

WASTE STREAM	7D24	ILW Reactor Components
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SITE HMNB Devonport

SITE OWNER Ministry of Defence (MOD)

WASTE CUSTODIAN Babcock International Group

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025 = 2.0			
Future arisings:	1.4.2025 - 31.3.2033 < 4.0			
Total future arisings:	4.0			
Total waste volume:	6.0			

Number of waste packages in stock: At 1.4.2025..... - packages

Comment on arising rates: Arisings are 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).

Additional information on quantities: Stock based on current stock of metallic ILW waste. The rate of future arisings is relatively unknown and dependent on the submarine refit/disposal programme. Future volumes have been estimated on similar items to current stock being stored.

Uncertainty factors on volumes:

Stock (upper):	x 1.20	Arisings (upper):	x 2.00
Stock (lower):	x 0.80	Arisings (lower):	x 0.50

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

Changes since waste generated: No changes to physical/chemical form, these are solid steel items

Bulk density (t/m³): ~ 7.8

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

CHEMICAL COMPOSITION

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

Chemical state: Neutral

Sheet metal proportion / thickness: The items are a variety of different sizes and thicknesses. The items will be anonymised/size reduced to either be disposed of as non-compactable waste or to fit inside an appropriate disposal container.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 99.9	316 Stainless Steel.	100.0
Other ferrous metals.....	= 0	-	
Iron.....	P	In the stainless steel.	
Aluminium.....	-	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	= 0.10	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
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.....		-	
Highly friable.....		-	
Free aqueous liquids.....	= 0	-	
Free non-aqueous liquids.....	= 0	-	
Powder/Ash.....	= 0	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%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	-
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:

	(%wt)	Type(s) and comment
Acrylamide.....	= 0	-
Benzene.....		-
Chlorinated solvents.....		-
Formaldehyde.....		-
Organometallics.....	= 0	-
Phenol.....		-
Styrene.....		-
Tri-butyl phosphate.....		-
Other organophosphates.....	= 0	-
Vinyl chloride.....		-
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.....	= 0	-
Tin.....		-
Vanadium.....		-
Mercury compounds.....		-
Others.....	= 0	-

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	-

Physical components:

	Number	Type(s) and comment
Sources.....	= 0	-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1.....		= 0
EEE Type 2.....		= 0
EEE Type 3.....		= 0
EEE Type 4.....		= 0
EEE Type 5.....		= 0

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction	On-site	= 100.0
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration		
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation		
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments:

Store and decay until appropriate/alternative disposal route made available. The main radionuclide of interest on the DRDL site is Co-60 with a half-life of ~ 5.27 years. Irradiated items however will likely contain a high ratio of Ni-63 with a longer half-life of approx. 100 years, therefore longer onsite storage may be required.

Conditioning method:

-

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

Unknown

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:	Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
	-	-	-	-	-	-

Range in container waste loading: Potential container for disposal not known at this stage due to items requiring decay storage. If a disposal route becomes available, these items will be likely be transferred in a bespoke container appropriate for activity content and security classification, to a treatment site prior to disposal

Other information on packaging and conditioning: Recycling is unlikely. Due to defence security requirements these items may require anonymisation and/or encapsulation prior to disposal.

Conditioned density (t/m³): NE
Conditioned density comment: -

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)			
Expected to be Non-NSD HAW managed under Scottish Government's policy			
Expected to be disposed to LLW Vaults NRS Dounreay			
Expected to be consigned to the Geological Disposal Facility			
Expected to be consigned to a Near Surface Disposal Facility			
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be disposed On-Site			
Expected to be managed by In-Situ Disposal			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be Out of Scope			
Expected to be recycled / reused			
Disposal route not known	= 100.0	~ 7.8	

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

Opportunities for alternative disposal routing: Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: The waste consists of reactor components which are neutron activated reactor assemblies, thermal shields and other irradiated core components. Radionuclides are mainly Ni-63, Fe-55, C-14 and Co-60 with other beta nuclides. The activity arises from neutron activation of the predominant material stainless steel. Other inferred radionuclides are based on the standard DRDL fingerprint to account for contamination on the material surfaces.

