WASTE STREAM 2C312 Mild Steel (Reactor) ILW

SITE	Chapelcross
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Magnox Limited
WASTE TYPE	ILW
Is the waste subject to Scottish Policy:	Yes

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022......................	0 m³
Future arisings -	1.4.2089 - 31.3.2095.........	782.0 m³
Total future arisings:		782.0 m³
Total waste volume:		782.0 m³

Comment on volumes: For inventory purposes the arisings are assumed to arise at a uniform rate over 6 years. Final Dismantling & Site Clearance is assumed to commence in 2085 with reactor dismantling commencing in 2089 and lasting for 6 years. The volumes and radioactivity have been calculated for 85 years after reactor shutdown, i.e. 2089

Uncertainty factors on volumes:				
	Stock (upper):	x	Arisings (upper)	x 1.2
	Stock (lower):	x	Arisings (lower)	x 0.8

WASTE SOURCE Mild steel items from the reactor structure.

PHYSICAL CHARACTERISTICS

General description:	A variety of mild steel items.
Physical components (%vol):	Mild steel items (100%).
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): Mild steel (100%).

Chemical state: Neutral

Chemical form of radionuclides:
H-3: The tritium is incorporated in the steel.
C-14: The carbon 14 is incorporated in the steel. There also may be some contamination as graphite.
Se-79: The selenium content is insignificant.
Tc-99: The chemical form of technetium has not been determined.
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): All of the waste will be bulk metal items which will be cut for packaging. Metal thicknesses will probably range from a few mm to about 100 mm.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel....................................	0		
Other ferrous metals..........................	100.0	Mild steel types are MEEHANITE and CONLO (PV).	100.0
Iron..			
Aluminium..	0		
Beryllium..			
Cobalt..	<0.02	Greatest measured value from the	

		various components.
Copper	0	
Lead	0	
Magnox/Magnesium	0	
Nickel	<0.20	Greatest measured value from the various components.
Titanium		
Uranium		
Zinc	0	
Zircaloy/Zirconium	0	
Other metals	TR	Silver and niobium.

Organics (%wt): None expected. No halogenated plastics or rubbers will be present.

	(%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): Some graphite dust may be associated with reactor materials.

	(%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	TR		

Desiccants/Catalysts	
Asbestos	0
Non/low friable	
Moderately friable	
Highly friable	
Free aqueous liquids	0
Free non-aqueous liquids	0
Powder/Ash	0

Inorganic anions (%wt): There may be a trace of chloride present.

	(%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		
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	<0.03	Greatest measured value from the various components.
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	

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Potential for the waste to contain discrete items: Yes. Large Metal Items (LMIs)/"substantial" thickness items considered "durable" assumed DIs. NB If recycled then DI Limits n/a

PACKAGING AND CONDITIONING

Conditioning method: 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.

Plant Name: -

Location: Chapelcross Power Station

Plant startup date: 2089

Total capacity (m³/y incoming waste): ~5000.0

Target start date for packaging this stream: 2089

Throughput for this stream (m³/y incoming waste): ~112.0

Other information: -

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
4m box (no shielding)	100.0	~16.2	18.9	49

Likely container type comment: 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 signifcant variability is expected.

Other information on containers: The container material is expected to be stainless steel. Container choice may be influenced by Transport Regulations at the time of final site clearance.

Likely conditioning matrix: Blast Furnace Slag / Ordinary Portland Cement

Other information: The waste is now assumed to be encapsulated.

Conditioned density (t/m³): 3.0

Conditioned density comment: The conditioned waste density now assumes the waste will be encapsulated.

Other information on conditioning: The waste will be in baskets placed in the waste packages. Baskets of different Final Dismantling & Site Clearance ILW wastes may be in the same waste package. Should encapsulation not be required the density of the waste product would be about 1.2 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 mild steel and its impurities.

Uncertainty: The values quoted were derived by calculation from available material specifications and are indicative of the activities that are to be 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 have been estimated using a neutron activation calculation.
Other information:	The activities quoted are those at 85 years after reactor shutdown, i.e. in 2089. There may be some contamination by Cs137.

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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			5.78E-04	C C 2	Gd 153				8
Be 10				8	Ho 163				8
C 14			9.57E-03	C C 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			1.99E-06	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				8	Pt 193				8
Mn 53				8	Tl 204			1.89E-08	C C 2
Mn 54				8	Pb 205				8
Fe 55			5.07E-08	C C 2	Pb 210				8
Co 60			2.04E-04	C C 2	Bi 208				8
Ni 59			1.95E-03	C C 2	Bi 210m				8
Ni 63			5.96E-02	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			2.2E-05	C C 2	Th 234				8
Mo 93			5.34E-04	C C 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			6.41E-06	C C 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			4.25E-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				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				8	Other a				
Eu 152			3.84E-06	C C 2	Other b/g				
Eu 154			2.73E-08	C C 2	**Total a**	**0**		**0**	
Eu 155				8	**Total b/g**	**0**		**7.25E-02**	**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