

WASTE STREAM**5G303****DRAGON Reactor Decommissioning LLW**

SITE Winfrith
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Magnox Limited
WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m ³
Future arisings -	1.4.2019 - 31.3.2023.....	71.3 m ³
Total future arisings:		71.3 m ³
Total waste volume:		71.3 m ³

Comment on volumes: Decommissioning and deplanting of buildings prior to demolition and clearance of structures. Volume updated for 2016 RWI to reflect SMART Inventory review.

Uncertainty factors on volumes: Stock (upper): x Arisings (upper) x 1.5
 Stock (lower): x Arisings (lower) x 0.5

WASTE SOURCE Reactor decommissioning.

PHYSICAL CHARACTERISTICS

General description: Waste comprising mostly redundant plant items and building structures; some change barrier and care & maintenance wastes. Large items of dismantled plant will be placed directly into containers. Large tanks will be size reduced. Concrete expected mostly to be scabblings.

Physical components (%wt): Concrete and brick from building structures 70%, Pressure vessel, Main Shield Plug and Associated metalwork 23%, mixed waste including waste in IP2 drums, plastic from various fittings 7%.

Sealed sources: -

Bulk density (t/m³): ~1.02

Comment on density: Waste stream mass divided by volume taken from WCH.

CHEMICAL COMPOSITION

General description and components (%wt): Concrete and brick ~70%, metalwork ~23%, mixed waste 7%.

Chemical state: -

Chemical form of radionuclides: H-3: Radionuclides are present as trace elements in the activated materials. Present through contamination.
 C-14: Radionuclides are present as trace elements in the activated materials. Present through contamination.
 Cl-36: Radionuclides are present as trace elements in the activated materials.
 Se-79: Radionuclides are present as trace elements in the activated materials.
 Tc-99: Radionuclides are present as trace elements in the activated materials.
 I-129: Radionuclides are present as trace elements in the activated materials.
 Ra: Radionuclides are present as trace elements in the activated materials. Possible presence through contamination.
 Th: Radionuclides are present as trace elements in the activated materials. Possible presence through contamination.
 U: Radionuclides are present as trace elements in the activated materials. Present through contamination.
 Np: Radionuclides are present as trace elements in the activated materials. Possible presence through contamination.
 Pu: Radionuclides are present as trace elements in the activated materials. Present through contamination.

Metals and alloys (%wt): Plate thicknesses are 1" for the thermal shield plates, ~2" for the pressure vessel. Other material will be present from non-core items. It should be noted that the material will be sized reduced to allow it to be packed into the containers.

WASTE STREAM

5G303

DRAGON Reactor Decommissioning LLW

	Stainless steel.....	~0.14	Stainless steel AISI 321.
	Other ferrous metals.....	17.5	Pressure vessel steel Marwe 426.
	Iron.....		
	Aluminium.....	TR	
	Beryllium.....	0	
	Cobalt.....		
	Copper.....	~0.01	Copper items from Dragon facility
	Lead.....	~0.07	Solid (chevrons etc.) / lead shot
	Magnox/Magnesium.....	~0.05	Magnesium Oxide (within pyro cable)
	Nickel.....		
	Titanium.....		
	Uranium.....	TR	
	Zinc.....	P	
	Zircaloy/Zirconium.....	0	
	Other metals.....	5.2	Undefined from WCH data
Organics (%wt):	-		
	Total cellulosics.....	1.0	
	Paper, cotton.....	0	
	Wood.....	1.0	
	Halogenated plastics	~0.01	PVC
	Total non-halogenated plastics.....	0.46	
	Condensation polymers.....	~0.23	
	Others.....	~0.23	
	Organic ion exchange materials....	0	
	Total rubber.....	1.0	
	Halogenated rubber	0.50	
	Non-halogenated rubber.....	0.50	
	Hydrocarbons.....		
	Oil or grease	~0.01	
	Fuel.....		
	Asphalt/Tarmac (cont.coal tar)...		
	Asphalt/Tarmac (no coal tar)....		
	Bitumen.....		
	Others.....		
	Other organics.....		
Other materials (%wt):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs.....	0	
	Soil.....	0	
	Brick/Stone/Rubble.....	70.0	
	Cementitious material.....	P	
	Sand.....		

WASTE STREAM

5G303 DRAGON Reactor Decommissioning LLW

	Glass/Ceramics.....	~0.08	Man Made Mineral Fibres
	Graphite.....	P	
	Desiccants/Catalysts.....		
	Asbestos.....	~0.13	
	Non/low friable.....		
	Moderately friable.....		
	Highly friable.....	~0.13	Chrysotile and Amosite
	Free aqueous liquids.....	0	
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	P	
Inorganic anions (%wt):	~0.02% is thermal insulation (Newtherm), a, calcium silicate		
	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:	~1.8 m3 asbestos in IP2 containers was identified in the SMART review.		
	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	
	Non-putrescible wastes.....	1.0	
	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:	Some lead will be present. Powders are likely to result from cutting during removal and size reduction. Asbestos present.		
	Acrylamide.....		
	Benzene.....		

