WASTE STREAM 9R102 Berkeley Centre Decommissioning : Primary LLW

SITE Berkeley

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2019 - 31.3.2022.....	249.0 m³
Total future arisings:		249.0 m³
Total waste volume:		249.0 m³

Comment on volumes: -

Uncertainty factors on volumes:

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

WASTE SOURCE A variety of materials from plant and ILW store dismantling. Consists of wastes that arose from early decommissioning activities in the Berkeley Shielded Area, prior to full decommissioning. The main source of the waste is from active plant and cells used for the examination of irradiated fuels, graphite and steels as well as ILW store decommissioning. Activation and fission product, as well as actinide contamination, is expected.

PHYSICAL CHARACTERISTICS

General description: Contaminated structural material, fixtures, fittings and equipment including metals and plastics resulting from decommissioning. Also some concrete and some secondary waste. The shield doors originating from cells one to ten have been added to this waste stream. These doors are steel clad concrete weighing about 7.5 tonnes each.

Physical components (%vol): Plant waste: Ferrous metal, lead, copper, rubber, concrete (pond scabblings), wood, paper/cotton and plastics.

Sealed sources: -

Bulk density (t/m³): ~1.37

Comment on density: The average bulk density is estimated using material densities and composition.

CHEMICAL COMPOSITION

General description and components (%wt): A variety of materials including plastic materials (2%), concrete (5%), metals (85%), rubber (1%), wood (1%), cellulosics - cloth and paper (2%), and others (4%) Percentage breakdown of chemical components has not been assessed.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: The chemical form of tritium has not been assessed.
C-14: The chemical form of carbon 14 has not been assessed.
Cl-36: The chemical form of chlorine 36 has not been assessed.
Ra: The radium isotope content is expected to be insignificant.
Th: Thethorium isotope content is expected to be insignificant.
U: The chemical form of uranium isotopes has not been assessed.
Pu: The chemical form of plutonium isotopes has not been assessed.

Metals and alloys (%wt): Some items may have been cut for packaging but an assessment of item dimensions has not been made.

Stainless steel.....	~33.0	Tanks, liners, electron microscope components
Other ferrous metals.....	~28.5	Ventilation equipment, plates, drums, casing, tensile tester
Iron.....	~12.4	Lathe body
Aluminium.....	~0.10	Size reduced ladders, sheets,
Beryllium.....	NE	
Cobalt.....	TR	Alloy constituent
Copper.....	~6.5	Cabling, wires

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	Lead	~4.5	Gamma block, lead shielding, transfer tunnel blocks, gamma gates
	Magnox/Magnesium	0	
	Nickel	TR	Alloy constituent
	Titanium		
	Uranium	NE	
	Zinc	TR	Constituent of galvonised ducting
	Zircaloy/Zirconium	0	
	Other metals	NE	
Organics (%wt):	Some organic materials may be present.		
	Total cellulosics	~3.0	
	Paper, cotton	~2.0	
	Wood	~1.0	
	Halogenated plastics	~1.0	Gamma blocks, pipes, secondary waste arising
	Total non-halogenated plastics	~1.0	
	Condensation polymers	~0.50	Secondary waste arising, plastic components/casing
	Others	~0.50	Secondary waste arising, plastic components/casing
	Organic ion exchange materials	0	
	Total rubber	~1.0	
	Halogenated rubber	~1.0	
	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	NE	
	Brick/Stone/Rubble	NE	
	Cementitious material	~5.0	
	Sand		
	Glass/Ceramics	TR	Glass fibre insulation
	Graphite	NE	
	Desiccants/Catalysts		
	Asbestos	~1.5	
	Non/low friable	~1.5	Gaskets, lagging, etc

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	Moderately friable.....	~0.01	Vacuum cleaner contents, chrysotile (whilte)
	Highly friable.....		
	Free aqueous liquids.....	0	
	Free non-aqueous liquids.....	0	
	Powder/Ash.....	0	
Inorganic anions (%wt):	Not fully assessed.		
	Fluoride.....	NE	
	Chloride.....	NE	
	Iodide.....	NE	
	Cyanide.....	NE	
	Carbonate.....	NE	
	Nitrate.....	NE	
	Nitrite.....	NE	
	Phosphate.....	TR	
	Sulphate.....	NE	
	Sulphide.....	NE	
Materials of interest for waste acceptance criteria:	less than 2% by weight asbestos is 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:	Approximately 2% by weight asbestos is present		
	Acrylamide.....		
	Benzene.....		
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....		
	Styrene.....		

Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....		
Cadmium.....		
Caesium.....		
Selenium.....		
Chromium.....	TR	Alloy constituent
Molybdenum.....		
Thallium.....		
Tin.....	TR	Shelves
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): Yes

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	On-site	4.6
Supercompaction (HFC)	Off-site	4.6
Incineration	Off-site	14.3
Solidification		
Decontamination		
Metal treatment	Off-site	58.8
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		22.3

Comment on planned treatments: ~4.2% of this waste stream is expected to be sent to Landfill as VLLW .

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Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	22.7
Expected to be consigned to a Landfill Facility	4.2
Expected to be consigned to an On-Site Disposal Facility	
Expected to be consigned to an Incineration Facility	14.3
Expected to be consigned to a Metal Treatment Facility	58.8
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 m³	Number of packages
1/3 Height IP-1 ISO			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	~4.6	43.2	< 1
1/2 Height IP-2 Disposal/Re-usable ISO	~18.1	10	5
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: It is likely that this waste will be placed in a container with other LLW. 43.2m3 loading volume for WAMAC 1/2 height ISO is calculated based on the fact that you can low force compact two times the normal volume of waste into a 200 litre/0.2m3 drum (400 litres/0.4m3), you can then fit 36 drums (14.4m3) into a ½ height ISO, each drum can be super-compacted to a 1/3 of its original volume so therefore we can get 3 x the amount of un-compacted drums into the final disposal container (43.2m3).

Waste Planned for Disposal at the LLW Repository:

Container voidage: No significant inaccessible voidage is expected to be present.

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

Waste consigned for disposal to LLWR in year of generation: Yes. The waste will be packaged as it arises during site decommissioning activities. At present the timing of consignment of the waste for disposal cannot be determined.

Potential for the waste to contain discrete items: -

Non-Containerised Waste for In-Vault Grouting: (Not applicable to this waste stream)

Stream volume (%): -

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Waste stream variation:	-
Bounding cuboidal volume:	
Inaccessible voidage:	-
Other information:	-

RADIOACTIVITY

Source:	Contamination of the materials.
Uncertainty:	Only approximate estimates have been made of specific activities from measured activity on waste drums and the use of fingerprints.
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 fingerprint for Berkeley 9R102 was originally derived from five sources; Magnox and AGR Graphite, AGR Fuel Waste, General Magnox Trash Steel. The waste inventory was derived from fingerprints based on multiple swab samples and bulk samples. Swab samples were initially analysed by gamma spectrometry to obtain fingerprint ratios for all significant gamma emitting radionuclides. Once this was completed, a portion of the samples underwent dissolution by acid digestion and fusion and were analysed for Ca45, Fe55, Ni63, Sr90, Pm147 as well as Pu, Am and Cm isotopes. Individual aliquots of the remaining bulk area solids were then used to determine H3, C14 and Cl36 activities. Bulk samples were subjected to gamma spectrometry to determine the ratios of key gamma radionuclides to Co60. Standard acid digestion and fusion techniques were used on the samples and the solution was then subjected to further gamma spectrometry to ensure all activity was dissolved.
Other information:	No radionuclides other than those listed as possibly being present are expected to be significant.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3			8.56E-06	B B 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			1.23E-06	B B 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			2.9E-06	B B 2	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			1.53E-06	B B 2	Pb 210				8
Co 60			2.64E-06	B B 1	Bi 208				8
Ni 59				8	Bi 210m				8
Ni 63			3.48E-05	B B 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			6.89E-04	B B 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				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			7.01E-07	B B 2	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				8	Pu 238			1.77E-05	B B 2
Sn 123				8	Pu 239			4.45E-06	B B 2
Sn 126				8	Pu 240			8.23E-06	B B 2
Sb 125			2.18E-07	B B 2	Pu 241			2.79E-04	B B 2
Sb 126				8	Pu 242				8
Te 125m			5.47E-08	B B 2	Am 241			1.8E-05	B B 2
Te 127m				8	Am 242m				8
I 129				8	Am 243				8
Cs 134			1.72E-07	B B 2	Cm 242				8
Cs 135				8	Cm 243			1.04E-07	B B 2
Cs 137			6.35E-04	B B 1	Cm 244			3.78E-06	B B 2
Ba 133			2.45E-07	B B 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			3.15E-06	B B 2	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151				8	Other a				
Eu 152				8	Other b/g				
Eu 154			3.71E-06	B B 2	**Total a**	**0**		**5.23E-05**	**B B 2**
Eu 155			6.87E-07	B B 2	**Total b/g**	**0**		**1.66E-03**	**B B 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