

WASTE STREAM	9D322	Reactor Neutron Sources R1
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SITE Hinkley Point A
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 m ³
Future arisings -	1.4.2085 - 31.3.2088.....	0.5 m ³
Total future arisings:		0.5 m ³
Total waste volume:		0.5 m ³

Comment on volumes: Final Dismantling & Site Clearance is assumed to commence in 2081 and end in 2090. Reactor dismantling will commence in 2085 and last for three years. Volumes and radioactivity have been calculated for 85 years after reactor shutdown, i.e. 2085.

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

WASTE SOURCE Neutron sources installed in the reactor to support reactor operations.

PHYSICAL CHARACTERISTICS

General description: Each source is an antimony and beryllium mix in a stainless steel tube. There are 10 sources in each reactor. The weight per source of antimony is 2920 g. The weight per source of beryllium is 810 g. The approximate containment volume for the whole assembly is 1.2E-3 m³ per source. The approximate volume of the antimony/beryllium mix is 0.83E-3 m³ per source. The approximate weight of the stainless steel container is 2.2 kg per source. The overall length of each source is about about 60 cm. Since the neutron sources in their containers were installed in the reactor they will have undergone activation. The stainless steel containers will be contaminated.

Physical components (%wt): Each source has 3 assemblies of 7 slugs, which are cold compacted slugs of beryllium and antimony powder. This mixture is contained in a stainless steel tube. There are 10 such neutrons sources in the reactor. Breakdown for each source is: antimony (2.92 kg), beryllium (0.81 kg) and stainless steel (2.2 kg). Which gives: antimony (49%), beryllium (14%) and stainless steel (37%).

Sealed sources: The waste contains sealed sources. There are 10 sources in each reactor.

Bulk density (t/m³): ~1.4

Comment on density: -

CHEMICAL COMPOSITION

General description and components (%wt): Antimony, beryllium and stainless steel. Percentage by weight is: antimony (49%), beryllium (14%) and stainless steel (37%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: The tritium content is insignificant.
 C-14: The chemical form of carbon-14 has not been determined.
 Se-79: The selenium content is insignificant.
 Tc-99: The chemical form of technetium has not been determined.
 Ra: The radium isotopes content is insignificant.
 Th: The thorium isotopes content is insignificant.
 U: The uranium isotopes content is insignificant.
 Np: The neptunium isotopes content is insignificant.
 Pu: The plutonium isotopes content is insignificant.

Metals and alloys (%wt): -

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	37.0	Stainless steel 79 EN58B.	
Other ferrous metals.....	0		
Iron.....			
Aluminium.....	0		
Beryllium.....	~14.0		
Cobalt.....			
Copper.....	0		
Lead.....	0		
Magnox/Magnesium.....	0		
Nickel.....			
Titanium.....			
Uranium.....			
Zinc.....	0		
Zircaloy/Zirconium.....	0		
Other metals.....	~49.0	Other metals include antimony(~49% wt)	

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulose.....	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): Trace amounts of graphite may be present on the stainless steel outer container.

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	(%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): -

	(%wt)	Type(s) and comment
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: Beryllium is a component of each neutron source.

	(%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.....		

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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: Beryllium. Percentage by weight in the waste is 14%.

	(%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.....		
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.....

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

PACKAGING AND CONDITIONING

Conditioning method: The waste is not expected to be supercompacted. It will be placed in baskets in the waste packages, and is now assumed to be encapsulated.

Plant Name: None
 Location: Hinkley Point A Site
 Plant startup date: 2085
 Total capacity (m³/y incoming waste): ~5000.0
 Target start date for packaging this stream: 2085
 Throughput for this stream (m³/y incoming waste): <1.0

Other information: Waste will be conditioned when removed from the reactor.

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	< 1

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.

Other information on containers: The container material is expected to be stainless steel.

Likely conditioning matrix: Not specified
 Other information: It is now assumed that the waste will be encapsulated. The matrix could be BFS/OPC.

Conditioned density (t/m³): ~3.0
 Conditioned density comment: -

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.

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:	-
Uncertainty:	-
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:	-
Other information:	The activities quoted are those at 85 years after reactor shutdown, i.e. in 2085. There may be some contamination by Cs137.

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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			6E+00	CC 2	Ho 166m				8
Na 22				8	Tm 170				8
Al 26				8	Tm 171				8
Cl 36			2E-04	CC 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		2E-05	CC 2	8
Mn 54				8	Pb 205				8
Fe 55			4E-06	CC 2	Pb 210				8
Co 60			2E-02	CC 2	Bi 208				8
Ni 59			9E+00	CC 2	Bi 210m				8
Ni 63			7E+02	CC 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			4E-07	CC 2	Th 230				8
Nb 93m				8	Th 232				8
Nb 94			3E-02	CC 2	Th 234				8
Mo 93			3E-02	CC 2	Pa 231				8
Tc 97				8	Pa 233				8
Tc 99			5E-03	CC 2	U 232				8
Ru 106				8	U 233				8
Pd 107				8	U 234				8
Ag 108m			2E-03	CC 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				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				8	Other b/g				8
Eu 154				8	Total a	0	0		
Eu 155				8	Total b/g	0	7.15E+02	CC 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