

<b>WASTE STREAM</b>	<b>5C328</b>	<b>BEPO Reactor Decommissioning VLLW and LA-LLW</b>
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**SITE** Harwell  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Magnox Limited  
**WASTE TYPE** VLLW

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	38.0 m <sup>3</sup>
Future arisings -	1.4.2021 - 31.3.2025.....	5020.0 m <sup>3</sup>
Total future arisings:		5020.0 m <sup>3</sup>
Total waste volume:		5058.0 m <sup>3</sup>

Comment on volumes: VLLW and LA-LLW soil and rubble arising from buildings decommissioning. Volumes updated for 2016 RWI to reflect SMART Inventory Review. This waste was originally part of 5C300 but this has been split to provide greater clarity.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 2.0  
 Stock (lower): x 0.8 Arisings (lower) x 0.2

**WASTE SOURCE** VLLW and LA-LLW arising from decommissioning of BEPO reactor and associated buildings.

**PHYSICAL CHARACTERISTICS**

General description: Predominantly soil. There should be no large items in this waste stream. Land and buildings on the Harwell site, contaminated as a result of past operations.  
 Physical components (%wt): Soil ~85%; concrete/rubble ~15%.  
 Sealed sources: -  
 Bulk density (t/m<sup>3</sup>): ~1.4  
 Comment on density: Average density for soil.

**CHEMICAL COMPOSITION**

General description and components (%wt): Soil ~85%; concrete/rubble ~15%.  
 Chemical state: -  
 Chemical form of radionuclides: -  
 Metals and alloys (%wt): There should be no sheet metal or bulk metal items present in the waste stream.  
 Stainless steel..... NE  
 Other ferrous metals..... NE  
 Iron.....  
 Aluminium..... NE  
 Beryllium..... NE  
 Cobalt.....  
 Copper..... NE  
 Lead..... NE  
 Magnox/Magnesium..... NE  
 Nickel.....  
 Titanium.....  
 Uranium..... NE  
 Zinc..... NE  
 Zircaloy/Zirconium..... NE

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	Other metals.....	NE
Organics (%wt):	-	
	Total cellulose.....	NE
	Paper, cotton.....	NE
	Wood.....	NE
	Halogenated plastics .....	NE
	Total non-halogenated plastics.....	NE
	Condensation polymers.....	NE
	Others.....	NE
	Organic ion exchange materials....	NE
	Total rubber.....	NE
	Halogenated rubber .....	NE
	Non-halogenated rubber.....	NE
	Hydrocarbons.....	
	Oil or grease .....	
	Fuel.....	
	Asphalt/Tarmac (cont.coal tar)...	
	Asphalt/Tarmac (no coal tar)....	
	Bitumen.....	
	Others.....	
	Other organics.....	NE
Other materials (%wt):	-	
	Inorganic ion exchange materials.	NE
	Inorganic sludges and flocs.....	NE
	Soil.....	~~85.0
	Brick/Stone/Rubble.....	~~10.0
	Cementitious material.....	~~5.0
	Sand.....	
	Glass/Ceramics.....	NE
	Graphite.....	NE
	Desiccants/Catalysts.....	
	Asbestos.....	
	Non/low friable.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	
	Free non-aqueous liquids.....	
	Powder/Ash.....	
Inorganic anions (%wt):	-	

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Fluoride.....	NE
Chloride.....	NE
Iodide.....	NE
Cyanide.....	NE
Carbonate.....	NE
Nitrate.....	NE
Nitrite.....	NE
Phosphate.....	NE
Sulphate.....	NE
Sulphide.....	NE

Materials of interest for  
waste acceptance criteria:

-
Combustible metals.....
Low flash point liquids.....
Explosive materials.....
Phosphorus.....
Hydrides.....
Biological etc. materials.....
Biodegradable materials.....
Putrescible wastes.....
Non-putrescible wastes.....
Corrosive materials.....
Pyrophoric materials.....
Generating toxic gases.....
Reacting with water.....
Active particles.....
Soluble solids as bulk chemical compounds.....

Hazardous substances /  
non hazardous pollutants:

-
Acrylamide.....
Benzene.....
Chlorinated solvents.....
Formaldehyde.....
Organometallics.....
Phenol.....
Styrene.....
Tri-butyl phosphate.....
Other organophosphates.....
Vinyl chloride.....
Arsenic.....
Barium.....
Boron.....

