WASTE STREAM	7F22	Submarine Reactor Wastes (Non-metallic)

SITE Clyde Submarine Base

SITE OWNER Ministry of Defence (MOD)

WASTE CUSTODIAN Ministry of Defence (MOD)

WASTE TYPE LLW

WASTE VOLUMES

		Reported (m^3)
Stocks:	At 1.4.2025	= 4.0
Future arisings:	1.4.2025 - 31.3.2026	7.0
	1.4.2026 - 31.3.2027	7.0
	1.4.2028 - 31.3.2029	15.0
	1.4.2029 - 31.3.2040	70.0
	1.4.2040 - 31.3.2050	70.0
	1.4.2050 - 31.3.2060	70.0
	1.4.2060 - 31.3.2070	70.0
	1.4.2070 - 31.3.2080	70.0
	1.4.2080 - 31.3.2090	70.0
	1.4.2090 - 31.3.2100	70.0
	1.4.2100 - 31.3.2110	10.0
Total future arisings:		**529.0**
Total waste volume:		**533.0**

OR

Conditioned (m^3)	Packaged (m^3)

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

Comment on arising rates: The rate of future arisings depends on the number of submarines berthed at Clyde and site decommissioning work. This is subject to considerable variation.

Additional information on quantities: Future arisings largely depends on submarine maintenance programme and changes to reactor design and operations. Maintenance programmes for nuclear submarines are very well developed and predictable; however, there have been historical examples of unexpected repairs which could generate significant quantities of additional waste.

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 Non-metallic LLW is generated primarily from reactor maintenance; secondary wastes are generated in facilities that provide submarine support services e.g. radioactive component processing, radiochemistry laboratory, etc.

PHYSICAL CHARACTERISTICS

General description: The waste mainly consists of combustible materials such as polythene sheeting, contaminated swabs, hoses, clothing, etc. There are no large items.

Changes since waste generated: -

Bulk density (t/m^3): = 0.053

Comment on density: Total mass of waste in stock is 212 kg.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is principally plastic, cellulose, and rubber in polythene bags. The waste contains small amounts of metal where segregation from the bulk non-metallic items is not practicable. It is neutral, and neither oxidising or reducing. Plastic (50%), cellulose (25%), PVC (15%), mild steel (3%), iron (3%) rubber (2%) and others (2%).

Chemical state: Neutral

Sheet metal proportion / thickness: The trace metals present are flux wire, swarf and grindings (fine metal dust).

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	= 0	-	
Other ferrous metals	= 3.0	includes mild steel	
Iron	= 3.0	-	
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	There are no 'other' metals in the waste.	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	= 25.0	-	
Paper, cotton	= 10.0	-	
Wood	= 15.0	-	
Halogenated plastics	= 15.0	PVC	
Total non-halogenated plastics	= 50.0	-	
Condensation polymers	= 23.0	-	
Others	= 27.0	polythene	
Organic ion exchange materials	= 0	-	
Total rubber	= 2.0	-	
Halogenated rubber	= 1.0	-	
Non-halogenated rubber	= 1.0	-	
Hydrocarbons	TR	-	
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	= 1.9	-	
Cementitious material	= 0	-	
Sand	= 0	-	
Glass/Ceramics	< 0.10	-	
Graphite	= 0	-	
Desiccants/Catalysts	= 0	-	
Asbestos	TR	The amount of asbestos within the waste may increase as older facilities are decommissioned.	
Non/low friable	= 0	-	
Moderately friable	= 0	-	
Highly friable	= 0	-	
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	NE	-
Iodide	NE	-
Cyanide	= 0	-
Carbonate	NE	-
Nitrate	NE	-
Nitrite	NE	-
Phosphate	= 0	-
Sulphate	NE	-
Sulphide	NE	-

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	NE	-
Benzene	NE	-
Chlorinated solvents	NE	-
Formaldehyde	NE	-
Organometallics	NE	-
Phenol	NE	-
Styrene	NE	-
Tri-butyl phosphate	NE	-
Other organophosphates	NE	-
Vinyl chloride	NE	-
Arsenic	NE	-
Barium	NE	-
Boron	NE	-
Boron (in Boral)		-
Boron (non-Boral)		-
Cadmium	NE	-
Caesium	TR	-
Selenium	NE	-
Chromium	TR	-
Molybdenum	NE	-
Thallium	NE	-
Tin	NE	-
Vanadium	NE	-
Mercury compounds	NE	-
Others	NE	-

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA		-
DPTA		-
NTA		-
Polycarboxylic acids		-
Other organic complexants		-
Total complexing agents	= 0	-

Physical components:

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

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction 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	Off-site	~ 100.0

Comments on planned treatments: Incineration has been identified as the BPM for all recent disposals of 7F22 waste, including disposals completed in 2020, 2021, and 2023. It is intended to use this route extensively for future disposals, although each disposal shall be subject to a BPM assessment/review.

Conditioning method: -

Conditioning plants:

Plant Name	Location

Likely conditioning matrix: -

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m^3)	Payload (m^3)	Number of packages	Estimated start date for packaging
-	-	-	-	-	-

Range in container waste loading:

Other information on packaging and conditioning: -

Conditioned density (t/m^3): -
Conditioned density comment: -

Management Routes:

Disposal Route	Stream volume %	Raw density t/m^3	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		2025

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

Opportunities for alternative disposal routing: No

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

RADIOACTIVITY

Source: Submarine reactor plant maintenance and secondary wastes from support services.

Uncertainty: Systematic sampling and analysis is periodically undertaken to provide a generic fingerprint for heterogeneous waste. This may result in a change to the fingerprint over time as operations evolve. Difficult to measure radionuclides are inferred from gamma activity assessment and fingerprint application.

Measurement of radioactivities: Active waste monitors are used to assess waste for medium to high energy gamma activity. The 7F22 waste stream characterisation fingerprint is used to infer the activity of difficult to measure radionuclides. Future arisings will be subject to further radiochemical analysis to substantiate or augment the derived fingerprint.

Chemical form of radionuclides:

H-3: HTO
C-14: Methane
Cl-36: Chloride
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM **7F22** **Submarine Reactor Wastes (Non-metallic)**

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	= 1.40E-07	A C 2	= 1.40E-07	A C 2	Gd 153				
Be 10					Ho 163				
C 14	= 5.97E-06	A C 2	= 5.97E-06	A C 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	= 8.43E-10	A C 1	= 8.43E-10	A C 1	Pb 205				
Fe 55	= 1.89E-07	A C 2	= 1.89E-07	A C 2	Pb 210				
Co 60	= 1.58E-06	A C 1	= 1.58E-06	A C 1	Bi 208				
Ni 59					Bi 210m				
Ni 63	= 4.27E-07	A C 2	= 4.27E-07	A C 2	Po 210				
Zn 65	= 2.53E-09	A C 1	= 2.53E-09	A C 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	= 4.22E-09	A C 1	= 4.22E-09	A C 1	U 233				
Pd 107					U 234				
Ag 108m	= 4.72E-08	A C 1	= 4.72E-08	A C 1	U 235				
Ag 110m	= 1.69E-09	A C 1	= 1.69E-09	A C 1	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	= 6.91E-08	A C 1	= 6.91E-08	A C 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	= 8.43E-10	A C 1	= 8.43E-10	A C 1	Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144	= 8.43E-10	A C 1	= 8.43E-10	A C 1	Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Unsp a				
Eu 152					Unsp b/g				
Eu 154					**Total a**	**0**	*	**0**	*
Eu 155					**Total b/g**	**8.43E-06**	*	**8.43E-06**	*

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