

WASTE STREAM	2N03	Plutonium Contaminated Material; Drummed (Operational Mixed Waste)
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SITE LLWR (near Drigg)

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN LLWR SLC Limited

WASTE TYPE ILW; SPD1

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	360.6 m ³
Total future arisings:		0 m ³
Total waste volume:		360.6 m ³

Comment on volumes: This stream (2N03) reflects the secondary soft waste drums from PCM operations and the hard waste drums from PCM decommissioning operations. All PCM drums have been generated from decommissioning activities on the LLWR Site and are currently undergoing re-assay to determine whether they are truly PCM. This includes the 12 drums identified in 2N17.

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

WASTE SOURCE The PCM waste at LLWR is from the decommissioning of PCM facilities, contaminated due to the storage of PCM. The PCM at LLWR mainly originated from Sellafield, but significant amounts were from other UK nuclear installations e.g. Harwell and Aldermaston.

PHYSICAL CHARACTERISTICS

General description: The soft PCM waste consists of PPE and other operational wastes e.g. plastic gloves, air fed suits, hoses, boots, wipes, sizalcraft etc. The hard PCM waste consists of building fabric and redundant equipment contaminated above LLW levels. The waste will mainly comprise of scabbled concrete from the magazines and also from metal and wood fittings within the building as well as any metallic equipment that cannot be adequately monitored to prove it is not PCM. The PCM at LLWR mainly originated from Sellafield, but significant amounts were from other UK nuclear installations e.g. Harwell and Aldermaston. The waste has been size reduced for packing into drums.

Physical components (%wt): The overall waste composition is estimated to be metal (33%), concrete and brick (28%), PVC (17%), rubber - including neoprene (9%), cellulose (5%), bitumen (3%), wood (2%), other plastics (3%) (also <1% others (including glass)).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³):

Comment on density: For soft waste there are a range of densities of 0.01 - 0.1 te/m³. For hard waste a range of densities of 2 - 4 te/m³ is typical. It depends on the drum content (whether it is concrete, metal or a mixture and how well it is packed). Drum weight limits will preclude very efficient packing.

CHEMICAL COMPOSITION

General description and components (%wt): See physical characteristics.

Chemical state: Alkali

Chemical form of radionuclides: H-3: Trace quantities could be present.
 C-14: Not expected to be present.
 Cl-36: Not expected to be present.
 Se-79: Not expected to be present.
 Tc-99: Not expected to be present.
 I-129: Not expected to be present.
 Ra: Trace quantities could be present.
 Th: Trace quantities could be present.
 U: Oxides, fluorides.
 Np: Trace quantities could be present.
 Pu: Nitrate, sulphide, fluoride or mixed oxides.

Metals and alloys (%wt): No significant sheet metal is expected to be present as this can be decontaminated to LLW.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~33.0	Breakdown not estimated.	
Other ferrous metals.....	NE		
Iron.....	NE		
Aluminium.....	NE		
Beryllium.....	NE		
Cobalt.....	NE		
Copper.....	NE		
Lead.....	NE		
Magnox/Magnesium.....	NE		
Nickel.....	NE		
Titanium.....	NE		
Uranium.....	NE		
Zinc.....	NE		
Zircaloy/Zirconium.....	NE		
Other metals.....	NE		
Organics (%wt):	others includes bitumen		
	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	~7.0		
Paper, cotton.....	~5.0	Filters, covershoes, tyveks, wipes etc.	
Wood.....	~2.0	Wood building fittings.	
Halogenated plastics	~17.0	Assumed PVC and Neoprene.	
Total non-halogenated plastics.....	~3.0		
Condensation polymers.....	NE		
Others.....	~3.0	Types not known.	
Organic ion exchange materials....	0		
Total rubber.....	~9.0		
Halogenated rubber	~9.0	Types not known; gloves, O-rings, neoprene	
Non-halogenated rubber.....	NE		
Hydrocarbons.....	~3.0	Captured as bitumen 3% below	
Oil or grease	NE		
Fuel.....	NE		
Asphalt/Tarmac (cont.coal tar)...	NE		
Asphalt/Tarmac (no coal tar)....	NE		
Bitumen.....	~3.0	Bitumen (removed from building structure)	
Others.....	NE		
Other organics.....	NE		

Other materials (%wt): The concrete is estimated to contain ~1-2% brick.

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	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	~2.0		
Cementitious material.....	~26.0		
Sand.....	0		
Glass/Ceramics.....	P	glass (<1%)	
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0	None found to date.	
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): If present at all, will be in negligible trace quantities.

	(%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: Waste materials are not expected to contain any of these properties, with the exception of active particles.

	(%wt)	Type(s) and comment
Combustible metals.....	0	Not expected.
Low flash point liquids.....	0	Not expected.
Explosive materials.....	0	Not expected.
Phosphorus.....	0	Not expected.
Hydrides.....	0	Not expected.
Biological etc. materials.....	0	Not expected.
Biodegradable materials.....	0	Not expected.
Putrescible wastes.....	0	Not expected.
Non-putrescible wastes.....	0	Not expected.

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Corrosive materials.....	0	Not expected.
Pyrophoric materials.....	0	Not expected.
Generating toxic gases.....	0	Not expected
Reacting with water.....	0	Not expected
Higher activity particles.....	P	Potentially present.
Soluble solids as bulk chemical compounds.....	0	Not expected.

Hazardous substances / non hazardous pollutants: Only expected to be present within alloys (e.g. stainless steel).

