WASTE STREAM 2A309 Final Dismantling & Site Clearance: Secondary 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.....	1113.0 m³
Total future arisings:		1113.0 m³
Total waste volume:		1113.0 m³

Comment on volumes: Waste arisings are assumed to occur at a uniform rate over seven years. Final Dismantling & Site Clearance is assumed to commence in 2105, with dismantling of the plant associated with this waste stream 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 Wastes arising from contamination control procedures during plant dismantling.

PHYSICAL CHARACTERISTICS

General description: A variety of combustible and non-combustible materials. No large items are expected.

Physical components (%vol): Metallic pipe and other items (~50% vol), plastic pipework, sheet and other items (~10% vol), rubber gloves and other items (~5% vol), clothing (~5% vol), wood (~5% vol), encapsulated sludge (~5% vol), air filters (~5% vol), combustible material (e.g. paper sheet) (~15-20 % vol). Percentages of constituents are very uncertain.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1

Comment on density: The density is likely to lie between 0.5 and 1.5 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): The waste is expected to include cloth (~5%vol), plastics (~15%vol), paper (~15%vol), wood (~5%vol), rubber (~5%vol), encapsulated sludge (~5%vol), metals (~50%vol). Percentages of constituents are very uncertain.

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 from of chlorine has not been assessed.
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): Metal thicknesses will probably be typically 1-3 mm.

Stainless steel.....	<10.0
Other ferrous metals.....	~50.0
Iron.....	
Aluminium.....	<<1.0
Beryllium.....	NE
Cobalt.....	NE

WASTE STREAM	2A309	Final Dismantling & Site Clearance: Secondary LLW

	Copper	<<1.0	
	Lead	0	
	Magnox/Magnesium	0	
	Nickel	NE	
	Titanium		
	Uranium	NE	
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals	<<1.0	There may be "other" metals present.
Organics (%wt):	A wide variety of materials may be present. Halogenated plastics and rubbers are expected but the materials have not been determined.		
	Total cellulosics	~25.0	
	Paper, cotton	~20.0	
	Wood	~5.0	
	Halogenated plastics	~5.0	
	Total non-halogenated plastics	~10.0	
	Condensation polymers	~5.0	
	Others	~5.0	
	Organic ion exchange materials	0	
	Total rubber	~5.0	
	Halogenated rubber	<5.0	
	Non-halogenated rubber	<5.0	
	Hydrocarbons		
	Oil or grease		
	Fuel		
	Asphalt/Tarmac (cont.coal tar)		
	Asphalt/Tarmac (no coal tar)		
	Bitumen		
	Others		
	Other organics	TR	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	0	
	Soil	TR	
	Brick/Stone/Rubble	TR	
	Cementitious material	NE	
	Sand		
	Glass/Ceramics	0	
	Graphite	TR	
	Desiccants/Catalysts		
	Asbestos	0	
	Non/low friable		
	Moderately friable		

WASTE STREAM	2A309	Final Dismantling & Site Clearance: Secondary LLW

	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0
Inorganic anions (%wt):	Likely to be present in trace quantities.	
	Fluoride.....	TR
	Chloride.....	TR
	Iodide.....	0
	Cyanide.....	0
	Carbonate.....	TR
	Nitrate.....	TR
	Nitrite.....	TR
	Phosphate.....	TR
	Sulphate.....	TR
	Sulphide.....	TR
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): Not yet determined
EDTA.....
DPTA.....
NTA.....
Polycarboxylic acids……
Other organic complexants.....
Total complexing agents..... NE

TREATMENT, PACKAGING AND DISPOSAL

WASTE STREAM 2A309 Final Dismantling & Site Clearance: Secondary LLW

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)	On-site	40.0
Incineration		
Solidification		
Decontamination		
Metal treatment	Off-site	48.0
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		12.0

Comment on planned treatments: It has been assumed for the 2019 UK RWI that the organic wastes will be high force compacted at a WAMAC type facility. It has also been assumed that 80% of the metallic waste will be treated by the supply chain and will subsequently be 'out of scope', with the remaining 20% consigned to LLWR for disposal as non-compactable LLW. The encapsulated sludge is assumed to be non-compactable LLW that requires no further treatment.

Disposal Routes:

Disposal Route	Stream volume %
Expected to be consigned to the LLW Repository	52.0
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	48.0
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			
2/3 Height IP-2 ISO			
1/2 Height WAMAC IP-2 ISO	40.0	59.28	8
1/2 Height IP-2 Disposal/Re-usable ISO	12.0	10	14
2m box (no shielding)			
4m box (no shielding)			
Other			

Other information: -

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

WASTE STREAM 2A309 Final Dismantling & Site Clearance: Secondary LLW

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:	-

RADIOACTIVITY

Source:	Contamination by activation products from the reactor structure.
Uncertainty:	The activities quoted are those at the time of Final Dismantling & Site Clearance.
Definition of total alpha and total beta/gamma:	Total beta/gamma is given as the sum of the listed activities of all nuclides other than alpha emitters. All alpha emitter activities are insignificant and the total is therefore given as <1E-9 TBq/m³.
Measurement of radioactivities:	The specific activity has been calculated from the weighted average of all the other ILW and LLW streams assuming a total specific activity for the beta/gamma component.
Other information:	The activities quoted are those at the time of Final Dismantling & Site Clearance.

WASTE STREAM 2A309 Final Dismantling & Site Clearance: Secondary LLW

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			1.00E-07	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			1.00E-05	C C 2	Ho 166m			6.00E-09	C C 2
Na 22					Tm 170				8
Al 26			1.00E-09	C C 2	Tm 171				8
Cl 36			1.00E-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-07	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			5.00E-09	C C 2	Bi 208				8
Ni 59			2.00E-06	C C 2	Bi 210m				8
Ni 63			9.00E-05	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			1.00E-07	C C 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			1.00E-09	C C 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			2.00E-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			6.00E-08	C C 2	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				8	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				8	Other a				8
Eu 152			3.00E-09	C C 2	Other b/g				8
Eu 154				8	**Total a**	**0**		**<1.00E-09**	**D 3**
Eu 155				8	**Total b/g**	**0**		**1.00E-04**	**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