WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

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.....	3243.6 m³
Future arisings -	1.4.2022 - 31.3.2023.....	88.1 m³
	1.4.2023 - 31.3.2024.....	53.1 m³
	1.4.2024 - 31.3.2025.....	70.6 m³
	1.4.2025 - 31.3.2026.....	70.1 m³
	1.4.2026 - 31.3.2027.....	94.3 m³
	1.4.2027 - 31.3.2028.....	422.2 m³
	1.4.2028 - 31.3.2029.....	422.2 m³
	1.4.2029 - 31.3.2030.....	380.1 m³
	1.4.2030 - 31.3.2031.....	381.1 m³
	1.4.2031 - 31.3.2032.....	380.1 m³
	1.4.2032 - 31.3.2033.....	463.7 m³
	1.4.2033 - 31.3.2034.....	473.2 m³
	1.4.2034 - 31.3.2035.....	474.4 m³
	1.4.2035 - 31.3.2036.....	166.6 m³
	1.4.2036 - 31.3.2037.....	137.1 m³
	1.4.2037 - 31.3.2038.....	62.7 m³
	1.4.2038 - 31.3.2039.....	72.2 m³
	1.4.2039 - 31.3.2040.....	72.2 m³
	1.4.2040 - 31.3.2041.....	72.2 m³
	1.4.2041 - 31.3.2042.....	73.0 m³
	1.4.2042 - 31.3.2043.....	24.1 m³
	1.4.2043 - 31.3.2044.....	24.1 m³
	1.4.2044 - 31.3.2045.....	24.1 m³
	1.4.2045 - 31.3.2046.....	24.1 m³
	1.4.2046 - 31.3.2047.....	24.1 m³
	1.4.2047 - 31.3.2048.....	24.1 m³
	1.4.2048 - 31.3.2049.....	24.1 m³
	1.4.2049 - 31.3.2050.....	24.1 m³
	1.4.2050 - 31.3.2051.....	24.1 m³
	1.4.2051 - 31.3.2052.....	24.1 m³
	1.4.2052 - 31.3.2053.....	24.1 m³
	1.4.2053 - 31.3.2054.....	24.1 m³
	1.4.2054 - 31.3.2055.....	24.1 m³
	1.4.2055 - 31.3.2056.....	24.1 m³
	1.4.2056 - 31.3.2057.....	24.1 m³
	1.4.2057 - 31.3.2058.....	24.1 m³
	1.4.2058 - 31.3.2059.....	24.1 m³
	1.4.2059 - 31.3.2060.....	24.1 m³
	1.4.2060 - 31.3.2061.....	24.1 m³
	1.4.2061 - 31.3.2062.....	24.1 m³
Total future arisings:		4911.0 m³
Total waste volume:		8154.6 m³

Comment on volumes: Arisings of PCM are not generally predictable. Arisings volumes comprise PCM from current decommissioning projects and PCM transferred to Sellafield from the LLWR. The stock level provided reflects the current volume held at Sellafield in designated PCM stores, these items are tracked and hence known to a good level of accuracy. Arisings are linked to the decommissioning project schedule, hence are subject to variation depending on the change of priorities within the decommissioning area, which leads to an increase in

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

uncertainty.

Uncertainty factors on volumes:	Stock (upper): x 1.1	Arisings (upper) x 1.5
	Stock (lower): x 0.9	Arisings (lower) x 0.5

WASTE SOURCE PCM arising from current decommissioning projects at Sellafield and LLWR.

PHYSICAL CHARACTERISTICS

General description: The waste consists of a range of solid materials, including: PPE such as PVC suits and rubber gloves, wastes from routine plant operations such as swabs and lab equipment to more substantial items and pieces of building fabric such as perspex sheets, metal items and brickwork. No items require special handling. No physical or chemical changes.

Physical components (%wt): PVC gloves, filters, paper towels, rubble/tarmac and small plant items. All items are double bagged in PVC and heat sealed. Small plant items include hand tools, laboratory equipment (especially glassware) and packaging cans. Material breakdown: PVC (26%), Rubber (9%), Metal (54%), Cellulose (2%), Plastic (3%), Other (6%). Note that this includes the sacrifical mild steel drums and mild steel drum liner.

