

WASTE STREAM	7D41 ILW Submarine Ion Exchange Resin
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SITE HMNB Devonport

SITE OWNER Ministry of Defence

WASTE CUSTODIAN Babcock International Group

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	3.6 m ³
Future arisings -	1.4.2019 - 31.3.2030.....	10.0 m ³
Total future arisings:		10.0 m ³
Total waste volume:		13.6 m ³

Comment on volumes: Generation rate is dependent upon the submarine refit/maintenance plan, which is variable. The volume quoted above is the total volume of the ion exchange resin and water within the primary containment.

Uncertainty factors on volumes: Stock (upper): x 1.5 Arisings (upper) x 2.0
 Stock (lower): x 0.5 Arisings (lower) x 0.5

WASTE SOURCE During operation of the submarine reactor system primary coolant is passed through an onboard ion exchange resin which removes soluble activation products and also acts as a very coarse filter.

PHYSICAL CHARACTERISTICS

General description: Resin is held within a Resin Storage Vessel (RSV). Resin is held in a raw state. Nominally resin 40% and water 60% by weight. No additional physical/chemical processes have been undertaken. The waste will be stored in the raw state until it has decayed to LLW levels and is able to be managed in accordance with 7D26/C.

Physical components (%wt): Resin (40%), water (60%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.1

Comment on density: Raw waste is organic ion exchange resin headed by an amount of water.

CHEMICAL COMPOSITION

General description and components (%wt): Organic ion exchange resin and water.

Chemical state: Alkali

Chemical form of radionuclides: H-3: HTO. Possible minor contribution is as OBT.
 C-14: Carbonate predominately but other forms are possible (e.g. low carbon content organics).
 Cl-36: Radionuclide adsorbed to the ion exchange resin.
 I-129: Radionuclide adsorbed to the ion exchange resin.

Metals and alloys (%wt):

-
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.....

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	Uranium.....	0	
	Zinc.....	0	
	Zircaloy/Zirconium.....	0	
	Other metals.....	0	Not applicable.
Organics (%wt):	The resin is a commercial high nuclear grade anion/cation mixed resin.		
	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....	40.0	
	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.....	0	
	Glass/Ceramics.....	0	
	Graphite.....	0	
	Desiccants/Catalysts.....	0	
	Asbestos.....	0	
	Non/low friable.....		
	Moderately friable.....		
	Highly friable.....		
	Free aqueous liquids.....	60.0	
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	
Inorganic anions (%wt):	There should not be a significant amount of inorganic anions within the resin/water mixture.		

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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:

Raw waste is headed by an amount of water. There should be no other hazardous materials within the waste.

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.....	0
Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	0
Styrene.....	
Tri-butyl phosphate.....	0
Other organophosphates.....	
Vinyl chloride.....	0
Arsenic.....	0
Barium.....	
Boron.....	P

Average boron over inventory =

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5.5 mg/l

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.....
 EEE Type 5.....

Complexing agents (%wt):

No
 EDTA.....
 DPTA.....
 NTA.....
 Polycarboxylic acids..... <0.05 Formate
 Other organic complexants.....
 Total complexing agents..... <0.05

LAW TREATMENT, PACKAGING AND DISPOSAL

Waste that is currently ILW: The waste will decay to LLW limits. Major nuclide is Co-60. C-14 is also a major contributor to the total waste stream total. Preconditioning will be required to remove the C-14. This is dependent upon the specific activity of the waste at the time of generation. Treatment/conditioning is also expected to significantly reduce C-14 activity.

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

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

Comment on planned treatments:

It is planned that waste will be treated/conditioned to reduce the C-14 before the resulting product will be encapsulated for disposal.

WASTE STREAM**7D41 ILW Submarine Ion Exchange Resin****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 Consigned to the LLW Repository:**Container voidage:**

<10%.

Waste Characterisation Form (WCH):

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

Waste consigned for disposal to LLWR in year of generation:

No. The waste is an ILW stream. Held in store to allow for decay storage. There are also significant C-14 concentrations, which inhibits the resin conditioning for disposal. Resins can be stored for periods of up to 20 years before being acceptable for preconditioning to remove the C-14 content. Treatment/conditioning of waste form is planned to take place within the next 4-5 yrs i.e. pre 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:

-

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Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

RADIOACTIVITY

Source: During commission of the submarine reactor system, primary coolant is passed through an onboard ion exchange to remove soluble activation products.

Uncertainty: The ion exchange resin is representatively sampled and subject to rigorous radiochemical analysis. Errors associated with the measurements are within the tolerances of a UKAS accredited laboratory.

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). Specific Activity figures have been derived from current stock data and represent a reasonably consistent waste origin, therefore future arisings, which are expected to remain consistent, 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).

Other information: -

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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	2.76E-03	BB 1	~2.76E-03	BB 1	Gd 153				
Be 10					Ho 163				
C 14	2.18E-02	BB 1	~2.18E-02	BB 1	Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36	1.72E-05	BB 1	~1.72E-05	BB 1	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54	5.99E-08	BB 1	~5.99E-08	BB 1	Pb 205				
Fe 55	9.44E-05	BB 1	~9.44E-05	BB 1	Pb 210				
Co 60	4.79E-03	BB 1	~4.79E-03	BB 1	Bi 208				
Ni 59					Bi 210m				
Ni 63	1.17E-03	BB 1	~1.17E-03	BB 1	Po 210				
Zn 65	2.12E-09	BB 1	~2.12E-09	BB 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	8.38E-07	BB 1	~8.38E-07	CC 2	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	4.51E-07	BB 1	~4.51E-07	CC 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129	1.13E-06	BB 1	~1.13E-06	CC 2	Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137	2.73E-05	BB 1	~2.73E-05	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	7.81E-07	BB 1	~7.81E-07	CC 2
Eu 152					Other b/g				
Eu 154					Total a	7.81E-07	BB 1	~7.81E-07	CC 2
Eu 155					Total b/g	3.07E-02	BB 1	~3.07E-02	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