SITE Hinkley Point A

SITE OWNER **Nuclear Decommissioning Authority** 

No

**WASTE CUSTODIAN** Magnox Limited

**ILW WASTE TYPE** 

Is the waste subject to

Scottish Policy:

**WASTE VOLUMES** 

Reported Stocks: At 1.4.2022.....  $0 \, \text{m}^3$ 1.4.2085 - 31.3.2088.......  $0.5 \, \text{m}^3$ Future arisings -Total future arisings:  $0.5 \, \text{m}^3$  $0.5 \, \text{m}^3$ Total waste volume:

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

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

### PHYSICAL CHARACTERISTICS

Each source is an antimony and beryllium mix in a stainless steel tube. There are 10 General description:

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%).

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

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 H-3: The tritium content is insignificant.

radionuclides: 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):

		(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
	Stainless steel	37.0	Stainless steel 79 EN58B.	donvity
	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 (%v	vt): -			
		(%wt)	Type(s) and comment	% of total C14
	Total cellulosics	0		activity
	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.

	(%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		
lodide	0		
Cyanide	0		
Carbonate	0		
Nitrate	0		
Nitrite	0		
Phosphate	0		
Sulphate	0		
Sulphide	0		
Materials of interest for Beryllium is a comp waste acceptance criteria:	onent of e	ach 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			

С	Corrosive materials	0	
Р	yrophoric materials	0	
G	Senerating toxic gases	0	
R	eacting with water	0	
Н	ligher activity particles		
	oluble solids as bulk chemical ompounds		
Hazardous subs		e by weigh	t in the waste is 14%.
		(%wt)	Type(s) and comment
А	crylamide		
В	enzene		
С	Chlorinated solvents		
F	ormaldehyde		
0	Organometallics		
Р	henol		
S	tyrene		
Т	ri-butyl phosphate		
0	Other organophosphates		
V	'inyl chloride		
А	rsenic		
В	arium		
В	oron		
	Boron (in Boral)		
	Boron (non-Boral)		
С	Cadmium		
С	Caesium		
S	elenium		
С	Chromium		
N	Nolybdenum		
Т	hallium		
Т	ïn		
V	anadium		
N	Mercury compounds		
0	Others		
Е	Electronic Electrical Equipment (EEE)		
	EEE Type 1		
	EEE Type 2		
	EEE Type 3		
	EEE Type 4		
	EEE Type 5		

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 ~5000.0

(m³/y incoming waste):

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):

Conditioned density

comment:

~3.0

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 Opportunity Stream Date that Management Route Management Route volume (%)  Management Route Management Route volume (%)  Management Route Volume (%)	
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## **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.

