WASTE STREAM 2D02 High Level Liquid Waste

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

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	1060.5 m^3
Future arisings -	1.4.2022 - 31.3.2023.....	-55.5 m^3
	1.4.2023 - 31.3.2024.....	-127.5 m^3
	1.4.2024 - 31.3.2025.....	-19.5 m^3
	1.4.2025 - 31.3.2026.....	-88.3 m^3
	1.4.2026 - 31.3.2027.....	-31.0 m^3
	1.4.2027 - 31.3.2028.....	-67.0 m^3
	1.4.2028 - 31.3.2029.....	-31.0 m^3
	1.4.2029 - 31.3.2030.....	-31.0 m^3
	1.4.2030 - 31.3.2031.....	36.0 m^3
	1.4.2031 - 31.3.2032.....	18.0 m^3
Total future arisings:		-396.8 m^3
Total waste volume:		663.8 m^3

Comment on volumes: Arisings are based on the HA Liquor from Magnox, POCO washings and planned transfers to the Waste Vitrification Plants resulting in a net decrease in stocks over time. The remaining waste volume is from liquor heels in the HASTs which will not be removed until after POCO operations. The route for this removal has not been confirmed. Heels have been reported according to current approved plans. It should be noted that these plans do not account for reduced vitrification performance, and so are likely to be lower. Waste volumes are derived based on planned fuel reprocessing programmes for Thorp and Magnox plants and assumed waste liquor storage concentrations. These concentrations are comparable with historical storage concentrations and as such are expected to be reasonably representative. Uncertainties in arising and processing rates along with stored liquor dilution variability support an estimated uncertainty range of +/- 1.5 at this time.

Uncertainty factors on volumes:				
	Stock (upper):	x 1.1	Arisings (upper)	x 1.5
	Stock (lower):	x 0.9	Arisings (lower)	x 0.67

WASTE SOURCE Concentrated fission product solution from the first stage of primary separation in reprocessing plants. Concentrated washings from HALES POCO.

PHYSICAL CHARACTERISTICS

General description:	The waste is a nitric acid solution containing fission products, some actinides and some solids. There are no large items which require special handling.
Physical components (%vol):	Liquid (100%) with some suspended solids.
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m^3):	1.21
Comment on density:	The average material density of the waste is 1.21 t/m^3.

CHEMICAL COMPOSITION

General description and components (%wt):	Nitric acid, fission product nitrates and oxides, corrosion products (iron, magnesium, chromium, nickel, aluminium), actinides and phosphates.
Chemical state:	Acid
Chemical form of radionuclides:	H-3: Likely to be present as water. C-14: Unknown - possibly present as traces of dissolved solvent. Cl-36: Unknown Se-79: Present as nitrate. Tc-99: Present as nitrate. I-129: Unknown Ra: Likely to be present as nitrate.

Th: Present as nitrate.
U: Present as nitrate.
Np: Present as nitrate.
Pu: Present as nitrate.

Metals and alloys (%wt): No metallic items are present.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0		
Other ferrous metals	0		
Iron	0		
Aluminium			
Beryllium	0		
Cobalt	0		
Copper			
Lead	0		
Magnox/Magnesium	0		
Nickel	TR	Nickel will be present as corrosion product.	
Titanium			
Uranium	0		
Zinc	0		
Zircaloy/Zirconium	0		
Other metals	TR	Niobium will be present as corrosion product.	

Organics (%wt): The waste contains no organic materials, other than possible traces of complexing agents.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics			
Paper, cotton			
Wood			
Halogenated plastics			
Total non-halogenated plastics			
Condensation polymers			
Others			
Organic ion exchange materials			
Total rubber			
Halogenated rubber			
Non-halogenated rubber			
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics			

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Other materials (%wt): Solids in the waste are suspended in the bulk liquor by agitation.

	(%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.....			
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....	0		
Moderately friable.....	0		
Highly friable.....	0		
Free aqueous liquids.....	100.0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): The waste contains nitrates, phosphates, chlorides and trace quantities of oxides and sulphates. The waste also contains molybdates (not estimated).

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....	<0.10	
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	0	
Nitrate.....	<50.0	
Nitrite.....	NE	
Phosphate.....	<0.25	
Sulphate.....	TR	
Sulphide.....	0	

Materials of interest for waste acceptance criteria: The waste contains nitric acid which is a strong oxidising agent and can generate NOx gases.

	(%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	

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Putrescible wastes.....	0
Non-putrescible wastes.....	
Corrosive materials.....	~15.0
Pyrophoric materials.....	0
Generating toxic gases.....	~15.0
Reacting with water.....	0
Higher activity particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants: The waste contains toxic fission products (<10% in total). Nitric acid.

	(%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.....	<10.0	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

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Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids…….		
Other organic complexants.....		Organic complexing agents may be present at low concentrations.
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Conditioning method: The liquid will be vitrified.

