halogenated rubber	~0.07		
Non-halogenated rubber	NE		
Hydrocarbons			

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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.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	<1.9		100.0
Soil.....	0		
Brick/Stone/Rubble.....	0		
Cementitious material.....	0		
Sand.....			
Glass/Ceramics.....			
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
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.

	(%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: -

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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	0	
Putrescible wastes	0	
Non-putrescible wastes		
Corrosive materials	0	
Pyrophoric materials	0	
Generating toxic gases	0	
Reacting with water	0	
Higher activity 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.

	(%wt)	Type(s) and comment
Acrylamide	NE	
Benzene	NE	
Chlorinated solvents	NE	
Formaldehyde	NE	
Organometallics	NE	
Phenol	NE	
Styrene	NE	
Tri-butyl phosphate	NE	
Other organophosphates	NE	
Vinyl chloride	NE	
Arsenic	NE	
Barium	NE	
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.
Boron (in Boral)	1.0	
Boron (non-Boral)	0	
Cadmium	NE	
Caesium	NE	
Selenium	NE	
Chromium	NE	
Molybdenum	NE	

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

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA	NE	
DPTA	NE	
NTA	NE	
Polycarboxylic acids	NE	
Other organic complexants	NE	
Total complexing agents	NE	

Potential for the waste to contain discrete items: Yes. Size reduced boral sections have been identified as potential Discrete Items

TREATMENT, PACKAGING AND DISPOSAL

Waste that is currently ILW: The waste will be decay stored then decontaminated, if required, prior to disposal. Regularly between 2030 and 2050.

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 Recyling / reuse Other / various None	Off-site	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 2022 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 2022 UK Inventory.

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Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~40.0	~1.0
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	~60.0	
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: -

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: 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 m³	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	~40.0	~10	96
2m box (no shielding)			
4m box (no shielding)			
Other			

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

Waste Planned for Disposal at the LLW Repository:

Container voidage: Voidage to be minimised based upon size reduction technique and waste loading plan for size-reduced wastes.

It is not yet determined if the waste meets LLWR's Waste Acceptance Criteria (WAC).

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Waste consigned for disposal to LLWR in year of generation:	Not yet determined.

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^3. 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/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	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	A A 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					**Total a**	**0**		**5.16E-06**	**B C 2**
Eu 155					**Total b/g**	**0**		**2.45E-03**	**B 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