		Mean radioactivity, TBq/m³			Mean radioactivity, TBq/m³					
Be 10	Nuclide					Nuclide			Future arisings	Bands and Code
C 14	H 3				8	Gd 153				8
Na 22	Be 10				8	Ho 163				8
Na 22	C 14			6E+00						8
A   26										8
C136										8
Ar 39 Ar 42 K 40 Ar 42 K 40 B H 178n H 178n K 40 Ca 41 B P 193 Mn 53 Mn 54 Fe 55 Co 60 Co 2 Pb 210 Co 60 ZE-02 CC 2 Bi 208 Ni 59 Ni 59 Se 79 B Ra 223 Se 77 Se 79 B Ra 226 Kr 85 Kr 85 Kr 85 Kr 85 Rb 87 Sr 90 Sr 90 Sr 90 Nb 91 Nb 92 Nb 91 Nb 92 Nb 93 Nb 91 Nb 92 Nb 93 Nb 94 Se 70 Se 79 Se 79 Se 70 Se				2F-04						8
A				22 04						8
K 40										8
Ca 41     8     P1 193       Mn 53     8     Pb 205       Fe 55     4E-06     CC 2     Pb 205       Fe 55     4E-06     CC 2     Pb 210       Co 60     2E-02     CC 2     Bi 208       Ni 63     7E+02     CC 2     Po 210       Zn 65     8     Ra 223     Ra 225       Se 79     8     Ra 226     Rk 785       Kr 85     8     Ra 228     Ra 228       Rb 87     8     Ac 227     Th 229       Zr 93     8     Th 227     Th 230       Nb 91     8     Th 228     Th 228       Nb 92     4E-07     CC 2     Th 230       Nb 93m     8     Th 232     Th 230       Nb 94     3E-02     CC 2     Pa 231       Tc 97     8     U 233       Tc 97     8     U 234       Pd 107     8     U 234       Ag 110m     8     U 238       Cd 109     8     U 238       Ro 109     8     U 238       Pu 236     Pu 241       Sh 126     8     Pu 242       Te 127m     8     Pu 241       Sh 126     8     Pu 242       Te 127m     8     Am 243										8
Mn 53										
Mn 54									25.05	8 CC 2
Fe 55									2L-03	
Co 60				45.00						8
Ni 59 Ni 63 Ni 64 Ni 67										8
Ni 63										8
Zn 65   8										8
Se 79       8       Ra 225       R       Re 226       R       Re 226       R       Re 226       R       Re 226       R       Re 228       Re 328       Re 326       Re 328				7E+02						8
Kr 81 Kr 85 Kr 85 Rb 87 Rb 87 Sr 90 Zr 93 Nb 91 Nb 92 Nb 92 Nb 93m Nb 94 Nb 93 Sr 90					8					8
Kr 85       8       Ra 228         Rb 87       8       Ac 227         Sr 90       8       Th 227         2r 93       8       Th 228         Nb 91       8       Th 229         Nb 92       4E-07       CC 2       Th 230         Nb 93m       8       Th 232         Nb 94       3E-02       CC 2       Th 234         Mo 93       3E-02       CC 2       Pa 231         Tc 97       8       Pa 233       U 233         Ru 106       8       U 234         Pd 107       8       U 233         Ag 108m       2E-03       CC 2       U 235         Ag 110m       8       U 236         Cd 113m       8       Pu 236         Sn 121m       8       Pu 236         Sn 123       8       Pu 238         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 127m       8       Am 242m         I129       8       Am 243         Cs 134       8       Cm 243         Cs 137       8       Cm 246 <t< td=""><td>Se 79</td><td></td><td></td><td></td><td>8</td><td></td><td></td><td></td><td></td><td>8</td></t<>	Se 79				8					8
Rb 87 Sr 90 Zr 93 Nb 91 Nb 91 Nb 92 Nb 93m Nb 94 Ag 3E-02 CC 2 Pa 231 Tc 97 Tc 99 Tc 99 Tc 99 Tc 99 Tc 90 Se	Kr 81				8	Ra 226				8
Sr 90       27 93       8       Th 228       Nb 91       Nb 91       Nb 92       4E-07       CC 2       Th 230       Nb 93       Th 230       Nb 93m       Nb 94       3E-02       CC 2       Th 234       Nb 93       Th 232       Nb 94       3E-02       CC 2       Th 234       Nb 94       SE-03       CC 2       Th 234       SE-03       CC 2       Th 234       SE-03       SE-03       CC 2       U 235       SE-03       CC 2       U 235       SE-03       SE-03       CC 2       U 236       SE-03       SE-03       CC 2       U 236       SE-03       SE-03       CC 2       U 236       SE-03	Kr 85				8	Ra 228				8
Zr 93	Rb 87				8	Ac 227				8
Zr 93	Sr 90				8	Th 227				8
Nb 91					8	Th 228				8
Nb 92 Nb 93m Nb 94 Nb 94 Nb 93 Nb 94										8
Nb 93m Nb 94 Nb 93 Nb 94 Nb 93 SE-02 CC 2 Th 234 Pa 231 Tc 97 Tc 97 SE-03 CC 2 U 232 Ru 106 Pd 107 SE-03 CC 2 U 235 Ag 108m Ag				4E-07		Th 230				8
Nb 94   3E-02										8
Mo 93				3F-02						8
Tc 97 Tc 99 Ru 106 Pd 107 Ag 108m Ag 109 Cd 113m Sn 12m Sn 12a Sn 126 Sb 125 Sb 126 Te 125m Te 127m I 129 Cs 134 Cs 135 Cs 137 Ba 133 La 137 La 138 Ce 144 Pm 145										8
Tc 99 Ru 106 Pd 107 Ag 108m 2E-03 CC 2 U 232 Ru 106 Pd 107 Ag 108m 2E-03 CC 2 U 235 Ag 110m Cd 109 Ru 109 Ru 109 Ru 109 Ru 109 Ru 109 Ru 1009 Ru 1009 Ru 1009 Ru 1009 Ru 1009 Ru 1036				3L-02						8
