WASTE STREAM 5B22 ADU Floc

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

		Reported
Stocks:	At 1.4.2022.....	128.0 m³
Future arisings -	1.4.2025 - 31.3.2026.....	16.0 m³
Total future arisings:		16.0 m³
Total waste volume:		144.0 m³

Comment on volumes: Future arisings consist of nitric acid tank washings which will occur after processing of ADU Floc. This additional waste may move to a different UKRWI wastestream pending further review. Stocks figure has been adjusted using recent updates to ADU Floc datasheets. 128m3 is the raw waste. There is expected to be an addition of ~65m3 of conditioning to the stocks that has not been represented here but will be reflected in the conditioned density. This wastestream will also produce an addition of 16 m³ of future arisings as an allowance for Nitric Acid Tank Washings

Uncertainty factors on volumes:				
	Stock (upper):	x 1.05	Arisings (upper)	x 1.2
	Stock (lower):	x 0.95	Arisings (lower)	x 0.8

WASTE SOURCE The floc results from the decontamination of high alpha MA/LA liquors from the PFR fuel reprocessing plant.

PHYSICAL CHARACTERISTICS

General description:	The waste is an alpha and beta/gamma contaminated ammonium diuranate (ADU) floc. There are no large items present.
Physical components (%vol):	Other Liquid (100.00%),
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m³):	1.28
Comment on density:	Density includes addition of approx 20m3 of nitric acid and 45m3 of NaOH as pre treatment to the wasteform.

CHEMICAL COMPOSITION

General description and components (%wt):	Other Liquid (100.00%),
Chemical state:	Alkali
Chemical form of radionuclides:	Ra: Trace quantities present. Th: Trace quantities present. U: Present as ammonium diuranate and UO2. Np: Trace quantities present. Pu: Trace quantities present as PuO2.
Metals and alloys (%wt):	The waste contains only metal ions in solution.

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

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Copper	
Lead	0
Magnox/Magnesium	0
Nickel	
Titanium	
Uranium	~
Zinc	0
Zircaloy/Zirconium	0
Other metals	

Organics (%wt): Trace quantities of organic solvent are present (MBP, DBP, TBP, OK). Quantities undetermined but total phosphate is < 1% by weight.

	(%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			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	0		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	100.0	ADU Floc	
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand	0		
Glass/Ceramics	0		
Graphite	0		
Desiccants/Catalysts			

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Asbestos	0
Non/low friable	
Moderately friable	
Highly friable	
Free aqueous liquids	
Free non-aqueous liquids	TR
Powder/Ash	0

Inorganic anions (%wt): In addition to thoses below, hydroxide (1.77%).

	(%wt)	Type(s) and comment
Fluoride	0	
Chloride	0	
Iodide	0	
Cyanide	0	
Carbonate	0	
Nitrate	~6.3	
Nitrite	0	
Phosphate	~2.7	
Sulphate	~2.5	
Sulphide	0	

Materials of interest for waste acceptance criteria: Sulphuric acid is present. There are also traces of solvents.

	(%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	0	
Corrosive materials		
Pyrophoric materials	0	
Generating toxic gases		
Reacting with water	0	
Higher activity particles	NE	
Soluble solids as bulk chemical compounds	0	

Hazardous substances / non hazardous pollutants: The waste contains a small amount of cadmium (<0.001%).

	(%wt)	Type(s) and comment
Acrylamide		

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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	NE	
Caesium		
Selenium	NE	
Chromium	NE	
Molybdenum	NE	
Thallium		
Tin	NE	
Vanadium	NE	
Mercury compounds		
Others	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1		
EEE Type 2		
EEE Type 3		
EEE Type 4		
EEE Type 5		

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA		
DPTA		
NTA		
Polycarboxylic acids		
Other organic complexants	TR	The waste contains small amounts of degraded TBP, DBP, MBP and kerosene.
Total complexing agents	TR	

Potential for the waste to contain discrete items: No.

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PACKAGING AND CONDITIONING

Conditioning method:	Once removed the waste will be treated to result in an acceptable product. ADU Floc may have to be dissolved in nitric acid to allow transfer of the Floc to a reaction vessel where it will be conditioned with sodium hydroxide. Current strategy indicates that the waste will then transferred to a temporary cementation plant for cementation into 500L drums.
Plant Name:	ADU Floc Cementation Plant
Location:	Dounreay
Plant startup date:	2024
Total capacity (m^3/y incoming waste):	120.0
Target start date for packaging this stream:	2024
Throughput for this stream (m^3/y incoming waste):	120.0
Other information:	ADU Floc cementation plant is currently under construction

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
500 l drum	100.0	~0.24	0.5	600

