WASTE STREAM 9J313 Graphite LLW

SITE Hunterston A

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2072 - 31.3.2080.....	6.7 m³
Total future arisings:		6.7 m³
Total waste volume:		6.7 m³

Comment on volumes: Waste arisings are assumed to occur at a uniform rate over 8 years. Final Dismantling & Site Clearance is assumed to commence in 2071 lasting for 9 years. Volumes and radioactivity have been calculated for 85 years after reactor shutdown.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 1.2
Stock (lower):	x	Arisings (lower)	x 0.8

WASTE SOURCE Reflector graphite from reactor dismantling.

PHYSICAL CHARACTERISTICS

General description: Graphite blocks and other graphite components.

Physical components (%wt): Graphite (100%).

Sealed sources: -

Bulk density (t/m³): ~1.25

Comment on density: Density estimate based upon assumed packing efficiency of the waste. The density is the effective density for packaging assuming 90% of the graphite is in blocks and 10% is rubble.

CHEMICAL COMPOSITION

General description and components (%wt): Graphite and possibly traces of ferrous metals.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Tritium may be chemically bound with the graphite.
C-14: Carbon 14 will be present as graphite.
Cl-36: Chlorine 36 will probably be chemically bound to the graphite. Some may be linked chemically with impurities in the graphite.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
Ra: Radium isotope content is insignificant.
Th: The thorium content is insignificant.
U: Uranium isotope content is insignificant.
Np: The neptunium content is insignificant.
Pu: Plutonium isotope content is insignificant.

Metals and alloys (%wt): There are no metallic items present.

Stainless steel.....	TR	There may be trace contamination by ferrous metals.
Other ferrous metals.....	TR	There may be trace contamination by ferrous metals.
Iron.....		
Aluminium.....	0	
Beryllium.....	TR	
Cobalt.....		
Copper.....	0	
Lead.....	0	

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	Magnox/Magnesium	0	
	Nickel		
	Titanium		
	Uranium		
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals	0	There are no "other" metals present.
Organics (%wt):	Only graphite expected. Halogenated plastics or rubbers will not be present.		
	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	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):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	0	
	Soil	0	
	Brick/Stone/Rubble	0	
	Cementitious material	0	
	Sand		
	Glass/Ceramics	0	
	Graphite	100.0	
	Desiccants/Catalysts		
	Asbestos	0	
	Non/low friable		
	Moderately friable		
	Highly friable		
	Free aqueous liquids	0	

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	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	
Inorganic anions (%wt):	None of the inorganic anions listed in the table are expected to be present at greater than trace concentration.		
	Fluoride.....	TR	Detected at trace levels in inactive graphite material.
	Chloride.....	TR	
	Iodide.....	0	
	Cyanide.....	0	
	Carbonate.....	TR	
	Nitrate.....	TR	
	Nitrite.....	TR	
	Phosphate.....	TR	Detected at trace levels in inactive graphite material.
	Sulphate.....	TR	Detected at trace levels in inactive graphite material.
	Sulphide.....	0	
Materials of interest for waste acceptance criteria:	No materials likely to pose a fire or other non-radiological hazard have been identified. Graphite presents a low fire risk; it is difficult but not impossible to ignite.		
	Combustible metals.....	0	
	Low flash point liquids.....	0	
	Explosive materials.....	0	
	Phosphorus.....	TR	Detected at trace levels in inactive graphite material.
	Hydrides.....	0	
	Biological etc. materials.....	0	
	Biodegradable materials.....		
	Putrescible wastes.....	0	
	Non-putrescible wastes.....		
	Corrosive materials.....	0	
	Pyrophoric materials.....	0	
	Generating toxic gases.....	0	
	Reacting with water.....	0	
	Active particles.....		
	Soluble solids as bulk chemical compounds.....		
Hazardous substances / non hazardous pollutants:	None expected.		
	Acrylamide.....		
	Benzene.....		
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....		
	Styrene.....		
	Tri-butyl phosphate.....		

Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....	TR	Detected at trace levels in inactive graphite material.
Barium.....		
Boron.....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....		
Molybdenum.....		
Thallium.....	TR	Detected at trace levels in inactive graphite material.
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....	TR	
Electronic Electrical Equipment (EEE)		
EEE Type 1.....		
EEE Type 2.....		
EEE Type 3.....		
EEE Type 4.....		
EEE Type 5.....		

Complexing agents (%wt):

EDTA.....	
DPTA.....	
NTA.....	
Polycarboxylic acids……	
Other organic complexants.....	
Total complexing agents.....	TR

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		
Recyling / reuse		
Other / various		100.0
None		

Comment on planned treatments: -

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Disposal Routes:

Disposal Route	Stream volume %
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

Upcoming (2019/20-2021/22) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2019/20	2020/21	2021/22
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 Packaging for Disposal: (Not applicable to this waste stream)

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			

Other information: -

Waste Planned for Disposal at the LLW Repository: (Not applicable to this waste stream)

Container voidage: -

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

Potential for the waste to contain discrete items: -

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

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Source:	Activation of the graphite and impurities.
Uncertainty:	The values quoted were derived by calculation from available material specification and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels.
Definition of total alpha and total beta/gamma:	Total beta/gamma is defined as the sum of the listed activities of all nuclides other than alpha emitters. Activity estimates for individual alpha emitting nuclides have not been provided but are likely to be very low.
Measurement of radioactivities:	The specific activities were estimated from neutron activation calculations of the material and its impurities.
Other information:	There may be some contamination by Cs137. The activities quoted are those at 85 years after reactor shutdown. Fission of uranium impurity in the graphite may result in some fission product and actinide activity.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			3.95E-06	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			4.66E-06	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			1.57E-08	C C 2	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41			1.31E-08	C C 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55				8	Pb 210				8
Co 60				8	Bi 208				8
Ni 59			2.27E-09	C C 2	Bi 210m				8
Ni 63			1.37E-07	C C 2	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				8	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				8
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				8
Ag 108m				8	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				8
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m			3.39E-09	C C 2	Pu 238				6
Sn 123				8	Pu 239				6
Sn 126				8	Pu 240				6
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				6
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243				8
Cs 137				6	Cm 244				8
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			9.41E-09	C C 2	Other a				
Eu 152			1.8E-07	C C 2	Other b/g				
Eu 154				8	**Total a**	**0**		**0**	
Eu 155				8	**Total b/g**	**0**		**8.97E-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