

WASTE STREAM	9H15	Sludge
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SITE Wylfa
SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	~27.1 m ³
Future arisings -	1.4.2024 - 31.3.2025.....	8.5 m ³
Total future arisings:		8.5 m ³
Total waste volume:		35.6 m ³

Comment on volumes: Arisings during defuelling are included in this waste stream.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 1.2
Stock (lower): x 0.9 Arisings (lower) x 0.9

WASTE SOURCE The routine filtration of liquid effluents. Sand from the emptying of the sand filters at the end of defuelling.

PHYSICAL CHARACTERISTICS

General description: The sludge originates from routine filtration of liquid effluents. The sludge may include debris washed from persons, floors and clothing, corrosion products and extraneous materials such as flakes of paint. Filter sand will also be present. There is some oil with the waste. Sludge particles may be up to millimetre size, and there will probably be 50-450 kg/m³ of dry material. Once fluidised the sludges should be readily transferred by pumping, but reconcentration may be time consuming. Any exhausted ion exchange resins from pressure vessel cooling water system treatment plant and corrosion products from that system are accumulated with the sludge, as also is dust from the reactor by-pass filtration systems. There are no large items in the waste that may require special handling.

Physical components (%vol): Sludge (~88%) and sand (~12%). The breakdown of components constituting the sludge has not been assessed.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.3

Comment on density: The bulk density range of the sludge is estimated to be 1.05 to 1.15 t/m³ with a mean density of 1.1 t/m³. The density of the sand from the sand filters is assumed to be about 2.65 t/m³ so the overall mean bulk density is about 1.3 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): A wide range of materials, including sand, oil, grease and complexing agents may be present.

Chemical state: Neutral

Chemical form of radionuclides: H-3: Most tritium is expected to be present as water but some may be in the form of other inorganic compounds or as organic compounds.

C-14: Chemical form of carbon 14 has not been determined.

Cl-36: Chemical form of chlorine 36 has not been determined.

Se-79: The selenium content is insignificant.

Tc-99: The technetium content is insignificant.

Ra: Radium isotope content is expected to be insignificant.

Th: The thorium isotope content is insignificant.

U: Chemical form of uranium isotopes has not been determined but may be uranium oxides.

Np: The neptunium content is insignificant.

Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): No sheet metal or bulk metal items present.

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	TR	Only trace quantities of metals present.	
Other ferrous metals.....	TR	Only trace quantities of metals present.	
Iron.....			
Aluminium.....	TR	Only trace quantities of metals present.	
Beryllium.....	0		
Cobalt.....			
Copper.....	TR	Only trace quantities of metals present.	
Lead.....	0		
Magnox/Magnesium.....	TR	Only trace quantities of metals present.	
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....	TR	Only trace quantities of metals present.	
Zircaloy/Zirconium.....	0		
Other metals.....	TR	Trace quantities of "other" metals may be present.	

Organics (%wt): Not fully assessed. The organic ion-exchange resin material is polystyrene based. Cellulosics would be present in only trace quantities. No halogenated plastics or rubbers present.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	TR		
Paper, cotton.....	TR		
Wood.....	0		
Halogenated plastics	0		
Total non-halogenated plastics.....	0		
Condensation polymers.....	0		
Others.....	0		
Organic ion exchange materials....	<3.0		
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.....	~10.0		

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Other materials (%wt): A small quantity of graphite may be present.

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..	<1.0		
Inorganic sludges and flocs.....	~65.0		
Soil.....	<1.0		
Brick/Stone/Rubble.....	NE		
Cementitious material.....			
Sand.....	~19.0		
Glass/Ceramics.....	NE		
Graphite.....	<1.0		
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....	P		
Free non-aqueous liquids.....	P		
Powder/Ash.....	0		

Inorganic anions (%wt): Not assessed.

	(%wt)	Type(s) and comment
Fluoride.....	NE	
Chloride.....	NE	
Iodide.....	NE	
Cyanide.....	0	
Carbonate.....	NE	
Nitrate.....	NE	
Nitrite.....	NE	
Phosphate.....	NE	
Sulphate.....	NE	
Sulphide.....	NE	

Materials of interest for waste acceptance criteria: There may be trace quantities of biological material but such trace quantities are not considered to pose a non-radioactive hazard.

	(%wt)	Type(s) and comment
Combustible metals.....	0	
Low flash point liquids.....	0	
Explosive materials.....	0	
Phosphorus.....	0	
Hydrides.....	0	
Biological etc. materials.....	TR	
Biodegradable materials.....	0	
Putrescible wastes.....	0	

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

Hazardous substances / none expected
 non hazardous pollutants:

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

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Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	NE	

Potential for the waste to contain discrete items: No. In & of itself not a DI; assumed not likely to contain any "rogue" items that could be.

