WASTE STREAM 9B313 Miscellaneous Metal (Reactor) ILW

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

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m³
Future arisings -	1.4.2087 - 31.3.2090.....	7.0 m³
Total future arisings:		7.0 m³
Total waste volume:		7.0 m³

Comment on volumes: Final Dismantling & Site Clearance is assumed to commence in 2083 with reactor dismantling commencing in 2087 and lasting for three years. Volumes and radioactivity have been calculated for 85 years after reactor shutdown, i.e. 2087.

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 miscellaneous metallic wastes resulting from reactor dismantling.

PHYSICAL CHARACTERISTICS

General description:	A wide variety of miscellaneous metallic items including control rods, pins and restraint bars. Waste can be packaged in standard ILW containers.
Physical components (%wt):	Boron steel control rods (~65%wt), zirconium pins (~33%wt), nimonic control rods (~2%wt) and nimonic restraint rods (~1%wt).
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.

CHEMICAL COMPOSITION

General description and components (%wt):	A variety of metals including boron steel (~65%wt), zirconium (~33%wt) and Nimonic (~2% of which 52% is nickel) there is also some chromel and alumel.
Chemical state:	Neutral
Chemical form of radionuclides:	C-14: Carbon 14 is principally incorporated in zirconium. Some is also incorporated in Nimonic. There may be some graphite contamination. Cl-36: Chlorine 36 is principally incorporated in zirconium with some also in magnesium oxide associated with thermocouples. Tc-99: The chemical form of technetium has not been determined.
Metals and alloys (%wt):	Metal thicknesses will vary up from a few mm. The maximum thickness will probably not exceed 25 mm.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	~65.0	boron steel	
Iron.....			
Aluminium.....	0		
Beryllium.....	0		
Cobalt.....			
Copper.....	0		
Lead.....	0		
Magnox/Magnesium.....	NE		

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Nickel	<2.2	~2% Nimonic of which 52% is Nickel and "Other" metals are chromel <0.1%) and alumel (<0.1%).
Titanium		
Uranium		
Zinc	0	
Zircaloy/Zirconium	~33.0	
Other metals		

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
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): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand			
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): -

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

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

	(%wt)	Type(s) and comment
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	
Higher activity particles.....		
Soluble solids as bulk chemical compounds.....		

Hazardous substances / non hazardous pollutants: None expected

	(%wt)	Type(s) and comment
Acrylamide.....		
Benzene.....		
Chlorinated solvents.....		

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Formaldehyde.....

Organometallics.....

Phenol.....

Styrene.....

Tri-butyl phosphate.....

Other organophosphates.....

Vinyl chloride.....

Arsenic.....

Barium.....

Boron.....

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.....

Complexing agents (%wt): Yes

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

Potential for the waste to contain discrete items: Yes. Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs.

PACKAGING AND CONDITIONING

Conditioning method: The waste will be placed in baskets in the waste packages, and will be encapsulated in a BFS/OPC matrix.

Plant Name: -

Location: Bradwell Site

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Plant startup date:	2087
Total capacity (m^3/y incoming waste):	~5000.0
Target start date for packaging this stream:	2087
Throughput for this stream (m^3/y incoming waste):	~2.4
Other information:	Baskets of different ILW wastes may be in the same package. The waste is not expected to be supercompacted.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
4m box (100mm concrete shielding)	100.0	12.25	14.3	< 1

Likely container type comment:	Container choice may be influenced by Transport Regulations at the time of final site clearance. The waste is assumed to be in baskets in the waste package so the occupied volume in the package is greater than the original waste volume.
Range in container waste volume:	Not yet determined. No significant variability is expected.
Other information on containers:	The container material is expected to be stainless steel. If the calculated average specific activities are exceeded it could be necessary to use containers with 100mm of shielding.
Likely conditioning matrix:	Blast Furnace Slag / Ordinary Portland Cement
Other information:	-
Conditioned density (t/m^3):	~3.0
Conditioned density comment:	Density assumes that the waste will be encapsulated.
Other information on conditioning:	Baskets of different Final Dismantling ILW wastes may be in the same waste packages. The encapsulation matrix is likely to be BFS/OPC. The density of the encapsulated waste will probably be about 3 t/m3.
Opportunities for alternative disposal routing:	-

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	Activation of the metals and impurities.
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.
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 specific activities were estimated from neutron activation calculations of the material and its impurities.
Other information:	The activities quoted are those at 85 years after reactor shutdown, i.e. in 2087. There may be some contamination by Cs137.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		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			1.89E-01	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26			2E-06	C C 2	Tm 171				8
Cl 36			8.53E-03	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			4.76E-04	C C 2	Pt 193				8
Mn 53				8	Tl 204			2.01E-09	C C 2
Mn 54				8	Pb 205				8
Fe 55			6.06E-09	8	Pb 210				8
Co 60			1.73E-03	C C 2	Bi 208				8
Ni 59			1.5E-01	C C 2	Bi 210m				8
Ni 63			1.02E+01	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				6	Th 232				8
Nb 94			2.98E-05	C C 2	Th 234				8
Mo 93			1.54E-04	C C 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			2.95E-05	C C 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			6.79E-05	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			1.93E-02	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				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				8	Other a				
Eu 152				8	Other b/g				
Eu 154			1.67E-04	C C 2	**Total a**	**0**		**0**	
Eu 155			3.26E-06	C C 2	**Total b/g**	**0**		**1.06E+01**	**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