WASTE STREAM 2A01 Redundant Activated Control Rods ILW

SITE Calder Hall

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW; SPD1

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	2.9 m³
Total future arisings:		0 m³
Total waste volume:		2.9 m³

Comment on volumes: Waste stream 2A01 comprises redundant activated control rods and flux scanner guide tubes removed from the reactor in the 1960's and stored in a purpose built facility. Initial characterisation shows that approximately half the inventory has decayed to LLW and are covered under 2A06, the remainder is ILW covered by this waste stream.

Uncertainty factors on volumes:

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

WASTE SOURCE The waste has arisen from the operation of Calder reactors and activation of the materials due to neutron exposure.

PHYSICAL CHARACTERISTICS

General description: The control rods are boron steel tubes encased in a stainless steel outer tube, sealed at both ends. Some of the rods have an outer sheath of concrete. Control rods and flux scanner guide tubes are 7 metres long and therefore difficult to package without size reduction. Some of the rods have been sheathed in concrete as part of their installation in the storage facility.

Physical components (%wt): Boron steel (~62%), stainless steel (<5%), concrete (33%) by weight.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 1.5

Comment on density: Bulk density value is taken from waste stream characterisation document for ILW in the Control Rod Mortuary and reflects the expected density of the waste in each Type 416 disposable liner that will be sent to MBGWS on Sellafield site.

CHEMICAL COMPOSITION

General description and components (%wt): Boron steel (~62%) of which the boron comprises <4% of the total waste, stainless steel (<5%), concrete (33%) by weight.

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Nil.
C-14: Nil
Cl-36: Nil
Se-79: Nil
Tc-99: Nil.
I-129: Nil
Ra: Nil.
Th: Nil
U: Nil.
Np: Nil.
Pu: Nil.

Metals and alloys (%wt): The waste comprises boron steel tubes encased in a stainless steel outer tube, sealed at both ends.

Stainless steel.....	<5.0	18:8 austenitic grade.
Other ferrous metals.....	~62.0	
Iron.....		
Aluminium.....	0	
Beryllium.....	0	
Cobalt.....	0	

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	Copper	0	
	Lead	0	
	Magnox/Magnesium	0	
	Nickel	0	
	Titanium		
	Uranium	0	
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals	0	
Organics (%wt):	There are no organic materials in the waste.		
	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	33.0	As concrete sheathes around the outside of some of the control rods.
	Sand	0	No sand, other than that present in the concrete.
	Glass/Ceramics	0	
	Graphite	0	
	Desiccants/Catalysts		
	Asbestos	0	
	Non/low friable		

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	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0
Inorganic anions (%wt):	No inorganic anions are present.	
	Fluoride.....	0
	Chloride.....	0
	Iodide.....	0
	Cyanide.....	0
	Carbonate.....	0
	Nitrate.....	0
	Nitrite.....	0
	Phosphate.....	0
	Sulphate.....	0
	Sulphide.....	0
Materials of interest for waste acceptance criteria:	-	
	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.....	0
	Corrosive materials.....	0
	Pyrophoric materials.....	0
	Generating toxic gases.....	0
	Reacting with water.....	0
	Active particles.....	NE
	Soluble solids as bulk chemical compounds.....	NE
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

PACKAGING AND CONDITIONING

Conditioning method:	The exact method of waste conditioning has not yet been established.
Plant Name:	Not yet established.
Location:	-
Plant startup date:	-
Total capacity (m^3/y incoming waste):	-
Target start date for packaging this stream:	-
Throughput for this stream (m^3/y incoming waste):	-
Other information:	It is envisaged that the control rods will be cut to segregate the ILW from the LLW and into suitable lengths for transport to MBGWS in Type 416 disposable liners. The waste in the liners will then placed into MBGWS boxes, which are then interim stored in MBGWS. The MBGWS box may form the final package.

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Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
MBGWS box	100.0	~2	3.5	2

Likely container type comment: ILW waste will be segregated into two waste streams before sending to MBGWS: -
1. ILW which will decay to LLW over 30 years and will be decay stored in MBGWS
2. ILW which remains as ILW after 30 years.
ILW will be consigned to the MBGWS in Type 416 disposable liners. The contents of the liners will then be placed into MBGWS boxes, which will then placed into the vault for interim storage.

Range in container waste volume: -

Other information on containers: The packaged waste will be in a form suitable for disposal at a GDF.

Likely conditioning matrix:

Other information: -

Conditioned density (t/m^3): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: Not yet determined

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source: Co-60 and Ni-63 are the main sources of activity in the waste due to activation.

Uncertainty: The general activity accuracy is found to be good.

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: Activities have been estimated using available information on the activation process supported by in situ gamma spectrometry.

Other information: -

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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					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60	~6.81E-01	B B 2			Bi 208				
Ni 59					Bi 210m				
Ni 63	~2.45E-02	B B 2			Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m					U 236				
Cd 109					U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
Sn 126					Pu 240				
Sb 125					Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137					Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g				
Eu 154					**Total a**	**0**		**0**	
Eu 155					**Total b/g**	**~7.05E-01**	**B B 2**	**0**	

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