Uncertainty: Activity data based on metallic sampling of accessible areas of current stock items to determine activation activity. Where access for sampling is not possible, estimates have been based on similar component composition and position in the RPV plant, and application of standard radionuclide fingerprint to account for contaminated surfaces. ILW categorisation mainly based on Ni-63 content (~ 68% of radionuclide composition)

Measurement of radioactivities: 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

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.
Cl-36: -
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM				7D24		ILW Reactor Components			
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	~~	2.81E-03	B B 2	~~	2.81E-03	C C 2	Gd 153		
Be 10							Ho 163		
C 14	~~	1.66E-01	B B 2	~~	1.66E-01	C C 2	Ho 166m		
Na 22	~~	1.45E-10	B B 2	~~	1.45E-10	C C 2	Tm 170		
Al 26							Tm 171		
Cl 36	~~	1.24E-04	B B 2	~~	1.24E-04	C C 2	Lu 174		
Ar 39							Lu 176		
Ar 42							Hf 178n		
K 40							Hf 182		
Ca 41							Pt 193		
Mn 53							Tl 204		
Mn 54	~~	1.59E-17	B B 2	~~	1.59E-17	C C 2	Pb 205		
Fe 55	~~	2.37E-04	B B 2	~~	2.37E-04	C C 2	Pb 210		
Co 60	~~	7.36E-03	B B 2	~~	7.36E-03	C C 2	Bi 208		
Ni 59	~~	9.55E-04	B B 2	~~	9.55E-04	C C 2	Bi 210m		
Ni 63	~~	3.96E-01	B B 2	~~	3.96E-01	C C 2	Po 210		
Zn 65	~~	2.45E-21	B B 2	~~	2.45E-21	C C 2	Ra 223		
Se 79							Ra 225		
Kr 81							Ra 226		
Kr 85							Ra 228		
Rb 87							Ac 227		
Sr 90	~~	1.52E-05	B B 2	~~	1.52E-05	C C 2	Th 227		
Zr 93							Th 228		
Nb 91							Th 229		
Nb 92							Th 230		
Nb 93m							Th 232		
Nb 94							Th 234		
Mo 93	~~	2.46E-05	B B 2	~~	2.46E-05	C C 2	Pa 231		
Tc 97							Pa 233		
Tc 99	~~	2.20E-06	B B 2	~~	2.20E-06	C C 2	U 232		
Ru 106							U 233		
Pd 107							U 234		
Ag 108m	~~	4.28E-03	B B 2	~~	4.28E-03	C C 2	U 235		
Ag 110m	~~	1.17E-21	B B 2	~~	1.17E-21	C C 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	~~	4.67E-07	B B 2	~~	4.67E-07	C C 2	Pu 241		
Sb 126							Pu 242		
Te 125m							Am 241	~~	3.48E-03 B B 2
Te 127m							Am 242m		
I 129	~~	1.93E-04	B B 2	~~	1.93E-04	C C 2	Am 243		
Cs 134	~~	6.02E-10	B B 2	~~	6.02E-10	C C 2	Cm 242		
Cs 135							Cm 243		
Cs 137	~~	1.70E-03	B B 2	~~	1.70E-03	C C 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							Unsp a		
Eu 152	~~	4.31E-04	B B 2	~~	4.31E-04	C C 2	Unsp b/g	~~	1.83E-21 B B 2
Eu 154	~~	1.39E-04	B B 2	~~	1.39E-04	C C 2	Total a	3.48E-03	1.83E-21 C C 2
Eu 155	~~	3.10E-06	B B 2	~~	3.10E-06	C C 2	Total b/g	5.80E-01	3.48E-03
								*	*

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 the 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
* Total calculated from the 114 declared radionuclides