WASTE STREAM	7D26/C	Devonport Conditioned Low Level Ion-Exchange Resin

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			~ 7.5	10.9
Future arisings:	1.4.2025 - 31.3.2028			~ 18.0	26.1
	1.4.2028 - 31.3.2031			~ 16.2	23.4
	1.4.2031 - 31.3.2034			~ 15.5	22.5
	1.4.2034 - 31.3.2037			~ 0.2	0.3
Total future arisings:				**49.9**	**72.4**
Total waste volume:				**57.4**	**83.3**

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

Comment on arising rates: Submarine refit and maintenance programme is not constant. There are fluctuations dependent upon defence work program. Arisings have been predicted using best available information. Future arisings are based on new resin generation over next 10 years including resins from other DRDL resin wastestreams (7D28, 7D29, 7D34, 7D40 and 7D41) that have undergone conditioning/treatment campaign as part of a MoD driven Resin Disposal Project (RDP) to reduce C14 & chelates.

Additional information on quantities: Waste will be consigned to an external treatment facility in Resin Storage Vessels (RSVs) in a raw state for processing and encapsulation into 200 litre drums prior to disposal at NWS. Volumes reported are for the raw volume of the waste. At the discretion of the waste treatment provider, the waste may be used in a cement mixture to fill interstitial space between 200 litre drums of waste within a disposal container (e.g. 1/2 height ISO).

Uncertainty factors on volumes:

Stock (upper):	x 1.10	Arisings (upper):	x 1.30
Stock (lower):	x 0.90	Arisings (lower):	x 0.70

WASTE SOURCE (i) Effluent treatment plant, (ii) Active water treatment plant, (iii) Alternate core removal cooling plant, (iv) On board Primary circuit treatment plant, (v) Conforming resin from decontamination plants

PHYSICAL CHARACTERISTICS

General description: The waste consists of resin beads which are uniform spheroids of approximately 1.0 mm size. The ion exchange resin is organic mixed cation and anion hydrogen-hydroxide (H-OH) type. These are manufactured from polystyrene divinylbenzene copolymer. The ion exchange resin is mixed to ensure an even number of anion / cation active sites. When resin is shown to be exhausted it is discharged into a Resin Storage Vessel (RSV). Resin is headed by an amount of water and remains wet during its storage period.There are no large items present.

Changes since waste generated: No physical/chemical changes since the waste was generated. Resin waste is insoluble and is stored within a purpose designed resin storage vessel (RSV) until treatment/disposal. The waste resin will have been conditioned at an external treatment facility prior to disposal at NWS.

Bulk density (t/m^3): = 1.9

Comment on density: Raw waste has a density of 1.1 t/m^3 (resin/water mixture). The density given is the mean density of the conditioned waste and is based on 120 litres of resin encapsulated into each 200 litre drum.

CHEMICAL COMPOSITION

General description and components (%wt): Raw waste: Resin (75%), water (25%). Conditioned waste: Polystyrene bead resin (24%), OPC/BFS cement (64%), mild steel (drum) (12%).

Chemical state: Acid

Sheet metal proportion / thickness: The surface area of the package (drum) (0.58m diameter x 0.87m high) is 2.1 m2. Package thickness is 1.2 mm.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	= 0	-	
Other ferrous metals	= 12.0	Mild steel (drum used as package for conditioned resin waste)	
Iron		-	
Aluminium	= 0	-	
Beryllium	= 0	-	
Cobalt	= 0	-	
Copper	= 0	-	
Lead	= 0	-	
Magnox/Magnesium	= 0	-	
Nickel	= 0	-	
Titanium		-	
Uranium	= 0	-	
Zinc	= 0	-	
Zircaloy/Zirconium	= 0	-	
Other metals	= 0	-	

Organics (%wt):

	(%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	= 24.0	ion exchange resin of organic mixed cation and anion hydrogen-hydroxide (H-OH) type. These are manufactured from polystyrene divinylbenzene copolymer	100.0
Total rubber	= 0	-	
Halogenated rubber	= 0	-	
Non-halogenated rubber	= 0	-	
Hydrocarbons		-	
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	= 0	-	
Soil	= 0	-	
Brick/Stone/Rubble	= 0	-	
Cementitious material	= 64.0	9:1 BFS/OPC grout matrix	< 0.1
Sand	= 0	-	
Glass/Ceramics	= 0	-	
Graphite	= 0	-	
Desiccants/Catalysts	= 0	-	
Asbestos	= 0	-	
Non/low friable		-	
Moderately friable		-	
Highly friable		-	
Free aqueous liquids	= 0	Resin remains wet when stored with overstanding head of water.	
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	= 0	-
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		-
Benzene	= 0	-
Chlorinated solvents		-
Formaldehyde		-
Organometallics		-
Phenol	= 0	-
Styrene		-
Tri-butyl phosphate	= 0	-
Other organophosphates		-
Vinyl chloride	= 0	-
Arsenic	= 0	-
Barium		-
Boron	< 0.04	Average ~ 20.63 mg/l across entire waste stream volume (although not all packages will contain boron. Boron is also encapsulated in cement matrix). Average over boronated inventory only: 82.5 mg/l. max in any one RSV: 110 mg/l
Boron (in Boral)	= 0	-
Boron (non-Boral)	< 0.04	-
Cadmium	= 0	-
Caesium		-
Selenium	= 0	-
Chromium	= 0	-
Molybdenum	= 0	-
Thallium		-
Tin	= 0	-
Vanadium	= 0	-
Mercury compounds		-
Others	= 0	-

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA		-
DPTA		-
NTA		-
Polycarboxylic acids		-
Other organic complexants	<< 0.01	Sampling includes analysis for complexing agents. Only resins with results below detection thresholds will be disposed under this wastestream. However, although not expected, it is possible there may be very small trace quantities of undetected organic complexing agentspresent (i.e. << 0.01% w/o).
Total complexing agents	<< 0.01	-

Physical components:

	Number	Type(s) and comment
Sources		-
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	~ 3.4
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation	Off-site	~ 96.6
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments: The resin is mixed with a standard cement mixture before an inactive capping grout is applied to the drum to seal the active surface.

