WASTE STREAM	7D30/C	Devonport Conditioned Sludge (for Disposal to NWS)

SITE HMNB Devonport

SITE OWNER Ministry of Defence (MOD)

WASTE CUSTODIAN Babcock International Group

WASTE TYPE LLW

WASTE VOLUMES

		Reported (m^3)	OR	Conditioned (m^3)	Packaged (m^3)
Stocks:	At 1.4.2025			= 1.0	1.3
Future arisings:	1.4.2025 - 31.3.2028			= 9.0	11.5
	1.4.2028 - 31.3.2031			= 9.0	11.5
	1.4.2031 - 31.3.2034			= 9.0	11.5
Total future arisings:				**27.0**	**34.4**
Total waste volume:				**28.0**	**35.7**

Number of waste packages in stock: At 1.4.2025…… - packages

Comment on arising rates: The volumes are conditioned volumes.

Additional information on quantities: Generation of waste is programme driven. Programme tool was used to predict arisings, however volumes may vary depending on both planned and emergent maintenance on the DRDL site.

Uncertainty factors on volumes:

Stock (upper):	x 1.20	Arisings (upper):	x 2.00
Stock (lower):	x 0.80	Arisings (lower):	x 0.50

WASTE SOURCE The waste arises from the operation of the radioactive effluent treatment facilities. Particulate material can settle in tanks forming the sludge which is removed. Similar sludges are also removed from portable effluent tanks during maintenance operations.

PHYSICAL CHARACTERISTICS

General description: Conditioning method is encapsulation. The waste is a slurry of some inactive materials such as dust and rust particles. The active component is Co-60 and other activation products. The waste is encapsulated in cement powder within a 200 L mild steel drum. an inactive grout is applied to the drum to seal the active surface. There are no large items in this waste. Waste is currently stored awaiting conditioning before consignment to NWS.

Changes since waste generated: -

Bulk density (t/m^3): = 0.44

Comment on density: The density is that of the raw sludge in a mild steel 200 L drum. Value calculated from current stocks and previous consignments.

CHEMICAL COMPOSITION

General description and components (%wt): Tank cleaning sludge. The solid content of the raw sludge is mainly inactive inorganic materials such as rust particles, concrete and sand particles, non-asbestos lagging dust, together with a minor component of organic debris particles. The active component of the slurry is traces of CRUD which include Co-60, Fe-55, and Ni-63. The composition of the encapsulated product is 23% metal (including the drums), 67.9% encapsulated sludge, 9.1% soft organics and 0.1% plastics/ rubber.

Chemical state: Alkali

Sheet metal proportion / thickness: No sheet metal present. Only metal present in the conditioned waste product will be the 200 L drum (primary container).

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	= 0	-	
Other ferrous metals	= 23.0	Mild Steel Drum	
Iron		-	
Aluminium		-	
Beryllium		-	
Cobalt		-	
Copper		-	
Lead		-	
Magnox/Magnesium		-	
Nickel		-	
Titanium		-	
Uranium		-	
Zinc		-	
Zircaloy/Zirconium		-	
Other metals		-	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	~ 9.0	-	
Paper, cotton	~ 9.0	-	
Wood		-	
Halogenated plastics		-	
Total non-halogenated plastics	~ 0.05	-	
Condensation polymers		-	
Others		-	
Organic ion exchange materials		-	
Total rubber	~ 0.05	-	
Halogenated rubber		-	
Non-halogenated rubber		-	
Hydrocarbons		-	
Oil or grease		-	
Fuel		-	
Asphalt/Tarmac (cont.coal tar)		-	
Asphalt/Tarmac (no coal tar)		-	
Bitumen		-	
Others		-	
Other organics		-	

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	= 67.9	-	
Sand	= 0	-	
Glass/Ceramics	= 0	-	
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	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride	= 0	-
Chloride	= 0	-
Iodide	= 0	-
Cyanide	= 0	-
Carbonate	= 0	-
Nitrate	= 0	-
Nitrite	= 0	-
Phosphate	= 0	-
Sulphate	TR	-
Sulphide	= 0	-

Materials of interest for waste acceptance criteria:

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

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide	= 0	-
Benzene	= 0	-
Chlorinated solvents	= 0	-
Formaldehyde	= 0	-
Organometallics	= 0	-
Phenol	= 0	-
Styrene	= 0	-
Tri-butyl phosphate	= 0	-
Other organophosphates	= 0	-
Vinyl chloride	= 0	-
Arsenic	= 0	-
Barium	= 0	-
Boron	P	-
Boron (in Boral)		-
Boron (non-Boral)	< 0.01	-
Cadmium	= 0	-
Caesium	= 0	-
Selenium	= 0	-
Chromium	= 0	-
Molybdenum	= 0	-
Thallium	= 0	-
Tin	= 0	-
Vanadium	= 0	-
Mercury compounds	= 0	-
Others	= 0	-

Complexing agents (%wt): No

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

Physical components:

	Number	Type(s) and comment
Sources	= 0	-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1		-
EEE Type 2		-
EEE Type 3		-
EEE Type 4		-
EEE Type 5		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction		
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration	Off-site	~ 15.0
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation	Off-site	~ 85.0
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments: The table above assumes 85% of sludge disposals to NWS for cementation. There is a possibility that, depending on the BAT option, some lower activity sludges may undergo disposal via incineration as part of a waste diversion option (~ 15%).