Sealed sources: The waste contains sealed sources. The waste stream is known to contain a small number of thorium sources.

Bulk density (t/m³): 0.3

Comment on density: Range of densities is approximately 0.1 to 0.9 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): The waste has a mixed chemical composition: PVC (26%), Rubber (9%), Metal (54%), Cellulose (2%), Plastic (3%), Other (6%). Note that this includes the sacrifical mild steel drums and mild steel drum liner.

Chemical state: Neutral

Chemical form of radionuclides: U: Metal, oxides, nitrates.
Pu: Metal, oxides, fluorides, nitrates.

Metals and alloys (%wt): Mostly sheet metal, from the 200 litre drum. Some bulk metals present, largest dimensions 1m x 30mm square. May also include cut up scaffold poles and items of plant.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	5.9		
Other ferrous metals	47.1		
Iron	0		
Aluminium	<0.60		
Beryllium	0		
Cobalt	TR	May be present in hand tool alloys.	
Copper	TR		
Lead	0.30		
Magnox/Magnesium	0		
Nickel	TR	May be present in hand tool alloys.	
Titanium	TR	May be present in hand tool alloys.	
Uranium	0		
Zinc	0		
Zircaloy/Zirconium	0		
Other metals	P	Trace quantities of gold may be present.	

Organics (%wt): The waste contains cellulosics, rubber, halogenated plastics (PVC) and non-halogenated plastics (perspex and polythene). The total organics content is about 42%.

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	2.2		
Paper, cotton	1.8		
Wood	0.40		
Halogenated plastics	27.0	Includes PVC	
Total non-halogenated plastics	2.6		
Condensation polymers	0		
Others	2.6	Includes Perspex and Polythene	
Organic ion exchange materials	TR		
Total rubber	9.4		
Halogenated rubber	9.4		
Non-halogenated rubber	0		
Hydrocarbons	~1.3		
Oil or grease	TR		
Fuel	0		
Asphalt/Tarmac (cont.coal tar)	1.3		
Asphalt/Tarmac (no coal tar)	P		
Bitumen	TR		
Others	0		
Other organics	0		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	TR		
Inorganic sludges and flocs	0		
Soil	P		
Brick/Stone/Rubble	1.8		
Cementitious material	0.80		
Sand	0		
Glass/Ceramics	1.0		
Graphite	0		
Desiccants/Catalysts	NE		
Asbestos	P		
Non/low friable	NE		
Moderately friable	NE		
Highly friable	NE		
Free aqueous liquids	TR		
Free non-aqueous liquids	TR		
Powder/Ash	0		

Inorganic anions (%wt): Most of the listed anions may be present in trace quantities (<0.1%).

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

	(%wt)	Type(s) and comment
Fluoride	<0.10	
Chloride	<0.10	
Iodide	<0.10	
Cyanide	0	
Carbonate	<0.10	
Nitrate	<0.10	
Nitrite	NE	
Phosphate	<0.10	
Sulphate	<0.10	
Sulphide	<0.10	

Materials of interest for waste acceptance criteria: The waste will include chemical contaminants, acids and alkalis, and small amounts of asbestos.

	(%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	NE	
Putrescible wastes	NE	
Non-putrescible wastes	NE	
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: The waste stream specifically excludes toxic materials and therefore they are present in trace quantities only. Asbestos (<1%), laboratory chemicals (<1%).

	(%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	NE	
Boron (in Boral)	NE	
Boron (non-Boral)	NE	
Cadmium	TR	
Caesium	NE	
Selenium	NE	
Chromium	TR	May be present in hand tool alloys.
Molybdenum	NE	
Thallium	NE	
Tin	NE	
Vanadium	TR	May be present in hand tool alloys.
Mercury compounds	TR	
Others	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1	NE	
EEE Type 2	NE	
EEE Type 3	~0.10	
EEE Type 4	NE	
EEE Type 5	NE	

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA		
DPTA		
NTA		
Polycarboxylic acids	0	
Other organic complexants	TR	Trace amounts of organic complexing agents may be present.
Total complexing agents	TR	

Potential for the waste to contain discrete items: Yes. Waste is likely to contain a range of hand tools and metal plant items.

