

WASTE STREAM	5C301	BEPO Reactor Decommissioning LLW
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SITE Harwell
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 - 31.3.2025.....	185.0 m ³
Total future arisings:		185.0 m ³
Total waste volume:		185.0 m ³

Comment on volumes: Volumes updated for 2016 RWI to reflect SMART Inventory Review

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

WASTE SOURCE Decommissioning of BEPO redundant experimental reactor and its outer building.

PHYSICAL CHARACTERISTICS

General description: 6.5 MW(T) reactor with graphite moderator and air cooling, including waste from thermal columns and fuel transport bridging pieces - blocks of graphite, cadmium and bismuth.

Physical components (%wt): Steel (58%), concrete (41%), miscellaneous waste from care and maintenance (<0.5%) and others (0.5%).

Sealed sources: -

Bulk density (t/m³): 5

Comment on density: This is based on the theoretical densities of: Steel = 7.9 t/m³; Concrete = 3.4 t/m³; Bismuth = 9.8 t/m³; Cadmium = 8.7 t/m³; Care and Maintenance = 0.86 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Steel (58%), concrete (41%), Bismuth (<0.5%), Cadmium (<0.1%) and miscellaneous waste from care & maintenance (<0.5%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Tritiated waste may arise from concrete bioshield.

Metals and alloys (%wt): Metals will be present in a large range of thicknesses.

Stainless steel.....	P
Other ferrous metals.....	58.0
Iron.....	
Aluminium.....	P
Beryllium.....	
Cobalt.....	
Copper.....	NE
Lead.....	P
Magnox/Magnesium.....	NE
Nickel.....	
Titanium.....	
Uranium.....	
Zinc.....	NE
Zircaloy/Zirconium.....	NE
Other metals.....	<1.0

Other metals include bismuth (~0.5%) and cadmium (<0.1%).

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Organics (%wt):

The waste will contain small quantities of cellulose. Halogenated plastics in waste are PVC and PTFE, and rubbers are neoprene and hypalon.

Total cellulosics.....	P	
Paper, cotton.....	NE	
Wood.....	NE	
Halogenated plastics	P	PVC and PTFE
Total non-halogenated plastics.....	P	
Condensation polymers.....	NE	
Others.....	NE	
Organic ion exchange materials....	NE	
Total rubber.....	P	
Halogenated rubber	P	Neoprene and hypalon.
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.	0
Inorganic sludges and flocs.....	0
Soil.....	0
Brick/Stone/Rubble.....	0
Cementitious material.....	41.0
Sand.....	
Glass/Ceramics.....	0
Graphite.....	0
Desiccants/Catalysts.....	
Asbestos.....	P
Non/low friable.....	
Moderately friable.....	
Highly friable.....	
Free aqueous liquids.....	
Free non-aqueous liquids.....	
Powder/Ash.....	0

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:

Asbestos may be present in future arisings, quantities are not known at present.

Combustible metals.....	0
Low flash point liquids.....	0
Explosive materials.....	0
Phosphorus.....	0
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:

Cadmium will be present in future arisings. Asbestos, lead and antimony may be present in trace quantities in the waste stream.

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

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Cadmium..... <0.10

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):

No

EDTA.....

DPTA.....

NTA.....

Polycarboxylic acids.....

Other organic complexants.....

Total complexing agents..... 0

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	Off-site	~59.0
Supercompaction (HFC)		
Incineration		
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recycling / reuse		
Other / various		
None		

Comment on planned treatments:

-

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Disposal Route	Stream volume %	
Expected to be consigned to the LLW Repository	41.0	
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		59.0
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	41.0	10	8
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: The majority of this waste will be sent for metal treatment.

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: 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

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Source:	Activation of steel and concrete
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:	The specific activity data is based on a sampling campaign undertaken in the 1980's and calculations based on the operational life of the reactor. The specific activity data was calculated for 2003 in the original source data.
Other information:	-

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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			2.78E-04	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14				6	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36				6	Lu 174				8
Ar 39				8	Lu 176				8
Ar 42				8	Hf 178n				8
K 40				8	Hf 182				8
Ca 41			7.67E-07	C C 2	Pt 193				8
Mn 53				8	Tl 204				8
Mn 54				8	Pb 205				8
Fe 55			4.28E-05	C C 2	Pb 210				6
Co 60			1.07E-04	C C 2	Bi 208				8
Ni 59			1.38E-04	C C 2	Bi 210m				6
Ni 63			1.18E-02	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			4.03E-06	C C 2	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				6
Ag 108m				8	U 235				8
Ag 110m				8	U 236				8
Cd 109				8	U 238				6
Cd 113m				8	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m				8	Pu 238				6
Sn 123				8	Pu 239				6
Sn 126				8	Pu 240				8
Sb 125				8	Pu 241				8
Sb 126				8	Pu 242				8
Te 125m				8	Am 241				8
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				6
Ba 133			2.85E-06	C C 2	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				6	Other b/g				
Eu 154				6	Total a	0		0	
Eu 155				8	Total b/g	0		1.24E-02	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