	(%wt)	Type(s) and comment
Acrylamide.....	0	
Benzene.....	0	Not expected.
Chlorinated solvents.....	0	
Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	0	Not expected.
Styrene.....	0	
Tri-butyl phosphate.....	0	Not expected.
Other organophosphates.....	0	
Vinyl chloride.....	0	Not expected.
Arsenic.....	0	Not expected.
Barium.....	0	
Boron.....	0	Not expected.
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....	0	Not expected.
Caesium.....		
Selenium.....	0	Not expected.
Chromium.....	P	Could be present in stainless steel alloy.
Molybdenum.....	P	Could be present in stainless steel alloy.
Thallium.....	NE	
Tin.....	0	Not expected.
Vanadium.....	0	Not expected.
Mercury compounds.....	0	
Others.....	P	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	NE	
EEE Type 2.....	NE	
EEE Type 3.....	NE	
EEE Type 4.....	NE	
EEE Type 5.....	NE	

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....	NE	
DPTA.....	NE	
NTA.....	NE	
Polycarboxylic acids.....	NE	Not expected.
Other organic complexants.....	NE	Not expected.
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. small hand held tools and size reduced fork lift truck parts are contained within the drums and would be classed as discrete items.

PACKAGING AND CONDITIONING

Conditioning method: Waste is in 200 L drums which will be supercompacted at Sellafield Limited at a future date. Six supercompacted (1.2 m³ of total compacted volume) pucks will be loaded within a 500 L drum and there will be a cement annulus between the basket and the drum skin. This conditioning work will be completed by Sellafield Limited and not LLWR.

Plant Name: Engineered Drum Store (EDS).

Location: Sellafield.

Plant startup date: 1997

Total capacity (m³/y incoming waste): 1761.0

Target start date for packaging this stream: -

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

Other information: Decommissioning complete - all waste has been packaged in 200 litre drums and is being stored pending transfer to Sellafield Limited for long term storage.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum (basket for waste)	100.0	~1.2	0.504	301

Likely container type comment: As per current plant specification.

Range in container waste volume: Between 1 and 9 compacted 200 L drums will be put into a 500 L drum (on average 6).

Other information on containers: Stainless steel.

Likely conditioning matrix: PFA/OPC;None

Other information: -

Conditioned density (t/m³): ~2.0

Conditioned density comment: The density of the conditioned product will range from 1.5 to 2.6 t/m³ for drums.

Other information on conditioning: A modified WTC phase 1 (a super-compacting facility) began treating stored PCM and arising in 1997.

Opportunities for alternative disposal routing: Yes

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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	<<10.0	2023	Medium	The project has commenced and the 1000 drums assayed milestone was achieved in March 2022. Of the 1000 drums assayed, only 4 to date have been confirmed as HAW, with the remaining population being classed as LLW (<5%) and the remaining drums being classed as LA-LLW and VLLW. The BAT is to be concluded to confirm treatment and or disposal routes. It is anticipated that all LLW drums will be compacted. Prior to disposal in the LLWR Vault. Assessments of the data are due to commence in May 2022 (with the assumption that all 1808 drums will have completed assessments by the end of March 2023).
Disposal at a Geological Disposal Facility	Authorised landfill	<<85.0	2023	Medium	The project has commenced and the 1000 drums assayed milestone was achieved in March 2022. Of the 1000 drums assayed, only 4 to date have been confirmed as HAW, with the remaining population being classed as LLW (<5%) and the remaining drums being classed as LA-LLW and VLLW. The BAT is to be concluded to confirm treatment and or disposal routes. It is anticipated that all LLW drums will be compacted. Prior to disposal in the LLWR Vault. Assessments of the data are due to commence in May 2022 (with the assumption that all 1808 drums will have completed assessments by the end of March 2023).

RADIOACTIVITY

Source:	Material generated under the 2N03 waste stream has become Plutonium Contaminated (PCM) material through contact with PCM historically processed within the magazines. Additionally, Decommissioning Operations of the Magazines has also generated PCM.
Uncertainty:	All isotopic assay for PCM drums is carried out to produce a 'nuclear safety value' as required by the LLWR and Sellafield plant safety cases. Consequently a mean (accountancy) value is produced to which three standard deviations are added to provide 99% confidence in the final assay value for the drum contents. In addition to this, a factor of 8 is added to the U235 value to account for the U235 being in a discrete lump rather than a dispersed powder form. If no U235 is detected, a default value of 10g is attributed to the drum. Therefore, the overall fissile content reported for a drum is very pessimistic to ensure criticality safety. A factor of 10 uncertainty has been added to reflect uncertainty on the average, because the fingerprint will vary between drums. The fingerprint given here has been taken from the Waste Characterisation Document.
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:	All drums are assayed on equipment that complies with modern standards. Each drum has an accountancy value (a mean) and a standard deviation. A nuclear safety value is derived from the mean and the standard deviations. Each drum is weighed and from this a specific activity can be determined. The fingerprint applied is based on the original PCM inventory retrieved from the magazines. As a best estimate it is assumed that the activity characterisation of the materials decommissioning will be similar to the original PCM waste, since this is where the contamination will have come from.
Other information:	The fingerprint has not been decayed.

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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					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	~2.78E-11	CC 5		
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
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	~1.24E-06	CC 2		
Ag 110m					U 236				
Cd 109					U 238	~2.78E-11	CC 5		
Cd 113m					Np 237	~2.78E-11	CC 5		
Sn 119m					Pu 236				
Sn 121m					Pu 238	~9.75E-03	CC 2		
Sn 123					Pu 239	~7.75E-03	CC 2		
Sn 126					Pu 240	~1.17E-02	CC 2		
Sb 125					Pu 241	~1.04E+00	CC 2		
Sb 126					Pu 242	~1.12E-05	CC 2		
Te 125m					Am 241	~3.59E-02	CC 2		
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	~2.78E-11	CC 5			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	~6.51E-02	CC 2	0	
Eu 155					Total b/g	~1.04E+00	CC 2	0	

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