WASTE STREAM 2A07 Redundant Fuel Transport Flasks & Liners

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

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	86.4 m^3
Total future arisings:		0 m^3
Total waste volume:		86.4 m^3

Comment on volumes: Stocks consist of liners and redundant fuel transport flasks. The flasks have become redundant after the end of Calder Hall defuelling. However there is the possibility that a number of the flasks will be taken over by others (suitably qualified & licenced organisations) who will then be responsible for decommissioning and disposal of these flasks. This will affect the final volume associated to this waste stream and the rate at which these are decommissioned and disposed of. The total number of flask liners identified is 6. The total number of flasks identified is 6. The volume declared for disposal is the volume of the liners and the flasks without any size reduction, however this volume will only be taken up at the LLWR if the flasks are not broken up and recycled.

Uncertainty factors on volumes:				
	Stock (upper):	x 1.25	Arisings (upper)	x
	Stock (lower):	x 0.75	Arisings (lower)	x

WASTE SOURCE Both liners and flasks used for the transport of irradiated Magnox fuel from Calder Hall reactors.

PHYSICAL CHARACTERISTICS

General description: These are ferritic steel containers internally contaminated with traces of activation and fission products from the spent fuel. The flask liners have a 200 mm thick lining of 4% antimonial lead encased by 10mm stainless steel. The lead should be uncontaminated. The liners weigh up to 16.5 te each. Actual disposal weight may be less.
The flasks are painted with CEGB System 6 epoxy paint. The flasks weigh up to 41 t each. All flasks have handling trunnions fitted. This is the maximum all up weight of a flask assembly. Actual disposal weight may be less. The waste is not anticipated to undergo any changes since it was generated. Flasks sometimes undergo chemical decontamination as part of routine maintenance.

Physical components (%wt): Flask liners are estimated to be 85% lead, 15% stainless steel by weight.
Transport flasks are almost 100% by weight steel. Flask surfaces are painted with CEGB System 6 epoxy paint (~0.1% wt) and there is a seal (viton) (<0.01% wt).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): ~3.99

Comment on density: The average density of 3.99 t/m^3 refers to the mass of the components divided by the volume as stored prior to disposal. Density for the flask liners is 3.63 t/m^3. Density for the transport flasks is 4.16 t/m^3.

CHEMICAL COMPOSITION

General description and components (%wt): Flask liners are estimated to be 85% lead, 15% stainless steel by weight.
Transport flask surfaces are painted with CEGB System 6 epoxy paint and there is a seal made of viton. The chemical components are stainless steel and ferrous based alloys (approx. 100%) possibly with nickel, vanadium, molybdenum, manganese, niobium and chromium in alloying proportions, Viton (<0.01%), and CEGB System 6 epoxy based paint (~0.1%). Small components will give traces of bronze, copper, aluminium, brass, lead and graphite (total <0.5%).

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Chemical state: Neutral

Chemical form of radionuclides:
H-3: Tritium may be present as inorganic or organic compounds.
C-14: The carbon 14 content is insignificant.
Cl-36: The chlorine content is insignificant.
Se-79: The selenium isotope content is insignificant.
Tc-99: The technetium isotope content is insignificant.
I-129: The iodine content is insignificant.
Ra: The radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: The chemical form of uranium isotopes has not been determined but may be present as uranium oxides.
Np: The neptunium isotope content is insignificant.
Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.

Metals and alloys (%wt): Approximately 100% of waste is bulk metal in the form of flask liners and transport flasks.Flask liner casing and spacing formwork is in BS1501Part 3.Flask body material is a forging in BS 1503, ASTM/A350 with bolts and other fittings in stainless steel (unidentified). Nickel, niobium and molybdenum are present in alloying proportions in steels. Flask liner is stainless steel type MAT2A.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	~33.0		
Other ferrous metals	~43.0		
Iron			
Aluminium	TR		
Beryllium	0		
Cobalt	0		
Copper	TR	Copper and brass.	
Lead	~25.0	Lead/Antimony alloy (24:1 Pb/Sb).	
Magnox/Magnesium	TR		
Nickel	TR		
Titanium			
Uranium	P		
Zinc	0		
Zircaloy/Zirconium	0		
Other metals	0		

Organics (%wt): Viton "O" ring seals between flask lid and flask body, and around valves, are made of Viton B rubber. Flasks are coated with CEGB System 6 epoxy based. Viton B in "O" rings trapped into the flask assembly.

