

WASTE STREAM	7D34	Ion Exchange Resin from Primary Circuit Decontamination
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SITE HMNB Devonport
SITE OWNER Ministry of Defence
WASTE CUSTODIAN Babcock International Group
WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	~11.3 m ³
Future arisings -	1.4.2019 - 31.3.2030.....	~2.8 m ³
Total future arisings:		2.8 m ³
Total waste volume:		14.1 m ³

Comment on volumes: The waste is generated from the primary circuit decontamination (PCD) of submarines during major maintenance periods. Volume of waste produced is dependent upon the MOD's submarine maintenance requirements and operational profile. Generation rate is therefore not constant. The future arisings are an estimate of ILW resin (7D40) decaying to 7D34 resin. The volumes of waste that has been quoted above is a bounding assessment. As generated, an amount of PCD resin will be ILW. After a suitable decay period (and/or treatment e.g. remove complexants), the resulting LLW will be able to be conditioned and disposed as compliant LLW under wastestream 7D26/C. The figures that are presented above are for the volume of LLW that will be available for conditioning and disposal as LLW.

Uncertainty factors on volumes: Stock (upper): x 1.4 Arisings (upper) x 2.0
 Stock (lower): x 0.6 Arisings (lower) x 0.5

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: Ion exchange resin that is headed with an amount of water. The conditioned waste will require to be pre-treated to remove the chelate (and C-14) concentrations and the product will be encapsulated into either drums or other approved containers (e.g. THISO).

Physical components (%wt): Raw waste ion exchange resin (75%), water (25%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 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/m³. Once conditioned for disposal the density will increase as the waste will be encapsulated into an appropriate concrete matrix.

CHEMICAL COMPOSITION

General description and components (%wt): Raw waste ion exchange resin (75%), water (25%).

Chemical state: Acid

Chemical form of radionuclides: H-3: HTO predominantly.
 C-14: A number of potential forms. Most significant carbonate.
 Pu: Possibility of Pu-241, form not known. Present in extremely low concentration.

Metals and alloys (%wt): Not applicable.

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	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.....	
	Uranium.....	0
	Zinc.....	0
	Zircaloy/Zirconium.....	0
	Other metals.....	0
Organics (%wt):	-	
	Total cellulose.....	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.....	0
	Oil or grease	
	Fuel.....	
	Asphalt/Tarmac (cont.coal tar)...	
	Asphalt/Tarmac (no coal tar)....	
	Bitumen.....	
	Others.....	
	Other organics.....	0
Other materials (%wt):	-	
	Inorganic ion exchange materials.	0
	Inorganic sludges and flocs.....	0
	Soil.....	0
	Brick/Stone/Rubble.....	0
	Cementitious material.....	0
	Sand.....	
	Glass/Ceramics.....	0

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	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):	-	
	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:	Various chelating agents will be present within the waste (adhered to the resin surface).	
	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
	Active particles.....	0
	Soluble solids as bulk chemical compounds.....	0
Hazardous substances / non hazardous pollutants:	-	
	Acrylamide.....	
	Benzene.....	
	Chlorinated solvents.....	

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Formaldehyde.....

Organometallics.....

Phenol.....

Styrene.....

Tri-butyl phosphate.....

Other organophosphates.....

Vinyl chloride.....

Arsenic.....

Barium.....

Boron..... P

~12.5 mg/l (weighted average
over entire inventory)

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

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids.....

Other organic complexants..... <1.5

Picolinate (~1.31 %mass) and
Formate (~0.05 %mass)

Total complexing agents..... <1.5

TREATMENT, PACKAGING AND DISPOSAL

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Decontamination**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 Recycling / reuse Other / various None	Off-site	100.0

Comment on planned
treatments:

Due to the chelate and C14 concentrations, it is intended that the resin will be treated/conditioned prior to disposal to destroy the organic chelates and also remove significant proportions of C-14 (>90%) from the waste stream. Treatment/conditioning process yet to be confirmed. The resulting product will be encapsulated for final disposal at the LLWR.

Disposal Routes:

Disposal Route	Stream volume %
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	100.0

Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
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			

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m ³	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	~4	4

Other information:

Encapsulated resin direct into HHISO. If not, within standard 200 litre drums loaded into HHISO containers for disposal to LLWR. Alternative may be considered depending on the conditioning/treatment option used.

Waste Planned for Disposal at the LLW Repository:

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Container voidage: <10%.

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

Development work is being undertaken to determine the most appropriate way to manage the waste, e.g. C-14 removal and chelate destruction. This will allow a WCH to be generated and forwarded to LLWR for approval.

Waste consigned for disposal to LLWR in year of generation: No. It is presently envisaged that this waste will be treated/conditioned prior to disposal to LLWR (to remove C-14 and chelate content). Waste will be batched with other resins with the aim that disposal will take place within the next 4-5 yrs i.e. before 2025.

Potential for the waste to contain discrete items: No

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 plant during the decontamination process. The activity is collected and retained on ion exchange resin.

Uncertainty: All activities will be accurately determined through sampling and analysis. Treatment of the waste may significantly reduce C-14 content.

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: A core sample of the resin is taken from the RSV. This sample is subject to full radiochemical analysis for alpha and beta/gamma activities. The chelate concentration is also determined. The H-3 within the overstanding water is also assessed along with pH, conductivity and chloride analysis.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	1.51E-04	BB 1	~1.51E-04	CC 2	Gd 153				
Be 10					Ho 163				
C 14	2.92E-05	BB 1	~2.92E-05	CC 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	1.94E-06	BB 1	~1.94E-06	CC 2	Pb 205				
Fe 55	1.43E-03	BB 1	~1.43E-03	CC 2	Pb 210				
Co 60	3.60E-03	BB 1	~3.60E-03	CC 2	Bi 208				
Ni 59					Bi 210m				
Ni 63	4.05E-04	BB 1	~4.05E-04	CC 2	Po 210				
Zn 65	1.14E-08	BB 1	~1.14E-08	CC 2	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	5.42E-09	BB 1	~5.42E-09	CC 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	3.00E-06	BB 1	~3.00E-06	CC 2	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	7.85E-08	BB 1	~7.85E-08	CC 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	~3.65E-07	BB 1	~3.65E-07	CC 2
Eu 152					Other b/g	1.11E-09	BB 2	~1.11E-09	CC 2
Eu 154					Total a	~3.65E-07	BB 1	~3.65E-07	CC 2
Eu 155	1.20E-07	BB 1	~1.20E-07	CC 2	Total b/g	5.61E-03	BB 2	~5.61E-03	CC 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