WASTE STREAM 6C31/C NDS Contact Handled ILW

SITE	Harwell
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	No

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2022.....	10.8 m^3	13.1 m^3
Total future arisings:		0 m^3	0 m^3
Total waste volume:		10.8 m^3	13.1 m^3
Number of waste packages in stock:	At 1.4.2022.....	4 package(s)	

Comment on volumes: This waste has now been encapsulated in to 4 x 3m3 boxes. This waste stream covers the large NDS sources at Harwell, including RIPPLE sources 1 to 10, the teletherapy sources and the blood irradiator.

Uncertainty factors on volumes:

Stock (upper):	x 1.1	Arisings (upper)	x
Stock (lower):	x 0.9	Arisings (lower)	x

WASTE SOURCE RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. These were used for the production of Sr90 titanate sources to power navigation buoy lights and radio-direction equipment. Large teletherapy sources and blood irradiator used in the medical sector and collected by the National Disposal Service and latterly Safeguard International.

PHYSICAL CHARACTERISTICS

General description: RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. These were used for the production of Sr90m titanate sources to power navigation buoy lights and radio-direction equipment. Large teletherapy sources and blood irradiator used in the medical sector and collected by the National Disposal Service and latterly Safeguard International. Contains DU, tungsten alloy, mild steel, stainless steel, lead, aluminium, brass, copper, bismuth telluride, polyurethane foam, wood, concrete and Strontium titanate. The waste has been encapsulated using 3:1 PFA/OPC grout with a water/solid ratio of 0.42. Internal overpacks and sacrificial harnesses were used to contain the waste. Due the potential for DU metal reacting with grout, internal overpacks have been used in the 3m3 boxes to provide an expansion gap between the waste and grout.

Physical components (%wt): Cement/grout encapsulate 50%; Dep U 18%; Tungsten Alloy 8%; Mild Steel 13%; Stainless Steel 0.01%; Lead 7%; Aluminium 0.3%; Brass 2%; Copper 0.7%; Bismuth telluride 0.01%; Foam 0.05%; Wood 0.33%; Polyurethane foam 0.5%; Strontium titanate 0.1%;

Sealed sources: The waste contains sealed sources. RIPPLE (Radio Isotope Powered Prolonged Life Equipment) generators numbers I-X. Large teletherapy sources and blood irradiator used in the medical sector.

Bulk density (t/m^3): ~1.75

Comment on density: aligned to conditioned waste density

CHEMICAL COMPOSITION

General description and components (%wt): Cement/grout encapsulate 50%; Dep U 18%; Tungsten Alloy 8%; Mild Steel 13%; Stainless Steel 0.01%; Lead 7%; Aluminium 0.3%; Brass 2%; Copper 0.7%; Bismuth telluride 0.01%; Foam 0.05%; Wood 0.83%; Polyurethane foam 0.5%; Strontium titanate 0.1%;

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Chemical state: Alkali

Chemical form of radionuclides: U: Bulk metal

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

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	0.01		
Other ferrous metals	13.0	Mild steel	
Iron			
Aluminium	0.30		
Beryllium			
Cobalt			
Copper	2.7	2% brass	
Lead	7.0		
Magnox/Magnesium			
Nickel			
Titanium			
Uranium	18.0		
Zinc			
Zircaloy/Zirconium			
Other metals	8.1	Other metals = 8.11% and comprise of 8% Tungsten Alloy; 0.1% Strontium titanate and 0.01% Bismuth telluride	

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	0.33		
Paper, cotton			
Wood	0.33		
Halogenated plastics	0.50	PVC wrapping.	
Total non-halogenated plastics	0		
Condensation polymers			
Others			
Organic ion exchange materials	0		
Total rubber	0		
Halogenated rubber			
Non-halogenated rubber			
Hydrocarbons			
Oil or grease			
Fuel			
Asphalt/Tarmac (cont.coal tar)			
Asphalt/Tarmac (no coal tar)			
Bitumen			
Others			
Other organics	0.05	Polyurethane foam	

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Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials..			
Inorganic sludges and flocs.....			
Soil.....			
Brick/Stone/Rubble.....			
Cementitious material.....	50.0		
Sand.....			
Glass/Ceramics.....			
Graphite.....			
Desiccants/Catalysts.....			
Asbestos.....	0		
Non/low friable.....			
Moderately friable.....			
Highly friable.....			
Free aqueous liquids.....			
Free non-aqueous liquids.....			
Powder/Ash.....			

