WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

SITE	HMNB Devonport
SITE OWNER	Ministry of Defence
WASTE CUSTODIAN	Babcock International Group
WASTE TYPE	LLW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	10.2 m^3
Future arisings -	1.4.2022 - 31.3.2030.....	~110.4 m^3
Total future arisings:		110.4 m^3
Total waste volume:		120.6 m^3

Comment on volumes: Arisings are dependent upon the level of submarine refit and maintenance activity that is carried out. Arisings have been calculated using best available data.

Uncertainty factors on volumes:

Stock (upper):	x 1.3	Arisings (upper)	x 2.0
Stock (lower):	x 0.7	Arisings (lower)	x 0.5

WASTE SOURCE The waste is produced as a consequence of the general support of Naval nuclear propulsion programme e.g. reactor plant maintenance and refuelling operations.

PHYSICAL CHARACTERISTICS

General description: Solid low level waste for disposal to the NWS, comprising metal items of varying size from contaminated tools to large plant items. Other items include metal pipes, valves, swarf, glass and thermal lagging materials and mild steel waste drums. All items derive from the submarines or from shore based facilities. Large items do occasionally originate from the nuclear submarine reactor plant or from support services. In these instances the item will be classified as non-compactable waste and will be packed into half height ISO containers, or other container, as agreed by NWS Ltd, for disposal as non-compactable waste. Material may have been size reduced to fit within 200l drum. Certain large items of hard waste could be consigned as being non-compactable waste should they satisfy the NWS CFA.

Physical components (%wt): Metal (94%), soil/rubble (1%), biodegradable-non putrescibles (1%), plastic/rubber (3%), others (1%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): 0.6

Comment on density: The average density of hard trash within 200 litre drums is 600 kg/m^3.

CHEMICAL COMPOSITION

General description and components (%wt): The waste consists of mainly metallic components primarily stainless steel. There are lesser amounts of mild steel, iron and also aluminium. Drums are mild steel. Other constituents of the stream are calcium silicate lagging, glass. There will be small amounts of polythene within drums along with other soft organics, e.g. paper.

Chemical state: Neutral

Chemical form of radionuclides: H-3: Potential to be present as tritiated water adhered to internal surface of pipes (0.4% of total activity).
C-14: Present in waste in various chemical forms, predominately carbonate, (5% of total activity iaw extant WCH).

Metals and alloys (%wt): Large primary circuit components will be classed as non-compactable waste and will be disposed of in half height ISO containers, or other, as agreed with NWS Ltd. Difficult to provide dimensional information. Total percentage of waste <<10% of current arisings.

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	P	316L stainless steel	
Other ferrous metals	~83.8	Mild Steel Drum	
Iron			
Aluminium			
Beryllium			
Cobalt	P	In the form of mild/stainless steel for example stellite	
Copper			
Lead			
Magnox/Magnesium			
Nickel			
Titanium			
Uranium			
Zinc	~0.11	As a metal in solid form.	
Zircaloy/Zirconium			
Other metals	~10.1	Stellite is present in certain valve seats. Other metals include Chromium and Molybdenum	

Organics (%wt): There will be small quantities of organic material in the waste, namely polythene, paper and possibly cotton. The percentage composition is very small when compared to the total mass of metal present in the waste stream.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	~1.0	Paper/cotton.	
Paper, cotton	~1.0	Paper/cotton.	
Wood	0		
Halogenated plastics	0		
Total non-halogenated plastics	2.0	e.g. Polythene	
Condensation polymers	0		
Others	2.0	Polythene	
Organic ion exchange materials	0		
Total rubber	1.0		
Halogenated rubber	0		
Non-halogenated rubber	1.0		
Hydrocarbons	0		
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	0		

Other materials (%wt): -

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	0		
Inorganic sludges and flocs.....	0		
Soil.....	0		
Brick/Stone/Rubble.....	~0.50		
Cementitious material.....	~0.50		
Sand.....			
Glass/Ceramics.....	~1.0	Glass	
Graphite.....	0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	0		
Free non-aqueous liquids.....	0		
Powder/Ash.....	0		

Inorganic anions (%wt): Silicate from lagging is the only inorganic anion in the waste. However this will reduce in forthcoming years because new re-usable metallic lagging is being installed onto the submarine reactor plant.

	(%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.....	1.0	
Putrescible wastes.....	0	

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

Non-putrescible wastes.....	~1.0
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	TR
Higher activity particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances / non hazardous pollutants: There are no heavy metals in the waste. Certain identified items may contain boron-10 (<<0.1%) in nucleonic instrumentation and also titanium (<1%). Prior to consignment offsite, approval from NWS to accept waste will be obtained by D5 route. All documentation to comply with special waste regulations is also generated.

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....	0	
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....	0	
Styrene.....		
Tri-butyl phosphate.....	0	
Other organophosphates.....		
Vinyl chloride.....	0	
Arsenic.....	0	
Barium.....		
Boron.....	NE	
Boron (in Boral).....	NE	
Boron (non-Boral).....	NE	
Cadmium.....	0	
Caesium.....		
Selenium.....	0	
Chromium.....	~8.8	
Molybdenum.....	~1.4	
Thallium.....		
Tin.....	0	
Vanadium.....	0	
Mercury compounds.....		
Others.....	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		There are no organic complexing agents in the waste.
Total complexing agents.....	NE	

Potential for the waste to contain discrete items: Yes. Some items may be discrete items; however, the activities routinely seen make it unlikely to fall into this category.