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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.....

Complexing agents (%wt):

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

**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		100.0

Comment on planned treatments:

It is intended that the waste stream will be disposed of via controlled burial to an off-site landfill, therefore no waste containers will be produced. Disposal to landfill is expected to be in 1m3 bags.

**WASTE STREAM****5C328****BEPO Reactor Decommissioning VLLW and LA-LLW****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 m <sup>3</sup>	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**

**WASTE STREAM****5C328****BEPO Reactor Decommissioning VLLW and LA-LLW**

Source:	Contamination as a result of past operations.
Uncertainty:	-
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:	Specific activity estimates are based on consignments from this stream in 2012. These are the best estimates currently, but some areas have yet to be characterised, and so values may change as more data becomes available. Activities decayed to reflect arising date for 2019 UKRWI.
Other information:	-

**WASTE STREAM**

**5C328**

**BEPO Reactor Decommissioning VLLW and LA-LLW**

Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	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		8		8	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14		8		8	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		8	Pb 205		8		8
Fe 55		8		8	Pb 210	4.56E-09	BB 2	5.9E-09	BB 2
Co 60	8.97E-08	BB 2	6.89E-08	BB 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63		8		8	Po 210	4.17E-09	BB 2	5.53E-09	BB 2
Zn 65		8		8	Ra 223	1.36E-09	BB 2	1.36E-09	BB 2
Se 79		8		8	Ra 225		8		8
Kr 81		8		8	Ra 226	2.72E-08	BB 2	2.72E-08	BB 2
Kr 85		8		8	Ra 228	1.16E-09	BB 2	1.4E-09	BB 2
Rb 87		8		8	Ac 227	1.36E-09	BB 2	1.36E-09	BB 2
Sr 90		8		8	Th 227	1.34E-09	BB 2	1.34E-09	BB 2
Zr 93		8		8	Th 228		8		8
Nb 91		8		8	Th 229		8		8
Nb 92		8		8	Th 230	2.72E-08	BB 2	2.72E-08	BB 2
Nb 93m		8		8	Th 232	2.26E-09	BB 2	2.26E-09	BB 2
Nb 94		8		8	Th 234	2.72E-08	BB 2	2.72E-08	BB 2
Mo 93		8		8	Pa 231	1.36E-09	BB 2	1.36E-09	BB 2
Tc 97		8		8	Pa 233		8		8
Tc 99		8		8	U 232		8		8
Ru 106		8		8	U 233		8		8
Pd 107		8		8	U 234	2.72E-08	BB 2	2.72E-08	BB 2
Ag 108m		8		8	U 235	1.36E-09	BB 2	1.36E-09	BB 2
Ag 110m		8		8	U 236		8		8
Cd 109		8		8	U 238	2.72E-08	BB 2	2.72E-08	BB 2
Cd 113m		8		8	Np 237		8		8
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238	1.48E-08	BB 2	1.46E-08	BB 2
Sn 123		8		8	Pu 239	2.15E-07	BB 2	2.15E-07	BB 2
Sn 126		8		8	Pu 240	2.15E-07	BB 2	2.15E-07	BB 2
Sb 125		8		8	Pu 241	2.37E-07	BB 2	2.15E-07	BB 2
Sb 126		8		8	Pu 242		8		8
Te 125m		8		8	Am 241	1.93E-07	BB 2	1.93E-07	BB 2
Te 127m		8		8	Am 242m		8		8
I 129		8		8	Am 243		8		8
Cs 134		8		8	Cm 242		8		8
Cs 135		8		8	Cm 243		8		8
Cs 137	2.01E-07	BB 2	1.92E-07	BB 2	Cm 244		8		8
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		8	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147		8		8	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151		8		8	Other a				
Eu 152		8		8	Other b/g				
Eu 154		8		8	<b>Total a</b>	<b>7.59E-07</b>	<b>BB 2</b>	<b>7.60E-07</b>	<b>BB 2</b>
Eu 155		8		8	<b>Total b/g</b>	<b>5.62E-07</b>	<b>BB 2</b>	<b>5.12E-07</b>	<b>BB 2</b>

**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