Likely container type comment:	The conditioning factor is expected to be about 2.0.
Range in container waste volume:	LoC assumes around 535 drums - this accomodates only the stocks ADU Floc. The arisings will create additional drums.
Other information on containers:	Stainless Steel. The container is likely to be manufactured from 316 stainless steel.
Likely conditioning matrix:	Pulverised fuel ash/Ordinary Portland cement mixture
Other information:	The dissolved ADU floc would then be added to NaOH, producing NaDU slurry which would be cemented into 500 litre drums.
Conditioned density (t/m^3):	~1.7
Conditioned density comment:	Density is likely to be around 1.7 t/m^3 once conditioned and cemented. Confirmed by updated ADU Floc datasheets.
Other information on conditioning:	-
Opportunities for alternative disposal routing:	No

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

RADIOACTIVITY

Source:	Main source of radioactivity is fission products with Am-241, Cm-243 and plutonium (alpha).
Uncertainty:	Accuracy of tank analysis 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'.

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Measurement of radioactivities:	The specific activities of the principal radionuclides were measured by sampling followed by radiochemical analysis in 2006 and 2011 and adjusted to align with Nuclear Material Accountancy records. Other specific activities were estimated using a rigorous approach involving back calculation from the PFR raffinate inventory.
Other information:	Arisings Specific Activity is derived from Stocks SA lowered through addition of clean nitric acid.LoC reference volume of 128m3 used. PWI uses a measured 126m3. For puproses of UKRWI, assume this is the same volume.