	(%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	<0.01		
Halogenated rubber	<0.01	Viton B.	

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Non-halogenated rubber.....	0	
Hydrocarbons.....		
Oil or grease		
Fuel.....		
Asphalt/Tarmac (cont.coal tar)...		
Asphalt/Tarmac (no coal tar).....		
Bitumen.....		
Others.....		
Other organics.....	~0.10	CEGB System 6 Epoxy Paint.

Other materials (%wt): -

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

Inorganic anions (%wt): Inorganic 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: No materials likely to pose a fire or other non-radiological hazard have been identified.

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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.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: Lead (as a lead/antimony alloy) accounts for ~25% of the total mass of liners and flasks.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....		
Boron (in Boral).....		
Boron (non-Boral).....		
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

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. Discrete flasks and liners are the only components of this waste stream.

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	Off-site	~80.0
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		~20.0

Comment on planned treatments: It has been assumed for the 2022 UK RWI that 80% of the metallic waste will be treated by the supply chain and will subsequently be 'out of scope'. The remaining 20% is assumed to be consigned to LLWR for disposal as non-compactable LLW.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~20.0	4.0
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	~80.0	4.0
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):

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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: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Metal treatment	Recycle	~66.0	2025	Medium	Potential to reuse the Flask bodies for further waste management at Sellafield

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 2m box (no shielding) 4m box (no shielding) Other	~20.0	~10	2

Other information: -

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

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

Waste consigned for disposal to LLWR in year of generation: No.

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: Contamination from Magnox fuel.

Uncertainty: The flask waste is expected to be LLW but levels of contamination have to be determined.

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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 levels of the flasks have yet to be determined.
Other information:	There may be contamination by fission products, actinides and activation products in Magnox fuel.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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		6			Gd 153				
Be 10		8			Ho 163				
C 14		8			Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36		8			Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41		8			Pt 193				
Mn 53					Tl 204				
Mn 54		6			Pb 205				
Fe 55		6			Pb 210		6		
Co 60		6			Bi 208				
Ni 59		6			Bi 210m				
Ni 63		6			Po 210		6		
Zn 65		6			Ra 223				
Se 79		6			Ra 225		6		
Kr 81					Ra 226		6		
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90		6			Th 227				
Zr 93		6			Th 228				
Nb 91					Th 229		6		
Nb 92					Th 230		6		
Nb 93m		6			Th 232		8		
Nb 94		6			Th 234		6		
Mo 93		6			Pa 231		8		
Tc 97					Pa 233		6		
Tc 99		6			U 232				
Ru 106		6			U 233		6		
Pd 107		6			U 234		6		
Ag 108m		6			U 235		6		
Ag 110m					U 236		6		
Cd 109					U 238		6		
Cd 113m					Np 237		6		
Sn 119m					Pu 236				
Sn 121m		6			Pu 238		6		
Sn 123					Pu 239		6		
Sn 126		6			Pu 240		6		
Sb 125		6			Pu 241		6		
Sb 126					Pu 242		6		
Te 125m		6			Am 241		6		
Te 127m					Am 242m		6		
I 129		6			Am 243		6		
Cs 134		6			Cm 242		6		
Cs 135		6			Cm 243		6		
Cs 137		6			Cm 244		6		
Ba 133					Cm 245		8		
La 137					Cm 246		8		
La 138					Cm 248				
Ce 144		6			Cf 249				
Pm 145					Cf 250				
Pm 147		6			Cf 251				
Sm 147					Cf 252				
Sm 151		6			Other a		8		
Eu 152		6			Other b/g				
Eu 154		6			**Total a**	**0**	**8**	**NE**	
Eu 155		6			**Total b/g**	**<4.06E-04**	**C 3**	**NE**	

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