WASTE STREAM 7D40 ILW PCD Ion Exchange Resin

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

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	7.1 m^3
Future arisings -	1.4.2023 - 31.3.2025.....	~-2.1 m^3
	1.4.2025 - 31.3.2028.....	~-2.1 m^3
	1.4.2028 - 31.3.2031.....	~-2.9 m^3
Total future arisings:		-7.1 m^3
Total waste volume:		0 m^3

Comment on volumes: The PCD process is no longer being undertaken. Therefore, there are no future arisings expected for the 7D40 (ILW resin) waste stream. It should noted that this wastestream will be processed/treated to remove chelates and remove/reduce C-14 and/or decay to LLW which will subsequently be disposed under 7D26/C. In the next 10 years the reported 2022 volume will reduce by ~ 7.073 m^3. Waste generated from the primary circuit decontamination (PCD) of submarines during major maintenance periods. PCD operations have now ceased at Devonport therefore future arisings generation rate is based on expectation of future conditioning. Current Stocks declared are for waste stored in raw form awaiting treatment. Waste disposal due to commence c. 2024 which will follow a conditioning/treatment campaign as part of a MoD driven Resin Disposal Project (RDP) to remove C14 & chelates. Campaign expected to include all other DRDL resin waste streams which include C-14 as well as chelate content. Reported negative volumes in 'future arisings' represent the program of work in which this wastestream will be reduced and converted into conditioned wastestream: 7D26/C.

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 The primary circuit of the reactor power plant is decontaminated using a multi-stage chemical process. Resin is used to remove soluble metal activation products that are generated when the magnetite layer is removed from the primary plant.

PHYSICAL CHARACTERISTICS

General description: The waste contains organic based ion exchange resin where the active groups are quaternary amines and sulphonic groups. There are equal numbers of active anion and cation sites. The resin is a polystyrene based bead consisting of uniform spheroids of approximately 1mm diameter. Resin is always held in a wet state and is 'headed' by a quantity of demineralised water. Due to the chemical decontamination process being used the resin will contain appreciable quantities of chelating agents. There are no large items present.

Physical components (%vol): Ion exchange resin (75%), water (25%)

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): 1.1

Comment on density: The waste contains organic based ion exchange resin. There are equal numbers of active anion and cation sites. The resin is a polystyrene based bead consisting of uniform spheroids of approximately 1mm diameter. Pre-conditioned resin is always held in a wet state and is 'headed' by a quantity of demineralised water. Due to the chemical decontamination process being used the resin will contain appreciable quantities of chelating agents (>>1 % by weight). There are no large items present. The density will be in the region of 1-1.1 t/m^3. Once conditioned for disposal the density will increase as the waste will be encapsulated into an appropriate concrete matrix (~ 1.9 t/m^3).

CHEMICAL COMPOSITION

General description and components (%wt): Ion exchange resin (75%), water (25%)

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Chemical state: Acid

Chemical form of radionuclides: H-3: Present as HTO in the overstanding water. Not expected as organically bound tritium on resin. Total activity of tritium not significant
C-14: On resin in various chemical forms, mainly adhered to the resin.

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		
Cobalt	0		
Copper	0		
Lead	0		
Magnox/Magnesium	0		
Nickel	0		
Titanium	0		
Uranium	0		
Zinc	0		
Zircaloy/Zirconium	0		
Other metals	0	Not applicable apart from the metal activation products that may have adhered to the resin. This would be in very small concentrations.	

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	75.0		
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			

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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.....	0		
Sand.....	0		
Glass/Ceramics.....			
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	25.0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): Organic ion exchange resin used in conjunction with mainly organic main process chemicals in the decontamination process. Minimal free inorganic anions will be present in the waste as stored.

	(%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: There are no hazardous materials present in the waste apart from those already identified (e.g. picolinate and formate).Chelating agents will be present within the raw waste (adhered to the resin surface) and are declared for current stocks in raw state. Chelates will be removed, and C-14 removed/reduced following successful conditioning/treatment as part of the MoD driven Resin Disposal Project (RDP) in which this waste will move to the 7D26/C stream.