Inorganic anions (%wt): Carbonate has been used to stabilise reactive metals. Other chemicals may be present in trace quantities but are not expected- hence recorded as zero.

	(%wt)	Type(s) and comment
Fluoride.....	0	
Chloride.....		
Iodide.....	0	
Cyanide.....	0	
Carbonate.....	P	
Nitrate.....	0	
Nitrite.....	0	
Phosphate.....	0	
Sulphate.....	TR	
Sulphide.....	0	

Materials of interest for waste acceptance criteria: Although the waste contains depleted uranium this is in bulk form so will not present a pyrophoric hazard.

	(%wt)	Type(s) and comment
Combustible metals.....		
Low flash point liquids.....		
Explosive materials.....		
Phosphorus.....		
Hydrides.....		
Biological etc. materials.....		
Biodegradable materials.....	0	

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Putrescible wastes.....		
Non-putrescible wastes.....		
Corrosive materials.....		
Pyrophoric materials.....		
Generating toxic gases.....		
Reacting with water.....	TR	
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: The waste contains traces of solvents and pharmaceutical compounds

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		
Formaldehyde.....		
Organometallics.....		
Phenol.....		
Styrene.....		
Tri-butyl phosphate.....		
Other organophosphates.....		
Vinyl chloride.....		
Arsenic.....		
Barium.....		
Boron.....	0	
Boron (in Boral).....		
Boron (non-Boral).....		
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.....		

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Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA.....		
DPTA.....		
NTA.....		
Polycarboxylic acids…….		
Other organic complexants.....		
Total complexing agents.....	0	

Potential for the waste to contain discrete items: No. Grouted containers are considered DI

PACKAGING AND CONDITIONING

Container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
$3m^3$ box (round corners)	~100.0	2.7	2.7	4

Container type comment: The RIPPLE generator, blood irradiator and teletherapay sources have been packaged in 3m boxes.Internal overpacks and sacrificial harnesses were used to contain the waste. Due the potential for DU metal reacting with grout, internal overpacks have been

Range in container waste volume: Internal overpacks and sacrificial harnesses were used to contain the waste. Due the potential for DU metal reacting with grout, internal overpacks have been used in the 3m3 boxes to provide an expansion gap between the waste and grout. 3m3 Box 1 contains 3 overpacks; 3m3 Box 2 contains 3 overpacks; 3m3 Box 3 contains 4 overpacks; 3m3 Box 4 contains 3 overpacks. As a result the loading and payload volumes will not be consistent.

Other information on containers: Stainless Steel 316L

Conditioned density (t/m^3): 1.75

Conditioned density comment: The density is assumed to be consistent with that stated in the FLoC submission.

Other information on conditioning: -

RADIOACTIVITY

Source: Sealed sources inside units - some of which also contain DU

Uncertainty: Data taken from FLoC and Waste Product Specification. It should be noted that whilst this waste stream has been encapsulated the specific activity of the waste remains the same as it was pre-encapsulation. This is due to the fact that the radioactivity is contained in the sealed source and does not become distributed throughout the grout formulation i.e. it is not homogenously mixed into the grout.

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: Data taken from FLoC and Waste Product Specification. It should be noted that whilst this waste stream has been encapsulated the specific activity of the waste remains the same as it was pre-encapsulation. This is due to the fact that the radioactivity is contained in the sealed source and does not become distributed throughout the grout formulation i.e. it is not homogenously mixed into the grout.

Other information: -

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3		8			Gd 153		8		
Be 10		8			Ho 163		8		
C 14		8			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36		8			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		8			Pb 210		8		
Co 60	6.63E+00	B B 2			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63		8			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	9.09E+01	B B 2			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	1.24E-08	B B 2		
Nb 93m		8			Th 232		8		
Nb 94		8			Th 234	2.69E-04	B B 2		
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	1.5E-04	B B 2		
Ag 108m		8			U 235	7.13E-06	B B 2		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	2.69E-04	B B 2		
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	4.63E+00	B B 2			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				
Eu 152		8			Other b/g				
Eu 154		8			**Total a**	**4.26E-04**	**B B 2**	**0**	
Eu 155		8			**Total b/g**	**1.02E+02**	**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