PACKAGING AND CONDITIONING

Conditioning method: The current conditioning method for 2D90 is processing through the Waste Treatment Complex (WTC) where 200 litre drums of waste are supercompacted and the pucks loaded into a basket within a 500 litre drum (such that there is a cement annulus between the basket and the drum skin). Replacement WTC facilities are currently projected to use a similar treatment method.

Plant Name: Waste Treatment Complex (future capabilities are anticpated to be titled WTC2 & WTC3).

Location: Sellafield.

Plant startup date: 1997 (It is anticipated that WTC2 will become operational in ~2034 and WTC3 in ~2061).

Total capacity (m^3/y incoming waste): 500.0

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

Target start date for packaging this stream: -

Throughput for this stream (m³/y incoming waste): NE

Other information: Backlog and fresh arisings will be conditioned concurrently. Stream throughput is variable and cannot be estimated, this is due to waste streams 2D03, 2D90, 2F02 and 2F34 being processed concurrently in WTC.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
500 l drum (basket for waste)	~100.0	~0.767	~0.504	10631

Likely container type comment: -

Range in container waste volume: 90% of waste stream is assumed to be compatible with the current WTC supercompaction and grout process. Typically between 1 and 10 compacted 200 litre drums will be loaded into a 500 litre drum, with an average of 5.6. The range and variability for WTC2 & WTC3 have yet to be assessed, although it is assumed that the values will be similar to those for the current WTC facility.10% of the waste stream is estimated to be incompatible with supercompaction. It is assumed that such wastes will be grouted directly into 500 litre drums with no volume reduction attempted.

Other information on containers: Stainless Steel

Likely conditioning matrix: Other

Other information: GGBS/CEM I

Conditioned density (t/m³): 2.1

Conditioned density comment: Conditioned density calculated using data from current WTC product drum stock. The density is typically between 1.8 and 2.6 t/m³, although values outside of this range are possible.

Other information on conditioning: -

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Geological Disposal Facility	Disposal at LLWR	~12.0	2025	High	It is estimated that ~4900 drums will be consigned as LLW from 2D90 under the 2X40/1 waste stream. The work to introduce this new LLW waste stream is well advanced.
Disposal at a Geological Disposal Facility	Disposal at LLWR	~12.0	2032	Medium	It is estimated that 20% of arisings will be consigned as LLW (either directly from the point of arising or from the PCM Stores)
Disposal at a Geological Disposal Facility	Disposal at a Geological Disposal Facility		N/A	Low	Potential for further stream volume reduction if one of the planned future treatment plants utilises thermal treatment

RADIOACTIVITY

Source: The principal nuclides are Pu-238, Pu-239, Pu-240, Pu241, Pu 242 and Am241.

Uncertainty: The activity accuracy is based on records of arisings.

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'.

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

Measurement of radioactivities:	The specific activities were calculated using an average fingerprint for the stream (determined through measurements of several thousand drums through the WTC and EDS assay suites) and the total Pu mass of the current stocks.
Other information:	-

WASTE STREAM 2D90 Plutonium Contaminated Materials; Drums

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					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				
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					Th 227				
Zr 93					Th 228	2.94E-07	B B 2		
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232	3.01E-07	B B 2		
Nb 94					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	7.14E-07	B B 2		
Ag 110m					U 236				
Cd 109					U 238	6.03E-06	B B 2	8.07E-07	C C 2
Cd 113m					Np 237	1.32E-05	B B 2		
Sn 119m					Pu 236				
Sn 121m					Pu 238	6.85E-03	B B 2	3.80E-02	C C 2
Sn 123					Pu 239	8.59E-02	B B 2	8.38E-02	C C 2
Sn 126					Pu 240	2.69E-02	B B 2	7.10E-02	C C 2
Sb 125					Pu 241	2.90E-01	B B 2	2.07E+00	C C 2
Sb 126					Pu 242	8.72E-06	B B 2	4.52E-05	C C 2
Te 125m					Am 241	3.55E-02	B B 2	3.93E-02	C C 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					**Total a**	**1.55E-01**	**B B 2**	**2.32E-01**	**C C 2**
Eu 155					**Total b/g**	**2.90E-01**	**B B 2**	**2.07E+00**	**C 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