WASTE STREAM 5G03/C Conditioned SGHWR Sludges

SITE Winfrith

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	580.8 m³	1887.6 m³
Total future arisings:		0 m³	0 m³
Total waste volume:		580.8 m³	1887.6 m³

Comment on volumes: All the sludge from 5G03 has been encapsulated in 500 litre drums. As the waste is a stock and encapsulated, the volume quoted is the product of the number of drums and the external volume (968 x 0.6) and so has a relatively low uncertainty.

Uncertainty factors on volumes:

Stock (upper):	x 1.05	Arisings (upper)	x
Stock (lower):	x 0.95	Arisings (lower)	x

WASTE SOURCE The waste was derived from the encapsulation of stored sludges (5G03) with cement grout in 500L drums. The original sludge was derived from spent ion exchange resins, filter media, corrosion products and decontamination agents arising from SGHWR operations.

PHYSICAL CHARACTERISTICS

General description: Solid waste made up of cement grout and wastes from various ion exchange processes. The conditioning matrix is 9:1 BFS:OPC. The capping matrix is 3:1 PFA:OPC.

Physical components (%wt): 100% solids

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.72

Comment on density: The wasteform density including drums. derived from WCH mass and volume

CHEMICAL COMPOSITION

General description and components (%wt): Metal (12%), encapsulated waste (88%) - 38% Dried solids: including Ion exchange materials (Powdex - 29%, Metasil A - 2%, Solkafloc BW40 - 1%). The balance is cement encapsulant (50%)

Chemical state: Alkali

Chemical form of radionuclides: U: U-235 present in the sludge, its chemical form is not known.

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	9.8	Metal drum, solid.	
Other ferrous metals.....	1.9	Drum Paddle	
Iron.....	~0.21	Grouted sludge, solid	
Aluminium.....	TR	Grouted sludge, solid	
Beryllium.....	0		
Cobalt.....			
Copper.....	~0.03	Grouted sludge, solid	
Lead.....	0		
Magnox/Magnesium.....	TR	Grouted sludge, solid	
Nickel.....	~0.01	Grouted sludge, solid	
Titanium.....	P	Grout, solid	

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Uranium	TR	
Zinc	~0.01	Grouted sludge, solid
Zircaloy/Zirconium	0	
Other metals		

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	~0		
Paper, cotton	0		
Wood	0		
Halogenated plastics	0		
Total non-halogenated plastics	0		
Condensation polymers	0		
Others	0		
Organic ion exchange materials	31.6	29.29% Powdex, 0.69% Solkafloc BW40, 1.59% Metasil A	
Total rubber	0.01		
Halogenated rubber	0		
Non-halogenated rubber	0.01	Nitrile Rubber - drum seals	
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	TR	Silicon sealant under lid - Trace	

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials			
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	50.0	Grout. The conditioning matrix is 9:1 BFS:OPC. The capping matrix is 3:1 PFA:OPC.	
Sand			
Glass/Ceramics	0		
Graphite	0		
Desiccants/Catalysts			
Asbestos	0		
Non/low friable			
Moderately friable			
Highly friable			

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Free aqueous liquids.....	0	
Free non-aqueous liquids.....	0	
Powder/Ash.....	3.6	Hydrated lime powder

Inorganic anions (%wt): -

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

Materials of interest for waste acceptance criteria: There are no hazardous materials in the waste, and, the waste contains no toxic metals.

	(%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.....		
Corrosive materials.....	0	
Pyrophoric materials.....	0	
Generating toxic gases.....	0	
Reacting with water.....	0	
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: None expected

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

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Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	TR	Grouted sludge, solid
Boron (in Boral).....		
Boron (non-Boral).....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....	TR	Grouted sludge, solid
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....	~0.01	Grouted sludge, solid
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

Complexing agents (%wt): Yes

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids……		
Other organic complexants.....	<0.10	Acetate, formate, Citrate, oxalate & picolinate may be present but are believed to be <0.1% of wet weight.
Total complexing agents.....	<0.10	

Potential for the waste to contain discrete items: Yes. Grouted drums are considered to be DIs

TREATMENT, PACKAGING AND DISPOSAL

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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		
Recyling / reuse		
Other / various		
None		100.0

Comment on planned treatments: Waste has already been encapsulated ready for disposal.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	100.0	1.7
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		

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:

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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	100.0	6	97

Other information: There will be 10 drums placed in 1 cabriolet and 10 cabriolets in 1 rail shipment, so 100 drums at one time despatching to LLWR. 11 shipments in total, with the last shipment only having 68 drums instead of 100.

Waste Planned for Disposal at the LLW Repository:

Container voidage: Voidage will be minimal: limited to ullage within the 500 litre drum

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. Disposal to LLWR is currently planned for 2022-2024.

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 activity originated from removal of contamination from the SGHWR primary circuit and fuel ponds.

Uncertainty: A representative sample of sludge was taken for each batch of drums prior to encapsulation in the WETP. The radiological consistency of each batch was demonstrated by measuring the Cs-137 to Co-60 ratio. The encapsulated sludge batches were grouped together according to the Cs-137 to Co-60 ratio producing a total of 6 bulked samples which were sent for analysis. The results of the analysis were used to deduce a fingerprint.

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: A total of six samples were analysed. All of the samples were analysed for gross alpha and gross beta activity; gamma spectrometry; tritium; carbon-14; nickel-63; strontium-90; and uranium, thorium and plutonium separation followed by alpha spectrometry.Rad data taken from WCH submission: 1MXN-1WIN-0-WCH-0-4320 V16 and decayed by two years to 2022.

Other information: -

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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	1.43E-04	C C 1			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	1.46E-04	C C 1			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36		8			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41		8			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	3.32E-05	C C 1			Pb 210		8		
Co 60	7.07E-04	C C 2			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63	2.66E-03	C C 1			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	2.08E-04	C C 1			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m		8			Th 232		8		
Nb 94		8			Th 234	4.83E-09	C C 2		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99		8			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	2.59E-08	C C 1		
Ag 108m		8			U 235		8		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	4.83E-09	C C 1		
Cd 113m		8			Np 237		8		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	8.04E-07	C C 1		
Sn 123		8			Pu 239	1.05E-06	C C 1		
Sn 126		8			Pu 240	8.55E-07	C C 1		
Sb 125		8			Pu 241	8.44E-06	C C 2		
Sb 126		8			Pu 242	7.24E-09	C C 1		
Te 125m		8			Am 241	2.6E-06	C C 2		
Te 127m		8			Am 242m		8		
I 129	2.32E-08	C C 2			Am 243		8		
Cs 134	3.72E-09	C C 2			Cm 242		8		
Cs 135		8			Cm 243	1.50E-08	C C 2		
Cs 137	7.21E-03	C C 2			Cm 244	8.94E-07	C C 2		
Ba 133		8			Cm 245		8		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147		8			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151		8			Other a				
Eu 152		8			Other b/g				
Eu 154		8			**Total a**	**6.26E-06**	**C C 1**	**0**	
Eu 155		8			**Total b/g**	**1.11E-02**	**C C 1**	**0**	

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