Conditioning method: The waste consists of conditioned ion exchange resin. The resin is nuclear grade polystyrene bead based (H-OH resin), consisting of uniform spheroids of approximately 0.6 - 1 mm diameter. the resin is immobilised in a cement matrix using an in-drum mixing technique in order for NWS/LLW Repository wasteform requirements to be met. The wastestream is conditioned in the Tradebe Inutec LLW Cementation Plant at Winfrith and the final product consists of an uncompactable waste matrix. The encapsulation process will be carefully controlled to ensure that each container and its contents meet all aspects of the NWS WAC, including Discrete Item limits where applicable. The wastestream is conditioned by mixing the wet resin with a blend of cement powders so that the resultant grout sets to a dry, solid monolith. An IX/cement resin formulation has been developed which is based on 120 litres of fully water-saturated and flooded resin mixed with 170kg blended cement powder. The blended cement powder consists of a standard mixture of ground-granulated blast furnace slag (ggBFS) and ordinary Portland cement (OPC) in the mass ratio 9:1 respectively for non-borated resin and 100 % OPC for borated resin. The waste loading of the final cement wasteform for 7D26/C is typically 25% by mass

Conditioning plants:

Plant Name	Location

Likely conditioning matrix: Non-standard

Further information on the conditioning matrix: OPC/BFS cement (64%)

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)	96.7	3.3	13.0	18	-

Range in container waste loading:

Other information on packaging and conditioning: There is a possibility that the encapsulated resin could be transferred directly into an ISO as part of the cement mixture to fill interstitial spaces between other wastes. This method will only be used if confirmed as appropriate. Waste may be contained in drums (and subsequently placed in half height ISO containers) or directly into a suitable ISO. The volume stated in the table under the 'Volume' tab is the raw volume of the waste not the conditioned volume. The conditioned volume is approximately 4 times greater than the raw waste volume. It is assumed 13 m3 fill would be put into the TC01/TC02

Conditioned density (t/m^3): ~ 1.9

Conditioned density comment: The density given is the mean density of the conditioned waste and is based on 120 litres of resin encapsulated into each 200 litre drum.

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	= 96.6	~ 1.1	2026
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	~ 3.4	~ 1.1	2025
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 main source of activity held on the ion exchange resin are activation products from operation of PWR reactor. The main contaminants are cobalt-60, iron-55, carbon-14, nickel-63 and tritium at low levels The waste is generated by the processing of radioactive liquid by submarine coolant treatment systems and shore base facilities.

Uncertainty: The raw resin within each container is representatively sampled using a full core sampling technique. The resin is then analysed for a range of beta/gamma nuclides e.g. Co-60, Fe-55, Ni-63, C-14, Cl-36 and H-3 & gamma spectroscopy. There are triggers in the sampling and analysis routine that carries out additional analysis for other nuclides should certain key nuclides be detected.

Measurement of radioactivities: Representative core samples taken, then the sample subjected to a range of chemical analysis and radiochemical techniques. Average waste stream values have been presented. The resin is analysed for a range of beta/gamma nuclides e.g. Co-60, Fe-55, Ni-63, C-14, Cl-36 and H-3 & gamma spectroscopy. There are triggers in the sampling and analysis routine that carries out additional analysis for other nuclides should certain key nuclides be detected. Specific Activity figures have been derived from current stock data and represent a reasonably consistant waste origin, therefore future arisings, which are expected to remain consistant, can only be estimated based on the same SA estimated figure i.e. the values are specific activity not total activity (which would vary depending on expected volume). An assessment has identified the major nuclides and also Difficult to Measure (DTM) nuclides that could be present within the waste. The analysis procedure (for major and DTM nuclides) and techniques employed are detailed in the extant WCH.

Chemical form of radionuclides:

H-3: Tritium will be present as HTO.
C-14: On resin in various chemical forms, mainly adhered to the resin.
Cl-36: -
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM **7D26/C** **Devonport Conditioned Low Level Ion-Exchange Resin**

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	= 9.57E-04	A A 1	~ 9.57E-04	B B 2	Gd 153				
Be 10					Ho 163				
C 14	= 2.06E-03	A A 1	~ 2.06E-03	B B 2	Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40	= 1.07E-07	A A 1	~ 1.07E-07	B B 2	Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	= 1.78E-08	A A 1	~ 1.78E-08	B B 2	Pb 205				
Fe 55	= 1.68E-04	A A 1	~ 1.68E-04	B B 2	Pb 210				
Co 60	= 1.67E-03	A A 1	~ 1.67E-03	B B 2	Bi 208				
Ni 59					Bi 210m				
Ni 63	= 4.79E-04	A A 1	~ 4.79E-04	B B 2	Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m					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	= 2.91E-07	A A 1	~ 2.91E-07	B B 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241	= 3.83E-07	A A 2	~ 3.83E-07	B B 2
Te 127m					Am 242m				
I 129	= 6.53E-07	A A 1	~ 6.53E-07	B B 2	Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	= 7.16E-06	A A 1	~ 7.16E-06	B B 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					Unsp b/g				
Eu 154					**Total a**	**3.83E-07**	*	**3.83E-07**	*
Eu 155	= 4.80E-08	A A 1	~ 4.80E-08	B B 2	**Total b/g**	**5.34E-03**	*	**5.34E-03**	*

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