WASTE STREAM 5B04/C Cemented MTR Raffinate

SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Dounreay Site Restoration Limited

WASTE TYPE ILW

Is the waste subject to Scottish Policy: Yes

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	2432.0 m³	2777.3 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		2432.0 m³	2777.3 m³
Number of waste packages in stock:	At 1.4.2022.....	4864 package(s)	

Comment on volumes: There will be no further arisings.

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

WASTE SOURCE Materials Test Reactor (MTR) fuel reprocessing.

PHYSICAL CHARACTERISTICS

General description: The waste is an anion-deficient aluminium nitrate solution, containing fission products and some actinides from reprocessing spent MTR fuel, cemented in a 9:1 BFS/OPC matrix. There are no large items in the waste. The waste has been cemented into 500 litre drums.

Physical components (%vol): Cemented aqueous liquors (100%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.95

Comment on density: The density of the conditioned wasteform varies from 1.9 - 2.0 t/m³. The measurements were undertaken from cores taken from a full-scale inactive sample.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is composed mainly of cement containing neutralised MTR liquor. Cementitous grout (100%).

Chemical state: Alkali

Chemical form of radionuclides:
H-3: Likely to be present, form unknown.
C-14: Likely to be present, form unknown.
Cl-36: Likely to be present, form unknown.
Se-79: Likely to be present, form unknown.
Tc-99: Likely to be present, form unknown.
I-129: Likely to be present, form unknown.
Ra: Likely to be present, form unknown.
Th: Likely to be present, form unknown.
U: Likely to be present, form unknown.
Np: Likely to be present, form unknown.
Pu: Likely to be present, form unknown.

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	0		
Iron.....	0		
Aluminium.....	0		
Beryllium.....	0		

WASTE STREAM 5B04/C Cemented MTR Raffinate

Cobalt	0	
Copper	0	
Lead	TR	
Magnox/Magnesium	0	
Nickel	TR	
Titanium	0	
Uranium	0	
Zinc	0	
Zircaloy/Zirconium	0	
Other metals	<1.0	Metals are present but at trace levels within the cemented wasteform. Also includes Mercury.

Organics (%wt): The waste contains no organics. There are no halogenated plastics or rubbers present.

	(%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		
Halogenated rubber	0		
Non-halogenated rubber	0		
Hydrocarbons	0		
Oil or grease	0		
Fuel	0		
Asphalt/Tarmac (cont.coal tar)	0		
Asphalt/Tarmac (no coal tar)	0		
Bitumen	0		
Others	0		
Other organics	0		

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	>99.0		
Sand	0		
Glass/Ceramics	0		

WASTE STREAM 5B04/C Cemented MTR Raffinate

Graphite	0
Desiccants/Catalysts	0
Asbestos	0
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): The waste contains nitrates, sulphites, sulphates, phosphates and chlorides. Other anions, such as carbonates, will be present in small quantities.

	(%wt)	Type(s) and comment
Fluoride	0	
Chloride	P	
Iodide	0	
Cyanide	0	
Carbonate	P	
Nitrate	10.7	Sodium Nitrate 2.8M
Nitrite	TR	
Phosphate	P	
Sulphate	P	
Sulphide	P	

Materials of interest for waste acceptance criteria: The waste also contains mercury, cadmium and lead at trace quantities.

	(%wt)	Type(s) and comment
Combustible metals	0	
Low flash point liquids	0	
Explosive materials	0	
Phosphorus	TR	
Hydrides	0	
Biological etc. materials	0	
Biodegradable materials	0	
Putrescible wastes	0	
Non-putrescible wastes	0	
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	

WASTE STREAM 5B04/C Cemented MTR Raffinate

Hazardous substances / non hazardous pollutants: The waste contains mercury and trace quantities of cadmium and lead. Nickel, phosphorus and selenium may be present in trace quantities. Mercuric nitrate is present at <0.1%.

	(%wt)	Type(s) and comment
Acrylamide		
Benzene	NE	
Chlorinated solvents		
Formaldehyde		
Organometallics		
Phenol	NE	
Styrene		
Tri-butyl phosphate	NE	
Other organophosphates		
Vinyl chloride	NE	
Arsenic	NE	
Barium		
Boron	NE	
Boron (in Boral)		
Boron (non-Boral)		
Cadmium	TR	
Caesium		
Selenium	TR	
Chromium	NE	
Molybdenum	NE	
Thallium		
Tin	NE	
Vanadium	NE	
Mercury compounds	<1.0	
Others	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1		
EEE Type 2		
EEE Type 3		
EEE Type 4		
EEE Type 5		

Complexing agents (%wt):

	(%wt)	Type(s) and comment
EDTA		
DPTA		
NTA		
Polycarboxylic acids		
Other organic complexants		There are no organic complexing agents present.
Total complexing agents	0	

WASTE STREAM 5B04/C Cemented MTR Raffinate

Potential for the waste to contain discrete items: No.

PACKAGING AND CONDITIONING

Container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	100.0	0.5	0.5	4864

Container type comment: The waste is already conditioned.

Range in container waste volume: -

Other information on containers: -

Conditioned density (t/m^3): ~1.95

Conditioned density comment: The density of the conditioned wasteform varies from 1.9 - 2.0 t/m^3. The measurements were undertaken from cores taken from a full-scale inactive sample

Other information on conditioning: -

RADIOACTIVITY

Source: Activity arises mainly from fission products from the reprocessing of spent MTR fuel.

