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

SITE	HMNB Devonport
SITE OWNER	Ministry of Defence
WASTE CUSTODIAN	Babcock International Group
WASTE TYPE	LLW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	~2.8 m³	17.1 m³
Future arisings -	1.4.2023 - 31.3.2025.....	~16.3 m³	97.7 m³
	1.4.2025 - 31.3.2028.....	~23.3 m³	139.7 m³
	1.4.2028 - 31.3.2031.....	~18.3 m³	109.7 m³
	1.4.2031 - 31.3.2034.....	~5.3 m³	31.9 m³
Total future arisings:		63.2 m³	379.1 m³
Total waste volume:		66.0 m³	396.1 m³

Comment on volumes: 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 12 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 remove C14 & chelates. Waste will be consigned in 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. 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 1.1	Arisings (upper)	x 1.3
	Stock (lower):	x 0.9	Arisings (lower)	x 0.7

WASTE SOURCE (i) Effluent treatment plant, (ii) Active water treatment plant, (iii) Alternate core removal cooling plant (not boronated), (iv) On board Primary circuit treatment plant, (v) Conforming resin from decontamination plants

PHYSICAL CHARACTERISTICS

General description:	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. There are no large items present. The waste is mixed with a standard cement mixture (see below) before an inactive capping grout is applied to the drum to seal the active surface. The waste resin will have been conditioned at an external treatment facility prior to disposal at NWS.
Physical components (%wt):	Cation and anion exchange resin (24 wt%), OPC/BFS cement (64 wt%), metal drums (12 wt%).
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m³):	1.9
Comment on density:	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):	Polystyrene bead resin (24%), OPC/BFS cement (64%), mild steel (12%).
Chemical state:	Alkali
Chemical form of radionuclides:	H-3: Tritium will be present as HTO. C-14: C-14 is present on resin in a number of different chemical forms, mainly carbonate, organic acids and carbide in magnetite.
Metals and alloys (%wt):	The surface area of the package (drum) (0.58m diameter x 0.87m high) is 2.1 m2. Package thickness is 1.2 mm.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0		
Other ferrous metals	12.0	Mild steel	
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): The waste is made up of conditioned polystyrene type bead resin.

	(%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		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): -

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

Inorganic anions (%wt): There are no free inorganic anions in the waste.

	(%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	

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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: Boron may be present in the waste.

	(%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.....	<0.02	Average ~ 22 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: 65 mg/l. max in any one RSV: 110 mg/l
Boron (in Boral).....	0	
Boron (non-Boral).....	<0.02	
Cadmium.....	0	
Caesium.....		
Selenium.....	0	
Chromium.....	0	
Molybdenum.....	0	
Thallium.....		
Tin.....	0	
Vanadium.....	0	
Mercury compounds.....		
Others.....	0	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		

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EEE Type 5.....

Complexing agents (%wt): No

	(%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	

Potential for the waste to contain discrete items: No.

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction Supercompaction (HFC) Incineration Solidification Decontamination Metal treatment Size reduction Decay storage Recyling / reuse Other / various None	Off-site	100.0

Comment 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.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	100.0	~1.9
Expected to be consigned to a Landfill Facility		
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility		
Expected to be consigned to a Metal Treatment Facility		
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

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

Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):

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Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be consigned to an On-Site Disposal Facility Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be consigned as Out of Scope Expected to be recycled / reused Disposal route not known			

Opportunities for alternative disposal routing: -

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

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m³	Number of packages
1/3 Height IP-1 ISO 2/3 Height IP-2 ISO 1/2 Height WAMAC IP-2 ISO 1/2 Height IP-2 Disposal/Re-usable ISO 2m box (no shielding) 4m box (no shielding) Other	100.0	~3.25	21

Other information: 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 above 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

Waste Planned for Disposal at the LLW Repository:

Container voidage: <10%.

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).
The waste does not have a current WCH.

Current WCH being progressed/reviewed by Tradebe-Inutec. NWS comments being addressed.

Waste consigned for disposal to LLWR in year of generation: No. It is possible that the waste will be retained for periods greater than the year of generation. Disposals are undertaken on a campaign basis and will be carried out as soon as it is practicable to do so i.a.w. treatment contractor project plan.

Non-Containerised Waste for In-Vault Grouting: (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

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Other information: -

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. Other nuclides detected below limit of detection may have generic resin fingerprint values applied.
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:	Representative core samples taken, then the sample subjected to a range of chemical analysis and radiochemical techniques. 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.
Other information:	A core sample of the resin within the Resin Storage Vessel is taken and subjected to full radiochemical analysis for beta/gamma and alpha activities. The data is the specific activity of the conditioned waste (in terms of total volume the waste would take-up within the disposal container).

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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	1.63E-04	A A 1	~1.63E-04	B B 2	Gd 153				
Be 10					Ho 163				
C 14	2.61E-03	A A 1	~2.61E-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					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	5.39E-07	A A 1	~5.39E-07	B B 2	Pb 205				
Fe 55	9.22E-05	A A 1	~9.22E-05	B B 2	Pb 210				
Co 60	2.60E-03	A A 1	~2.60E-03	B B 2	Bi 208				
Ni 59					Bi 210m				
Ni 63	1.63E-04	A A 1	~1.63E-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	8.96E-07	A A 1	~8.96E-07	B B 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129	1.72E-06	A A 1	1.72E-06	B B 2	Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	1.83E-05	A A 1	~1.83E-05	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					Other a	3.52E-08	A A 1	~3.52E-08	B B 2
Eu 152					Other b/g				
Eu 154					**Total a**	**3.52E-08**	**A A 1**	**~3.52E-08**	**B B 2**
Eu 155					**Total b/g**	**5.65E-03**	**A A 1**	**~5.65E-03**	**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