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)	Off-Site	~7.5
Incineration	Off-site	~17.5
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recyling / reuse	Off-site	~~32.5
Other / various		
None	Off-site	~42.5

Comment on planned treatments: Aprroximate stream volumes derived from current holdings.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~22.5	~0.60
Expected to be consigned to a Landfill Facility	~27.5	~0.60
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	~17.5	~0.60
Expected to be consigned to a Metal Treatment Facility		
Expected to be consigned as Out of Scope		
Expected to be recycled / reused	~~32.5	~~0.60
Disposal route not known		

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			

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

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:

Container	Stream volume %	Waste loading m³	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	~22.5	~39.39	< 1

Other information: A typical conditioning factor for 7D23 drums is 0.33 relative to the original displaced volume of the 200 litre drum. It is assumed each 1/2 Height IP-2 Disposal/ Reusable ISO (TC01/TC02) will approximatively have a 13m3 waste loading which equates to approximately 39 m3 of raw waste

Waste Planned for Disposal at the LLW Repository:

Container voidage: <10%. Openings into plant items are covered with soluble polythene and vent holes are drilled into large items. When grouting occurs the grout should be able to permeate fully into the item.

Waste Characterisation Form (WCH): The waste meets the LLWR's Waste Acceptance Criteria (WAC).
The waste has a current WCH.
Inventory information is consistent with the current WCH.

Waste consigned for disposal to LLWR in year of generation: No. Not always consigned in the year of generation. Waste is consigned for conditioning on a batch basis. It is therefore possible that waste will be retained until sufficient drums (68) for a 'full' load is available for consignment to Tradebe Inutec Winfrith for supercompaction prior to consignment to NWS.

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: Contamination of plant items through contact with the submarine primary plant. Minor neutron activation of components can also occur. Major nuclides at time of generation are Fe-55 (34%), Co-60 (41%), C-14 (5%), Mn-54 (1.3%), Ni-63 (1.6%) and others.

Uncertainty: The drum monitor assesses the gamma activity of the waste using a segmented gamma spectroscopy system. The system accuracy is assessed to be ±20% of gamma activity. Activity of other beta/gamma nuclides associated with the waste is assessed using a generic fingerprint relative to the measured Co-60 activity. Accuracy of the total activity measurement and assessment is considered to be within 50%.

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'.

WASTE STREAM 7D23 Devonport RA Hard Trash (for Disposal to NWS)

Measurement of radioactivities:	Co-60 is measured directly by the drum monitor system using segmented gamma spectroscopy. Other gamma emitters will also be detected if present within the waste. The fingerprint has been derived by the use of best available sampling information and accepted international practice to determine correlations and relationships. All other nuclides are determined relative to Co-60 activity.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:	Drummed waste is subjected to gamma spectrometry. Beta nuclides are apportioned to Co-60 activity in normalised ratios.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	~2.78E-09	B B 2	~2.78E-09	C C 2	Gd 153				
Be 10					Ho 163				
C 14	~2.95E-07	B B 2	~2.95E-07	C C 2	Ho 166m				
Na 22	~1.27E-11	B B 2	~1.27E-11	C C 2	Tm 170				
Al 26					Tm 171				
Cl 36	~6.51E-12	B B 2	~6.51E-12	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	~3.78E-08	B B 2	~3.78E-08	C C 2	Pb 205				
Fe 55	~1.69E-06	B B 2	~1.69E-06	C C 2	Pb 210				
Co 60	~1.89E-06	B B 2	~1.89E-06	C C 2	Bi 208				
Ni 59	~2.69E-08	B B 2	~2.69E-08	C C 2	Bi 210m				
Ni 63	~4.67E-08	B B 2	~4.67E-08	C C 2	Po 210				
Zn 65	~1.21E-08	B B 2	~1.21E-08	C C 2	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	~3.38E-12	B B 2	~3.38E-12	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	~2.20E-11	B B 2	~2.20E-11	C C 2	Pa 231				
Tc 97					Pa 233				
Tc 99	~1.80E-13	B B 2	~1.80E-13	C C 2	U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m	~1.74E-11	B B 2	~1.74E-11	C C 2	U 235				
Ag 110m	~3.58E-07	B B 2	~3.58E-07	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	~3.07E-08	B B 2	~3.07E-08	C C 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241	~4.71E-12	B B 2	~4.71E-12	C C 2
Te 127m					Am 242m				
I 129	~9.89E-12	B B 2	~9.89E-12	C C 2	Am 243				
Cs 134	~4.35E-10	B B 2	~4.35E-10	C C 2	Cm 242				
Cs 135					Cm 243				
Cs 137	~1.64E-09	B B 2	~1.64E-09	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					Other a				
Eu 152	~1.32E-09	B B 2	~1.32E-09	C C 2	Other b/g	~1.72E-09	B B 2	~1.72E-09	C C 2
Eu 154	~5.59E-09	B B 2	~5.59E-09	C C 2	**Total a**	**~4.71E-12**	**B B 2**	**~4.71E-12**	**C C 2**
Eu 155	~1.08E-10	B B 2	~1.08E-10	C C 2	**Total b/g**	**~4.4E-06**	**B B 2**	**~4.40E-06**	**C C 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