WASTE STREAM**5G303****DRAGON Reactor Decommissioning LLW**

Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....	0.01	Alloy within steel
Molybdenum.....		
Thallium.....		
Tin.....		
Vanadium.....		
Mercury compounds.....		
Others.....		
Electronic Electrical Equipment (EEE)		
EEE Type 1.....	P	250 off Stripped down circuit boards
EEE Type 2.....		
EEE Type 3.....	P	150 items
EEE Type 4.....		
EEE Type 5.....	P	10 off Rechargeable batteries
Complexing agents (%wt):	No	
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids.....		
Other organic complexants.....		
Total complexing agents.....	0	

TREATMENT, PACKAGING AND DISPOSAL

WASTE STREAM**5G303****DRAGON Reactor Decommissioning LLW**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	Off-site	2.0
Supercompaction (HFC)		
Incineration		
Solidification	Off-site	1.0
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse	97.0	
Other / various		
None		

Comment on planned treatments:

89% of the stream is expected to be disposed of as VLLW to landfill.

Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	8.0
Expected to be consigned to a Landfill Facility	89.0
Expected to be consigned to an On-Site Disposal Facility	
Expected to be consigned to an Incineration Facility	2.0
Expected to be consigned to a Metal Treatment Facility	1.0
Expected to be consigned as Out of Scope	
Expected to be recycled / reused	
Disposal route not known	

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:

Container	Stream volume %	Waste loading m ³	Number of packages
1/3 Height IP-1 ISO	8.0	~10	< 1
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:

Container voidage: -

Waste Characterisation Form (WCH):

The waste meets the LLWR's Waste Acceptance Criteria (WAC).
The waste has a current WCH.

WASTE STREAM**5G303****DRAGON Reactor Decommissioning LLW**

Some waste from 5G303 has been accounted for in recent WCF's submitted metal treatment. However, this will not cover all future arisings.

Waste consigned for disposal to LLWR in year of generation:

Yes.

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

Source:

Neutron induced activity of structural components. Fuel/ fission product contamination not yet assessed, but believed to be negligible in core components. Contamination levels in non-core plant are significant and will be quantified in the future.

Uncertainty:

The radionuclide inventory has been derived from activation modelling of the core LLW components only. Therefore the radionuclides present are those theoretically predicted to arise by the model from neutron activation. The data therefore requires caution in two respects: (i) it will generally (except in the case of fission product contamination e.g. Cs137) be a very conservative upper limit. (ii) the radionuclides are theoretically predicted to arise from activation of trace elements in reactor components but may not actually be present. The strategy to address these issues is further sampling and analysis to produce fingerprints as the decommissioning work proceeds.

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 reactor activation study was carried out based on a 3-D Monte Carlo neutron transport code to determine energy dependent neutron flux spectra, and on the EASY/FISPACT neutron activation code. This addresses core components only (see above comments). The majority of wastes will actually be contaminated components. Activity data based on WCH: 1RSR-2WIN-0-WCH-0-4036 and decayed by two years.

Other information:

-

WASTE STREAM

5G303

DRAGON Reactor Decommissioning LLW

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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			6.96E-05	CC 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			1.22E-06	CC 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			1.37E-08	CC 2	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41			3.37E-07	CC 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55			8.07E-07	CC 2	Pb 210				8
Co 60			6.87E-06	CC 2	Bi 208				8
Ni 59			2.42E-07	CC 2	Bi 210m				8
Ni 63			1.67E-05	CC 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			2.88E-06	CC 2	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		1.73E-08	CC 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		1.41E-08	CC 2	
Ag 108m				8	U 235		2.28E-09	CC 2	
Ag 110m				8	U 236				8
Cd 109				8	U 238		1.73E-08	CC 2	
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m				8	Pu 238		1.53E-08	CC 2	
Sn 123				8	Pu 239		1.22E-09	CC 2	
Sn 126				8	Pu 240		1.22E-09	CC 2	
Sb 125				8	Pu 241		7.51E-08	CC 2	
Sb 126				8	Pu 242				8
Te 125m				8	Am 241		2.97E-08	CC 2	
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134				8	Cm 242				8
Cs 135				8	Cm 243		1.24E-09	CC 2	
Cs 137			1.03E-05	CC 2	Cm 244		1.2E-09	CC 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			4.22E-06	CC 2	Other b/g				
Eu 154			1.81E-07	CC 2	Total a	0	8.36E-08	CC 2	
Eu 155				8	Total b/g	0	1.14E-04	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