Plant Name: Waste Vitrification Plant

Location: Sellafield

Plant startup date: July 1990

Total capacity (m^3/y incoming waste): ~280.0

Target start date for packaging this stream: -

Throughput for this stream (m^3/y incoming waste): ~150.0

Other information: Initially intermediate age material will be vitrified as this is consistent with the aim to achieve optimum heat loadings per container, whilst meeting other constraints and objectives. Older material will be blended with higher heat content liquors.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
HLW canister	100.0	~0.85	0.15	781

Likely container type comment: 0.85m^3 waste will result in 0.15m^3 of conditioned waste in a HLW container with a displacement volume of 0.196m^3. The average conditioning factor is 0.176 and the packaging factor is 0.231.

Range in container waste volume: -

Other information on containers: Stainless steel grade 309.

Likely conditioning matrix: Glass

Other information: Glass block within a stainless steel container.

Conditioned density (t/m^3): 2.65

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: No

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Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	The main sources of activity in the waste are mixed fission products and actinides resulting from the reprocessing of irradiated Oxide and Magnox fuels.
Uncertainty:	The activity accuracy is good. Based on tank and analytical records with activities derived using FISPIN based decay calculations.
Definition of total alpha and total beta/gamma:	The total specific activity values given on the radionuclide table are the sum of the listed alpha or beta/gamma emitting radionuclides excluding "other alpha" and "other beta/gamma", which are not estimated.
Measurement of radioactivities:	Specific activity data has been derived using calculated activities from tank and analytical records along with nuclear codes. The resultant activities have been divided by the measured waste volume to produce the specific activities reported.
Other information:	Short-lived daughters are not included. Other radionuclides not listed represent less than 0.01% of the total activity.