Conditioning method: Conditioning method is encapsulation. Cement powder addition physically immobilises the solid particulate and ensures that there is no free liquid in the disposal wasteform.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix: Unknown

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m^3)	Payload (m^3)	Number of packages	Estimated start date for packaging
1/2 Height IP-2 Disposal/Re-usable ISO (TC01/TC02)	85.0	3.3	13.0	8	-

Range in container waste loading: As previously stated, sludge production is programme dependent and so volumes can vary.

Other information on packaging and conditioning: Drums containing encapsulated/solidified sludge will be sent in a 1/2 height container for final grouting at NWS. When conditioned the volume of waste will increase approximately by a factor of 4. It is assumed each 1/2 Height IP-2 Disposal/Re-usable ISO (TC01/TC02) will approximately have a 13 m3 payload. Therefore it will only contain 3.25 m3 of raw waste.

Conditioned density (t/m^3): ~ 1.7

Conditioned density comment: Raw bulk density = 0.435, conditioned waste volume increases by ~ factor of 4.

Management Routes:

Disposal Route	Stream volume %	Raw density t/m^3	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)			
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository	~ 85.0	~ 1.7	
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility	~ 15.0	~ 0.44	
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The waste is contaminated with Co-60, Fe-55, C-14, Ni-63 and other beta/gamma emitters. Activity is from activation products that have collected in the sludge during liquid effluent processing operations.

Uncertainty: The specific activity values are an estimate based on the activities of all sludge drums that have undergone radiochemical analysis. All waste is representatively sampled prior to conditioning. It is expected that the waste will be encapsulated.

Measurement of radioactivities: Representative sampling of sludge drum contents and radiochemical analysis determines the activity of primary beta/gamma emitters and other difficult to measure nuclides. Volumes of the waste drums are also assessed as part of the sampling procedure. A generic radionuclide fingerprint is used to estimate the activities of nuclides that are less than the limit of detection of the radiochemcial analysis techniques used.

Chemical form of radionuclides:

H-3: HTO will be present in the overstanding liquid. This will be assessed when the waste is samples.

C-14: C-14 will be present in the waste. The exact quantity will be determined by representative sampling.

Cl-36: May be present in trace amounts.
Se-79: -
Tc-99: May be present in trace amounts.
I-129: May be present in trace amounts.
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM **7D30/C** **Devonport Conditioned Sludge (for Disposal to NWS)**

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Mean radioactivity, TBq/m³ Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Mean radioactivity, TBq/m³ Future Arisings	Bands and Code
H 3	~ 9.24E-07	B B 2	~ 9.24E-07	C C 2	Gd 153				
Be 10					Ho 163				
C 14	~ 9.06E-05	B B 2	~ 9.06E-05	C C 2	Ho 166m				
Na 22	~ 1.36E-10	B B 2	~ 1.36E-10	C C 2	Tm 170				
Al 26					Tm 171				
Cl 36	~ 4.07E-10	B B 2	~ 4.07E-10	C C 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	~ 3.30E-07	B B 2	~ 3.30E-07	C C 2	Pb 205				
Fe 55	~ 5.31E-05	B B 2	~ 5.31E-05	C C 2	Pb 210				
Co 60	~ 3.09E-05	B B 2	~ 3.09E-05	C C 2	Bi 208				
Ni 59	~ 1.54E-08	B B 2	~ 1.54E-08	C C 2	Bi 210m				
Ni 63	~ 4.33E-06	B B 2	~ 4.33E-06	C C 2	Po 210				
Zn 65	~ 7.24E-07	B B 2	~ 7.24E-07	C C 2	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	~ 2.48E-10	B B 2	~ 2.48E-10	C C 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93	~ 2.45E-10	B B 2	~ 2.45E-10	C C 2	Pa 231				
Tc 97					Pa 233				
Tc 99	~ 1.31E-11	B B 2	~ 1.31E-11	C C 2	U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m	~ 9.49E-08	B B 2	~ 9.49E-08	C C 2	U 235				
Ag 110m	~ 1.29E-07	B B 2	~ 1.29E-07	C C 2	U 236				
Cd 109					U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
Sn 126					Pu 240				
Sb 125	~ 3.74E-07	B B 2	~ 3.74E-07	C C 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241	~ 1.24E-06	B B 2	~ 1.24E-06	C C 2
Te 127m					Am 242m				
I 129	~ 7.22E-10	B B 2	~ 7.22E-10	C C 2	Am 243				
Cs 134	~ 7.43E-09	B B 2	~ 7.43E-09	C C 2	Cm 242				
Cs 135					Cm 243				
Cs 137	~ 1.42E-07	B B 2	~ 1.42E-07	C C 2	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					Unsp a				
Eu 152	~ 7.69E-09	B B 2	~ 7.69E-09	C C 2	Unsp b/g	~ 7.44E-08	B B 2	~ 7.44E-08	C C 2
Eu 154	~ 4.17E-07	B B 2	~ 4.17E-07	C C 2	**Total a**	**1.24E-06**	*	**1.24E-06**	*
Eu 155	~ 8.24E-09	B B 2	~ 8.24E-09	C C 2	**Total b/g**	**1.82E-04**	*	**1.82E-04**	*

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 the 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
* Total calculated from the 114 declared radionuclides