

WASTE STREAM	7D24 ILW Reactor Components
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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.....	3.3m ³
Future arisings -	1.4.2022 - 31.3.2030.....	<5.0m ³
Total future arisings:		5.0m ³
Total waste volume:		8.3m ³
Comment on volumes:	Not constant. Dependent upon reactor components that must be removed during the course of the maintenance operations. Future Submarine Disposal Program waste arisings not yet quantified (not included). The rate of arising is dependent on the submarine refit/disposal programme.	
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 Activated reactor components.

PHYSICAL CHARACTERISTICS

General description: The waste consists of reactor components which are neutron activated: reactor assemblies, thermal shields and other irradiated core components. Waste hierarchy will be applied

Physical components (%wt): 100% metallic components comprising irradiated core components, thermal shields and miscellaneous assemblies.

Sealed sources: -

Bulk density (t/m³): ~8

Comment on density: The waste contains mostly steel items with little interstitial space.

CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel (99.9%), copper (0.1%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Highly unlikely to be present in any appreciable quantity.
C-14: Present in activated stainless steel in small concentration.

Metals and alloys (%wt): The items are a variety of different sizes and thicknesses. The items will be volume reduced to either be disposed of as non-compactable waste or to fit inside 200 litre drums.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	99.9	316 Stainless Steel.	
Other ferrous metals.....	0		
Iron.....	P	In the stainless steel.	
Aluminium.....			
Beryllium.....	0		
Cobalt.....	0		
Copper.....	0.10		
Lead.....	0		
Magnox/Magnesium.....	0		

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Nickel.....	P	In the stainless steel.
Titanium.....		
Uranium.....	0	
Zinc.....	0	
Zircaloy/Zirconium.....	0	
Other metals.....	0	

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
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....	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.....	0		
Sand.....	0		
Glass/Ceramics.....	0		
Graphite.....	0		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			

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Highly friable.....	
Free aqueous liquids.....	0
Free non-aqueous liquids.....	0
Powder/Ash.....	0

Inorganic anions (%wt): There are no inorganic anions present 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: There are no hazardous materials present in the waste.

	(%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 present in the waste.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....	0	
Chlorinated solvents.....		
Formaldehyde.....		

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Organometallics.....		
Phenol.....	0	
Styrene.....		
Tri-butyl phosphate.....	0	
Other organophosphates.....		
Vinyl chloride.....	0	
Arsenic.....	0	
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....	0	
Caesium.....		
Selenium.....	0	
Chromium.....	P	Present in the stainless steel
Molybdenum.....	P	Present in the stainless steel
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

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		No organic or inorganic complexing agents are present.
Total complexing agents.....	0	

Potential for the waste to contain discrete items: Yes. Potential for discrete items due to size of material. Items will be characterised at time of disposal when appropriate.

TREATMENT, PACKAGING AND DISPOSAL

Waste that is currently ILW: The main nuclide of interest is Co-60 which has a 5.27yr half-life. The Co-60 activity of the waste has been assessed from radiological survey information or by the drum monitor. This is to be confirmed following characterisation project due to commence in next 12 months.

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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	On-site	100.0

Comment on planned treatments:

Store and decay if determined to be ILW

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
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	~8.0

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: (Not applicable to this waste stream)

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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			

Other information: This is to be confirmed following characterisation project due to commence in next 12 months.

Waste Planned for Disposal at the LLW Repository: (Not applicable to this waste stream)

Container voidage: <10%.

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

There is no WCH for 7D24. However after a suitable period of decay storage the material will have decayed to LLW and will be disposed of under 7D23 waste stream.

Waste consigned for disposal to LLWR in year of generation:

No. The waste stream is believed to be in the ILW category (full characterisation to be carried out). Assessments have previously estimated the decay storage periods to LLW levels, however lack of access to all surfaces preclude the ability to determine current classification in current form. Full characterisation project to be undertaken to accurately determine classification.

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, mainly Co-60 with other beta nuclides Fe-55, Ni-63 and also C-14. The activity arises from neutron activation of the predominant material stainless steel.

Uncertainty: The total activity assessment is based on radiation survey measurement and then the use of appropriate shielding models and geometries to determine the total Co-60 activity. The activity of other nuclides will for the purpose of this assessment be based on the use of the generic LLW fingerprint. Actual calculations are based on available data from a small number of items currently stored at Devonport that have yet to be accurately characterised. This work is intended to take place within the next 36 months therefore the detail in this RWI is likely to change, possibly significantly. Final characterisation may determine that the items move out of the 7D24 ILW wastream to a LLW stream (7D23). Future arising is based on the possibility of similar un-characterised items being received on site.

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: The Co-60 activity of the waste material is assessed from basic survey information from accessible surfaces and then the use of basic shielding calculations. The other nuclides have been assessed by applying the generic radionuclide fingerprint of waste stream 7D23. Specific Activity figures have been derived from current stock data and represent a reasonably constant waste origin, therefore future arisings, which are expected to remain constant, 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: Full characterisation of current stocks due to be undertaken in next 12 months. This information will then inform future arisings.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	~-8.65E-07	DD 2	~-3E-05	DD 2	Gd 153				
Be 10					Ho 163				
C 14	~-8.08E-04	DD 2	~-8.1E-04	DD 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			~-2.1E-04	DD 2	Pb 205				
Fe 55	~-3.59E-05	DD 2	~-6.35E-03	DD 2	Pb 210				
Co 60	~-4.33E-04	DD 2	~-6E-03	DD 2	Bi 208				
Ni 59	~-5.62E-06	DD 2	~-6E-06	DD 2	Bi 210m				
Ni 63	~-1.69E-04	DD 2	~-1.92E-04	DD 2	Po 210				
Zn 65			~-5.4E-05	DD 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					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	~-4.33E-07	DD 2	~-4.8E-05	DD 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134			~-1.2E-06	DD 2	Cm 242				
Cs 135					Cm 243				
Cs 137	~-2.60E-06	DD 2	~-4.2E-06	DD 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				
Eu 152	~-1.30E-06	DD 2	~-4.2E-06	DD 2	Other b/g				
Eu 154					Total a	0		0	
Eu 155					Total b/g	~-1.46E-03	DD 2	~-1.37E-02	DD 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