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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		8		8	Gd 153	5.80E-10	AA 2	5.80E-10	DD 2
Be 10	7.36E-06	AA 2	7.36E-06	DD 2	Ho 163	1.78E-09	AA 2	1.78E-09	DD 2
C 14		8		8	Ho 166m	9.80E-05	AA 2	9.80E-05	DD 2
Na 22	NE		NE		Tm 170	5.35E-18	AA 2	5.35E-18	DD 2
Al 26	NE		NE		Tm 171	1.08E-05	AA 2	1.08E-05	DD 2
Cl 36		8		8	Lu 174	1.55E-10	AA 2	1.55E-10	DD 2
Ar 39		8		8	Lu 176	3.33E-15	AA 2	3.33E-15	DD 2
Ar 42		8		8	Hf 178n		8		8
K 40	2.13E-09	AA 2	2.13E-09	DD 2	Hf 182	6.44E-14	AA 2	6.44E-14	DD 2
Ca 41	5.40E-05	AA 2	5.40E-05	DD 2	Pt 193	1.98E-09	AA 2	1.98E-09	DD 2
Mn 53	1.64E-11	AA 2	1.64E-11	DD 2	Tl 204	1.02E-10	AA 2	1.02E-10	DD 2
Mn 54	1.29E-08	AA 2	1.29E-08	DD 2	Pb 205	1.56E-11	AA 2	1.56E-11	DD 2
Fe 55	1.96E-02	AA 2	1.96E-02	DD 2	Pb 210	6.32E-08	AA 2	6.32E-08	DD 2
Co 60	4.60E-01	AA 2	4.60E-01	DD 2	Bi 208	4.20E-15	AA 2	4.20E-15	DD 2
Ni 59	2.38E-04	AA 2	2.38E-04	DD 2	Bi 210m	8.88E-16	AA 2	8.88E-16	DD 2
Ni 63	2.56E-02	AA 2	2.56E-02	DD 2	Po 210	6.16E-08	AA 2	6.16E-08	DD 2
Zn 65	6.00E-10	AA 2	6.00E-10	DD 2	Ra 223	8.39E-07	AA 2	8.39E-07	DD 2
Se 79	2.07E-03	AA 2	2.07E-03	DD 2	Ra 225	4.43E-09	AA 2	4.43E-09	DD 2
Kr 81		8		8	Ra 226	1.57E-07	AA 2	1.57E-07	DD 2
Kr 85		8		8	Ra 228	7.92E-12	AA 2	7.92E-12	DD 2
Rb 87	7.74E-07	AA 2	7.74E-07	DD 2	Ac 227	8.41E-07	AA 2	8.41E-07	DD 2
Sr 90	1.51E+03	AA 2	1.51E+03	DD 2	Th 227	8.28E-07	AA 2	8.28E-07	DD 2
Zr 93	6.56E-02	AA 2	6.56E-02	DD 2	Th 228	4.84E-05	AA 2	4.84E-05	DD 2
Nb 91	7.47E-09	AA 2	7.47E-09	DD 2	Th 229	4.43E-09	AA 2	4.43E-09	DD 2
Nb 92	5.98E-11	AA 2	5.98E-11	DD 2	Th 230	1.30E-05	AA 2	1.30E-05	DD 2
Nb 93m	4.39E-02	AA 2	4.39E-02	DD 2	Th 232	9.52E-12	AA 2	9.52E-12	DD 2
Nb 94	3.93E-06	AA 2	3.93E-06	DD 2	Th 234	8.83E-06	AA 2	8.83E-06	DD 2
Mo 93	3.02E-05	AA 2	3.02E-05	DD 2	Pa 231	5.03E-03	AA 2	5.03E-03	DD 2
Tc 97	4.40E-12	AA 2	4.40E-12	DD 2	Pa 233	1.56E-11	AA 2	1.56E-11	DD 2
Tc 99	3.72E-01	AA 2	3.72E-01	DD 2	U 232	3.39E-07	AA 2	3.39E-07	DD 2
Ru 106	1.18E-02	AA 2	1.18E-02	DD 2	U 233	1.56E-07	AA 2	1.56E-07	DD 2
Pd 107	3.12E-03	AA 2	3.12E-03	DD 2	U 234	3.47E-05	AA 2	3.47E-05	DD 2
Ag 108m	4.95E-07	AA 2	4.95E-07	DD 2	U 235	4.87E-07	AA 2	4.87E-07	DD 2
Ag 110m	1.34E-07	AA 2	1.34E-07	DD 2	U 236	6.69E-06	AA 2	6.69E-06	DD 2
Cd 109	3.64E-09	AA 2	3.64E-09	DD 2	U 238	8.83E-06	AA 2	8.83E-06	DD 2
Cd 113m	2.77E-01	AA 2	2.77E-01	DD 2	Np 237	5.03E-03	AA 2	5.03E-03	DD 2
Sn 119m	1.88E-08	AA 2	1.88E-08	DD 2	Pu 236	1.21E-07	AA 2	1.21E-07	DD 2
Sn 121m	6.30E-01	AA 2	6.30E-01	DD 2	Pu 238	1.29E-01	AA 2	1.29E-01	DD 2
Sn 123	2.05E-14	AA 2	2.05E-14	DD 2	Pu 239	2.26E-02	AA 2	2.26E-02	DD 2
Sn 126	4.60E-03	AA 2	4.60E-03	DD 2	Pu 240	5.61E-02	AA 2	5.61E-02	DD 2
Sb 125	1.74E+00	AA 2	1.74E+00	DD 2	Pu 241	2.37E+00	AA 2	2.37E+00	DD 2
Sb 126	3.41E-03	AA 2	3.41E-03	DD 2	Pu 242	1.16E-04	AA 2	1.16E-04	DD 2
Te 125m	4.24E-01	AA 2	4.24E-01	DD 2	Am 241	4.39E+01	AA 2	4.39E+01	DD 2
Te 127m	5.21E-14	AA 2	5.21E-14	DD 2	Am 242m	1.19E-01	AA 2	1.19E-01	DD 2
I 129		8		8	Am 243	2.33E-01	AA 2	2.33E-01	DD 2
Cs 134	2.40E+00	AA 2	2.40E+00	DD 2	Cm 242	9.80E-02	AA 2	9.80E-02	DD 2
Cs 135	2.21E-02	AA 2	2.21E-02	DD 2	Cm 243	1.26E-01	AA 2	1.26E-01	DD 2
Cs 137	2.07E+03	AA 2	2.07E+03	DD 2	Cm 244	9.76E+00	AA 2	9.76E+00	DD 2
Ba 133	1.18E-06	AA 2	1.18E-06	DD 2	Cm 245	1.84E-03	AA 2	1.84E-03	DD 2
La 137	9.83E-08	AA 2	9.83E-08	DD 2	Cm 246	4.08E-04	AA 2	4.08E-04	DD 2
La 138	5.88E-12	AA 2	5.88E-12	DD 2	Cm 248	3.13E-09	AA 2	3.13E-09	DD 2
Ce 144	5.92E-04	AA 2	5.92E-04	DD 2	Cf 249	2.82E-08	AA 2	2.82E-08	DD 2
Pm 145	8.93E-06	AA 2	8.93E-06	DD 2	Cf 250	6.11E-08	AA 2	6.11E-08	DD 2
Pm 147	2.52E+01	AA 2	2.52E+01	DD 2	Cf 251	1.21E-09	AA 2	1.21E-09	DD 2
Sm 147	2.90E-07	AA 2	2.90E-07	DD 2	Cf 252	4.96E-10	AA 2	4.96E-10	DD 2
Sm 151	1.27E+01	AA 2	1.27E+01	DD 2	Other a		6		6
Eu 152	8.49E-02	AA 2	8.49E-02	DD 2	Other b/g		6		6
Eu 154	3.23E+01	AA 2	3.23E+01	DD 2	**Total a**	**5.44E+01**	**AA 2**	**5.44E+01**	**CC 2**
Eu 155	3.27E+00	AA 2	3.27E+00	DD 2	**Total b/g**	**3.66E+03**	**AA 2**	**3.66E+03**	**CC 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