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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	8.90E-06	B B 1	3.95E-06	B B 2	Gd 153	1.08E-20	B B 2	4.82E-21	B B 2
Be 10	2.95E-13	B B 2	1.31E-13	B B 2	Ho 163	8.76E-14	B B 2	3.89E-14	B B 2
C 14	2.42E-08	B B 2	1.07E-08	B B 2	Ho 166m	9.3E-12	B B 2	4.13E-12	B B 2
Na 22					Tm 170				
Al 26					Tm 171	1.51E-12	B B 2	6.69E-13	B B 2
Cl 36	6E-13	B B 2	2.67E-13	B B 2	Lu 174	5.34E-13	B B 2	2.37E-13	B B 2
Ar 39					Lu 176				
Ar 42					Hf 178n	6.39E-11	B B 2	2.84E-11	B B 2
K 40	4.43E-14	B B 2	1.97E-14	B B 2	Hf 182				
Ca 41	4.98E-11	B B 2	2.21E-11	B B 2	Pt 193	5.72E-10	B B 2	2.54E-10	B B 2
Mn 53	<3.8E-13	C 3	<1.69E-13	C 2	Tl 204	1.94E-09	B B 2	8.64E-10	B B 2
Mn 54	<8.09E-14	C 3	<3.60E-14	C 2	Pb 205	2.19E-14	B B 2	9.73E-15	B B 2
Fe 55	<2.20E-07	C 3	<9.78E-08	C 2	Pb 210	1.01E-09	B B 2	4.48E-10	B B 2
Co 60	2.28E-06	B B 1	1.01E-06	B B 2	Bi 208	1.63E-14	B B 2	7.24E-15	B B 2
Ni 59	8.96E-08	B B 2	3.98E-08	B B 2	Bi 210m				
Ni 63	3.84E-06	B B 2	1.71E-06	B B 2	Po 210	9.19E-10	B B 2	4.08E-10	B B 2
Zn 65	3.47E-17	B B 2	1.54E-17	B B 2	Ra 223	4.62E-09	B B 2	2.05E-09	B B 2
Se 79	1.59E-07	B B 2	7.07E-08	B B 2	Ra 225	2.10E-08	B B 2	9.32E-09	B B 2
Kr 81					Ra 226	6.66E-09	B B 2	2.96E-09	B B 2
Kr 85					Ra 228	5.84E-14	B B 2	2.60E-14	B B 2
Rb 87	5.55E-12	B B 2	2.47E-12	B B 2	Ac 227	4.68E-09	B B 2	2.08E-09	B B 2
Sr 90	8.46E-03	B B 2	3.76E-03	B B 2	Th 227	4.58E-09	B B 2	2.04E-09	B B 2
Zr 93	5.96E-06	B B 2	2.65E-06	B B 2	Th 228	6.73E-05	B B 2	2.99E-05	B B 2
Nb 91	1.34E-08	B B 2	5.97E-09	B B 2	Th 229	2.10E-08	B B 2	9.35E-09	B B 2
Nb 92	4.4E-13	B B 2	1.96E-13	B B 2	Th 230	1.85E-06	B B 2	8.22E-07	B B 2
Nb 93m	1.04E-05	B B 2	4.64E-06	B B 2	Th 232	1.03E-13	B B 2	4.56E-14	B B 2
Nb 94	1.41E-07	B B 2	6.27E-08	B B 2	Th 234	1.54E-03	B B 2	6.84E-04	B B 2
Mo 93	5.22E-08	B B 2	2.32E-08	B B 2	Pa 231	2.09E-08	B B 2	9.28E-09	B B 2
Tc 97	8.54E-12	B B 2	3.80E-12	B B 2	Pa 233	2.47E-04	B B 2	1.10E-04	B B 2
Tc 99	1.25E-01	B B 2	5.56E-02	B B 2	U 232	6.56E-05	B B 2	2.92E-05	B B 2
Ru 106	<2.72E-07	C 3	<1.21E-07	C 2	U 233	1.34E-05	B B 2	5.96E-06	B B 2
Pd 107	2.74E-07	B B 2	1.22E-07	B B 2	U 234	1.21E-02	B B 1	5.39E-03	B B 2
Ag 108m	4.53E-10	B B 2	2.01E-10	B B 2	U 235	5.91E-05	B B 1	2.63E-05	B B 2
Ag 110m	1.48E-15	B B 2	6.60E-16	B B 2	U 236	1.25E-04	B B 1	5.56E-05	B B 2
Cd 109	1.93E-13	B B 2	8.57E-14	B B 2	U 238	1.54E-03	B B 1	6.84E-04	B B 2
Cd 113m	7.51E-07	B B 2	3.34E-07	B B 2	Np 237	2.47E-04	B B 2	1.10E-04	B B 2
Sn 119m	1.21E-15	B B 2	5.38E-16	B B 2	Pu 236	1.25E-09	B B 2	5.55E-10	B B 2
Sn 121m	2.04E-05	B B 2	9.06E-06	B B 2	Pu 238	2.10E+00	B B 2	9.35E-01	B B 2
Sn 123	5.95E-25	B B 2	2.64E-25	B B 2	Pu 239	1.55E-01	B B 2	6.89E-02	B B 2
Sn 126	5.49E-07	B B 2	2.44E-07	B B 2	Pu 240	1.57E-01	B B 1	6.97E-02	B B 2
Sb 125	6.23E-06	B C 3	2.77E-06	B C 2	Pu 241	1.64E+00	B B 1	7.29E-01	B B 2
Sb 126	7.69E-08	B B 2	3.42E-08	B B 2	Pu 242	1.26E-04	B B 1	5.6E-05	B B 2
Te 125m	<1.56E-06	C 3	<6.93E-07	C 2	Am 241	1.00E-01	B B 2	4.46E-02	B B 2
Te 127m					Am 242m	9.68E-05	B B 2	4.30E-05	B B 2
I 129	3.17E-04	B B 2	1.41E-04	B B 2	Am 243	6.39E-06	B B 2	2.84E-06	B B 2
Cs 134	6.54E-07	B C 3	2.91E-07	B C 2	Cm 242	7.98E-05	B B 2	3.55E-05	B B 2
Cs 135	7.68E-07	B B 2	3.41E-07	B B 2	Cm 243	1.77E-05	B B 1	7.89E-06	B B 2
Cs 137	2.47E-02	B B 2	1.10E-02	B B 2	Cm 244	1.49E-04	B B 2	6.63E-05	B B 2
Ba 133	2.88E-09	B B 2	1.28E-09	B B 2	Cm 245	1.73E-08	B B 2	7.69E-09	B B 2
La 137	5.55E-12	B B 2	2.47E-12	B B 2	Cm 246	6.81E-10	B B 2	3.03E-10	B B 2
La 138					Cm 248				
Ce 144	<2.17E-11	C 3	<9.65E-12	C 2	Cf 249	1.84E-14	B B 2	8.18E-15	B B 2
Pm 145	4.36E-11	B B 2	1.94E-11	B B 2	Cf 250	5.93E-15	B B 2	2.64E-15	B B 2
Pm 147	7.41E-05	B B 2	3.29E-05	B B 2	Cf 251				
Sm 147	4.11E-12	B B 2	1.82E-12	B B 2	Cf 252				
Sm 151	1.35E-03	B B 2	6.00E-04	B B 2	Other a				
Eu 152	8.11E-07	B B 2	3.60E-07	B B 2	Other b/g				
Eu 154	1.18E-02	B B 1	5.24E-03	B B 2	**Total a**	**2.53E+00**	**B B 2**	**1.12E+00**	**B B 2**
Eu 155	6.36E-03	B B 2	2.82E-03	B B 2	**Total b/g**	**1.82E+00**	**B B 2**	**8.09E-01**	**B B 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