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	(%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: There are no heavy metals in the waste.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	<18.3	Weighted Average over the entire waste stream inventory is 18.3 mg/l. Average Boron concentration over only boronated packages: 42.7 mg/l. Maximum conc in any single RSV: 187 mg/l
Boron (in Boral).....	0	
Boron (non-Boral).....	<18.3	
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		

Thallium.....

Tin.....

Vanadium.....

Mercury compounds.....

Others.....

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.....	P	Detected in one sample (1 of 14) but possibly due to derivation and measurement error caused by prescence of picolinate.
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....	<2.6	Averaged across entire inventory: Picolinate Acid ~ 2.22 %wt , Formate Acid ~ 0.10 %wt. Average across chelated inventory: Picolinate Acid ~ 2.59 %wt , Formate Acid ~ 0.12 %wt. maximum chelate in any single RSV: Picolinate Acid ~ 10.7 %wt , Formate Acid ~ 0.40 %wt
Total complexing agents.....	<2.6	

Potential for the waste to contain discrete items: No.

TREATMENT, PACKAGING AND DISPOSAL

Waste that is currently ILW: The waste will become LLW as a result of radioactive decay into 7D34. Waste will be treated to reduce C-14 and remove chelate content. A appropriate treatment & conditioning option is currently underway for all resins containing chelates (and/or high C-14). This is likely to be in the next 2 to 5 years. This is dependent upon initial specific activity and potential treatment/conditioning option that is chosen.

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

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

Comment on planned treatments: When decayed to LLW (see 7D34 waste stream), the waste will require to be pre-treated to remove C-14 and also to destroy the chelates within the resin.

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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):

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			

Other information: Encapsulated resin direct into HHISO or within 205 litre drums. These are loaded into HHISO containers for disposal. Alternative may be considered depending on the conditioning/treatment option used.

Waste Planned for Disposal at the LLW Repository:

Container voidage: <10%.

The waste does not meet the LLWR's Waste Acceptance Criteria (WAC).

Waste consigned for disposal to LLWR in year of generation: No. Waste will have to be sampled prior to being sentenced for disposal. The waste is ILW and could be held in storage for up to 30 years to allow for decay to LLW levels. Treatment /conditioning of this waste form , together with other relevant

waste forms will be undertaken to enable disposal within the next 2 to 5 yrs i.e. before 2027.

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

Stream volume (%):	-
Waste stream variation:	-
Bounding cuboidal volume:	
Inaccessible voidage:	-
Other information:	-

RADIOACTIVITY

Source:	Activation products that have been removed from the primary circuit during plant decontamination. The soluble activation products are removed by ion exchange material.
Uncertainty:	Activity for the major nuclides is determined by sampling and radiochemical analysis. The total specific activity should therefore be within ±50%.
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:	Core samples are taken from each resin container. The sample is prepared and analysed to determine the major nuclides by gamma spectroscopy and other selective chemical techniques for other beta/gamma nuclides. Gross alpha and gross beta measurements are also taken. If certain trigger nuclides (e.g. Cs-137) are detected then additional analysis will be undertaken for other nuclides (e.g. I-129).
Other information:	The above activity information is considered to be bounding. MoD driven project has been set up to identify disposal option. Disposal planned within next 2-5 yrs i.e. before 2027.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	4.33E-04	A A 1	4.33E-04	A A 1	Gd 153				
Be 10					Ho 163				
C 14	2.45E-03	A A 1	2.45E-03	A A 1	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	9.25E-06	A A 1	9.25E-06	A A 1	Pb 205				
Fe 55	5.77E-02	A A 1	5.77E-02	A A 1	Pb 210				
Co 60	3.85E-02	A A 1	3.85E-02	A A 1	Bi 208				
Ni 59					Bi 210m				
Ni 63	4.60E-03	A A 1	4.60E-03	A A 1	Po 210				
Zn 65	2.79E-09	A A 1	2.79E-09	A A 1	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	2.86E-07	A A 1	2.86E-07	A A 1	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	8.42E-06	A A 1	8.42E-06	A A 1	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	~1.56E-07	A A 1	~1.56E-07	A A 1
Eu 152					Other b/g	1.2E-09	A A 1	1.2E-09	A A 1
Eu 154					**Total a**	**~1.56E-07**	**A A 1**	**~1.56E-07**	**A A 1**
Eu 155					**Total b/g**	**1.04E-01**	**A A 1**	**1.04E-01**	**A A 1**

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