TREATMENT, PACKAGING AND DISPOSAL

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:

Waste will be mixed in a cementitious matrix and solidified in nominal 210-litre drums, for disposal in a half-height ISO container.

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	2.4

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: -

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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 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	2.4	15

Other information: -

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

Waste Characterisation Form (WCH): The waste meets 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 stored pending Care and Maintenance Preparation when the waste will be retrieved for conditioning prior to disposal.

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: The waste consists of sludge contaminated principally by activation products plus small quantities of fission products and transuranics.

Uncertainty: Specific activity is a function of Station operating history. The values quoted are indicative of the activities that might be expected.

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: Total activity is based on approximate activity found in sludge at the Station. The accumulated sludge has been sampled and analysed. Radionuclide breakdown is based on measurement.

Other information: -

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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	9.92E-04	CC 2	2.55E-03	CC 2	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	9.99E-06	CC 2	9.99E-06	CC 2	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
Cl 36		8		8	Lu 174		8		8
Ar 39		8		8	Lu 176		8		8
Ar 42		8		8	Hf 178n		8		8
K 40		8		8	Hf 182		8		8
Ca 41		8		8	Pt 193		8		8
Mn 53		8		8	Tl 204		8		8
Mn 54		8	1.53E-08	CC 2	Pb 205		8		8
Fe 55	2.56E-05	CC 2	3.95E-04	CC 2	Pb 210	2.5E-09	CC 2	4.34E-09	8
Co 60	5.54E-05	CC 2	3.14E-04	CC 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63	9.02E-05	CC 2	9.46E-05	CC 2	Po 210	2.54E-09	CC 2	4.07E-09	8
Zn 65		8	<5.01E-09	C 3	Ra 223		8		8
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226		8	<2E-08	C 3
Kr 85		8		8	Ra 228		8	1.24E-09	8
Rb 87		8		8	Ac 227		8		8
Sr 90	3.69E-05	CC 2	5.78E-05	CC 2	Th 227		8		8
Zr 93		8		8	Th 228		8		8
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230	7E-09	CC 2	7E-09	CC 2
Nb 93m		8		8	Th 232	<2E-09	C 3	<2E-09	C 3
Nb 94		8		8	Th 234	2E-08	CC 2	2E-08	8
Mo 93		8		8	Pa 231		8		8
Tc 97		8		8	Pa 233	2E-07	8	2E-07	C 3
Tc 99	<9E-09	C 3	<9E-09	C 3	U 232		8		8
Ru 106		8	<2.04E-08	C 3	U 233	<1E-08	C 3	<1E-08	C 3
Pd 107		8		8	U 234	2.01E-08	CC 2	2.01E-08	CC 2
Ag 108m		8		8	U 235		8		8
Ag 110m		8		8	U 236		8		8
Cd 109		8		8	U 238	2E-08	CC 2	2E-08	CC 2
Cd 113m		8		8	Np 237	<2E-07	C 3	<2E-07	C 3
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238	3.62E-06	CC 2	4.21E-06	CC 2
Sn 123		8		8	Pu 239	3E-06	CC 2	3E-06	CC 2
Sn 126		8		8	Pu 240	4E-06	CC 2	4E-06	CC 2
Sb 125	<2.64E-08	C 3	<4.02E-07	C 3	Pu 241	5.56E-05	CC 2	1.36E-04	CC 2
Sb 126		8		8	Pu 242	<2E-08	C 3	<2E-08	C 3
Te 125m	6.6E-09	CC 2	1.01E-07	8	Am 241	1.15E-05	CC 2	1.1E-05	CC 2
Te 127m		8		8	Am 242m	9.3E-06	CC 2	9.61E-06	CC 2
I 129	<1E-08	C 3	<1E-08	C 3	Am 243	4E-08	CC 2	4E-08	CC 2
Cs 134	9.94E-08	CC 2	2.73E-06	CC 2	Cm 242	7.67E-06	CC 2	7.93E-06	8
Cs 135		8		8	Cm 243	3.82E-09	CC 2	6.65E-09	CC 2
Cs 137	5.25E-04	CC 2	8.32E-04	CC 2	Cm 244	6.44E-08	CC 2	1.47E-07	CC 2
Ba 133		8		8	Cm 245		8		8
La 137		8		8	Cm 246		8		8
La 138		8		8	Cm 248		8		8
Ce 144		8	2.45E-09	C 3	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147	2.23E-08	CC 2	3.62E-07	CC 2	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151	1E-06	CC 2	1.88E-06	CC 2	Other a				
Eu 152	1.06E-07	CC 2	2.66E-07	CC 2	Other b/g				CC 2
Eu 154	3.19E-07	CC 2	1.05E-06	CC 2	Total a	3.02E-05	CC 2	3.06E-05	CC 2
Eu 155	4.96E-08	CC 2	3.19E-07	CC 2	Total b/g	1.80E-03	CC 2	4.41E-03	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