Uncertainty: The average specific activity is based on analysis of raffinate from Tanks 1, 2, 3, 4, 7, 8 and 18. FISPIN estimates were used where no analysis results were available. Tank 1 data have been used for the remaining tanks for which no assessment has been made. Analysis figures are accurate to within a factor of 3.

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: Those radionuclides not available by analysis have been estimated from Fispin calculations.

Other information: Specific activity uses UKRWI 2019 data decayed to 2022. DSRL is currently undertaking a package inventory review as part of the revalidation of the final LoC. This may lead to a change in radionuclide information in future UKRWI submissions.

WASTE STREAM 5B04/C Cemented MTR Raffinate

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	4.86E-03	B B 1			Gd 153	4.84E-19	B B 2		
Be 10	1.03E-04	B B 2			Ho 163	1.11E-15	B B 2		
C 14	6.82E-06	B B 2			Ho 166m	1.08E-10	B B 2		
Na 22					Tm 170				
Al 26					Tm 171	3.00E-13	B B 2		
Cl 36	3.74E-04	B B 1			Lu 174	4.75E-21	B B 2		
Ar 39					Lu 176	7.57E-27	B B 2		
Ar 42					Hf 178n				
K 40					Hf 182	1.59E-19	B B 2		
Ca 41	2.38E-05	B B 2			Pt 193				
Mn 53					Tl 204				
Mn 54	7.66E-15	B B 2			Pb 205				
Fe 55	4.63E-07	B B 2			Pb 210	5.80E-10	B B 2		
Co 60	1.69E-04	B B 2			Bi 208				
Ni 59	1.30E-04	B B 2			Bi 210m	2.93E-25	B B 2		
Ni 63	4.68E-03	B B 2			Po 210	5.68E-10	B B 2		
Zn 65	1.56E-21	B B 2			Ra 223	3.48E-09	B B 2		
Se 79	1.86E-04	B B 2			Ra 225	1.50E-11	B B 2		
Kr 81					Ra 226	1.29E-09	B B 2		
Kr 85					Ra 228	3.44E-13	B B 2		
Rb 87	7.87E-10	B B 2			Ac 227	3.48E-09	B B 2		
Sr 90	9.35E+00	B B 1			Th 227	3.43E-09	B B 2		
Zr 93	1.40E-03	B B 2			Th 228	3.69E-10	B B 2		
Nb 91	2.55E-18	B B 2			Th 229	1.50E-11	B B 2		
Nb 92	1.54E-18	B B 2			Th 230	7.82E-08	B B 2		
Nb 93m	4.91E-03	B B 2			Th 232	3.46E-13	B B 2		
Nb 94	7.81E-04	B B 2			Th 234	2.52E-07	B B 2		
Mo 93	6.42E-03	B B 2			Pa 231	5.00E-09	B B 2		
Tc 97	4.45E-17	B B 2			Pa 233	2.47E-05	B B 2		
Tc 99	8.95E-03	B B 2			U 232	2.95E-10	B B 2		
Ru 106	2.02E-08	B B 2			U 233	6.19E-09	B B 2		
Pd 107	5.58E-06	B B 2			U 234	4.16E-05	B B 2		
Ag 108m	1.27E-11	B B 2			U 235	8.44E-07	B B 1		
Ag 110m	8.56E-17	B B 2			U 236	2.37E-06	B B 1		
Cd 109	<8.70E-07	A 3			U 238	2.52E-07	B B 1		
Cd 113m	1.28E-04	B B 2			Np 237	2.47E-05	B B 2		
Sn 119m	7.56E-17	B B 2			Pu 236	7.20E-11	B B 2		
Sn 121m	1.39E-03	B B 2			Pu 238	1.76E-02	B B 1		
Sn 123	1.98E-31	B B 2			Pu 239	2.09E-03	B B 1		
Sn 126	4.34E-05	B B 2			Pu 240	1.15E-03	B B 1		
Sb 125	4.00E-05	B B 2			Pu 241	1.59E-02	B B 1		
Sb 126	6.08E-06	B B 2			Pu 242	9.14E-07	B B 1		
Te 125m	1.00E-05	B B 2			Am 241	2.11E-02	B B 1		
Te 127m	8.66E-36	B B 2			Am 242m	7.48E-06	B B 2		
I 129	9.48E-07	B B 2			Am 243	8.92E-06	B B 2		
Cs 134	1.91E-05	B B 1			Cm 242	6.17E-06	B B 2		
Cs 135	1.79E-04	B B 2			Cm 243	1.16E-06	B B 2		
Cs 137	1.01E+01	B B 1			Cm 244	9.81E-05	B B 2		
Ba 133	1.95E-13	B B 2			Cm 245	1.77E-08	B B 2		
La 137	5.21E-12	B B 2			Cm 246	1.54E-09	B B 2		
La 138	1.36E-16	B B 2			Cm 248	5.81E-18	B B 2		
Ce 144	1.44E-11	B B 2			Cf 249	1.55E-17	B B 2		
Pm 145	3.80E-16	B B 2			Cf 250	1.31E-17	B B 2		
Pm 147	1.17E-03	B B 2			Cf 251	2.00E-19	B B 2		
Sm 147	2.96E-10	B B 2			Cf 252	3.26E-21	B B 2		
Sm 151	7.06E-02	B B 2			Other a	1.2E-14	B B 2		
Eu 152	4.42E-03	B B 2			Other b/g				
Eu 154	9.93E-03	B B 2			**Total a**	**4.21E-02**	**B B 2**	**0**	
Eu 155	8.65E-04	B B 2			**Total b/g**	**1.96E+01**	**A B 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