WASTE STREAM	2A307	Final Dismantling & Site Clearance Concrete (Reactor & Non-Reactor) LLW

SITE Calder Hall

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE LLW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0 m³
Future arisings -	1.4.2019 - 31.3.2106.....	0 m³
	1.4.2106 - 31.3.2113.....	16604.0 m³
Total future arisings:		16604.0 m³
Total waste volume:		16604.0 m³

Comment on volumes: For inventory purposes the arisings are assumed to arise at a uniform rate over seven years. Final Dismantling & Site Clearance is assumed to commence in 2105, with reactor dismantling commencing in 2107, and lasting for ten years. Volumes and radioactivity have been calculated for 100 years after reactor shutdown, i.e. 2103, but the volume in this stream would not change for decommissioning in 2106.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 5.0
Stock (lower):	x	Arisings (lower)	x 0.2

WASTE SOURCE Concrete wastes from dismantling of reactors and associated plant.

PHYSICAL CHARACTERISTICS

General description: A wide variety of concrete and reinforced concrete items (reinforcing steel is described in waste stream 2A306).

Physical components (%vol): Concrete and reinforced concrete from reactor bioshield (~97% vol) and other structures (3%vol).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.4

Comment on density: The density is of the waste as cut for packaging assuming 20% in blocks and 80% as rubble.

CHEMICAL COMPOSITION

General description and components (%wt): Concrete (100%). Some of the concrete may include iron shot.

Chemical state: Alkali

Chemical form of radionuclides:
H-3: The tritium is incorporated in the concrete.
C-14: The carbon 14 content is insignificant.
Cl-36: The chemical form of chlorine has not been determined.
Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
I-129: The iodine content is insignificant.
Ra: The radium content is insignificant.
Th: The thorium content is insignificant.
U: The uranium content is insignificant.
Np: The neptunium content is insignificant.
Pu: The plutonium content is insignificant.

Metals and alloys (%wt): There are no large or bulk metal items.

Stainless steel.....	0
Other ferrous metals.....	NE
Iron.....	
Aluminium.....	0
Beryllium.....	0
Cobalt.....	0
Copper.....	0

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	Lead	0
	Magnox/Magnesium	0
	Nickel	0
	Titanium	
	Uranium	0
	Zinc	0
	Zircaloy/Zirconium	0
	Other metals	0
Organics (%wt):	None expected. No halogenated plastics or rubbers are expected to 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	~100.0
	Sand	
	Glass/Ceramics	0
	Graphite	TR
	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): Principal anions will be silicates and aluminates in various anionic forms. Carbonates could be up to 20% if limestone was used as an aggregate.

Fluoride..... <1.0

Chloride..... <1.0

Iodide..... <1.0

Cyanide..... 0

Carbonate..... <2.0

Nitrate..... <1.0

Nitrite..... <1.0

Phosphate..... <1.0

Sulphate..... ~2.0

Sulphide..... <1.0

Materials of interest for waste acceptance criteria: No materials likely to pose a fire or other non-radiological hazard have been identified.

Combustible metals..... 0

Low flash point liquids..... 0

Explosive materials..... 0

Phosphorus..... 0

Hydrides..... 0

Biological etc. materials..... 0

Biodegradable materials..... 0

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: -

Acrylamide.....

Benzene.....

Chlorinated solvents.....

Formaldehyde.....

Organometallics.....

Phenol.....

Styrene.....

Tri-butyl phosphate.....

Other organophosphates.....

Vinyl chloride.....

Arsenic.....

Barium.....

Boron.....

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): 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		
Supercompaction (HFC)		
Incineration		
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		100.0

Comment on planned treatments: It has been assumed for the 2019 UK RWI that no further treatment will be carried out prior to disposal and that the LLW will be non-compactable waste to be consigned to LLWR for disposal.

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Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	10.0
Expected to be consigned to a Landfill Facility	90.0
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	

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			
1/2 Height IP-2 Disposal/Re-usable ISO	10.0	10	167
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): It is not yet determined if the waste meets LLWR's Waste Acceptance Criteria (WAC).

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: -

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RADIOACTIVITY

Source:	Activation of the concrete and impurities. There may be some contamination.
Uncertainty:	The values quoted were derived by calculation from available material specifications and are indicative of the activities that are expected. The major source of uncertainty is the impurity levels. The calculations only apply to the Reactor Waste (97% of total) and Non-Reactor waste is assumed to have the same specific activity.
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. All alpha emitters are insignificant and the total is therefore given as <1E-9 TBq/m^3.
Measurement of radioactivities:	The specific activities have been estimated using a neutron activation calculation.
Other information:	The activities quoted are those at 100 years after reactor shutdown, i.e. in 2103. There may be some contamination by Cs137.

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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			2.00E-05	C C 2	Gd 153				8
Be 10				8	Ho 163			3.00E-09	C C 2
C 14				8	Ho 166m			6.00E-09	C C 2
Na 22					Tm 170				8
Al 26					Tm 171				8
Cl 36			9.00E-07	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			1.00E-05	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			2.00E-08	C C 2	Bi 210m				8
Ni 63			1.00E-06	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			2.00E-08	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				8
Ag 108m			4.00E-08	C C 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				8
Sn 123				8	Pu 239				8
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				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			6.00E-07	C C 2	Other a				8
Eu 152			2.00E-06	C C 2	Other b/g				8
Eu 154			5.00E-09	C C 2	**Total a**	**0**		**<1.00E-09**	**C 3**
Eu 155				8	**Total b/g**	**0**		**3.00E-05**	**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