Ru 106 Pd 107 Ag 108m Ag 110m Cd 109 Cd 113m Sn 119m Sn 121 Sn 123 Sn 126 Sb 125 Sb 126 Te 125m Te 127m I 129 Cs 134 Cs 135 Cs 137 Ba 133 La 137 La 138 Ce 144 Pm 145				5E 03						8
Pd 107       8       U 234         Ag 108m       2E-03       C 2       U 235         Ag 110m       8       U 236         Cd 109       8       U 238         Cd 113m       8       Np 237         Sn 119m       8       Pu 236         Sn 121m       8       Pu 238         Sn 123       8       Pu 240         Sh 125       8       Pu 241         Sh 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 243         Cs 134       8       Cm 242         Cs 134       8       Cm 243         Cs 137       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       Cm 248       Cm 248         Ce 144       Pm 145       8       Cf 250				3E-03						8
Ag 108m Ag 110m Cd 109 Cd 113m Sn 119m Sn 121m Sn 123 Sn 126 Sb 125 Sb 126 Te 125m Te 127m I 129 Cs 134 Cs 135 Cs 137 Ba 133 La 137 La 138 Ce 144 Pm 145										8
Ag 110m       8       U 236         Cd 109       8       U 238         Cd 113m       8       Np 237         Sn 119m       8       Pu 236         Sn 121m       8       Pu 238         Sn 123       8       Pu 239         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 243         I 129       8       Am 243         Cs 134       Cm 242         Cs 135       Cm 243         Cs 137       8       Cm 244         Ba 133       Cm 246         La 137       Cm 246         La 138       Cm 248         Ce 144       Cf 250				05.00						8
Cd 109       8       U 238         Cd 113m       8       Np 237         Sn 119m       8       Pu 236         Sn 121m       8       Pu 238         Sn 123       8       Pu 239         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 243         I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 246         La 137       8       Cm 248         Ce 144       8       Cf 249         Pm 145       8       Cf 250	-			2E-03						8
Cd 113m	-									8
Sn 119m       8       Pu 236         Sn 121m       8       Pu 238         Sn 123       8       Pu 239         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 243m         I 129       8       Am 243         Cs 134       8       Cm 242m         Cs 135       8       Cm 242         Cs 137       8       Cm 243m         Cs 137       8       Cm 244m         Ba 133       8       Cm 245m         La 137       8       Cm 246m         La 138       8       Cm 248m         Ce 144       8       Cf 249m         Pm 145       8       Cf 250m										
Sn 121m       8       Pu 238         Sn 123       8       Pu 239         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 242m         I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       8       Cm 248         Ce 144       8       Cf 249         Pu 145       8       Cf 250						*				8
Sn 123       8       Pu 239         Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 243m         I 129       8       Am 243m         Cs 134       8       Cm 242m         Cs 135       8       Cm 242m         Cs 137       8       Cm 243m         Cs 137       8       Cm 244m         Ba 133       8       Cm 245m         La 137       8       Cm 246m         La 138       8       Cm 248m         Ce 144       8       Cf 249m         Pu 145       8       Cf 250m										8
Sn 126       8       Pu 240         Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 242m         I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       8       Cm 248         Ce 144       8       Cf 249         Pm 145       8       Cf 250										8
Sb 125       8       Pu 241         Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 242m         I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       8       Cm 248         Ce 144       8       Cf 249         Pm 145       8       Cf 250					8					8
Sb 126       8       Pu 242         Te 125m       8       Am 241         Te 127m       8       Am 242m         I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       8       Cm 248         Ce 144       8       Cf 249         Pm 145       8       Cf 250	Sn 126				8					8
Te 125m Te 127m I 129 Response to 134 Cs 134 Cs 135 Cs 137 Response to 137 Response to 138 La 137 La 138 Ce 144 Pm 145 Response to 148 Response to 158 Respons										8
Te 127m I 129 Cs 134 Cs 135 Cs 137 Ba 133 La 137 La 138 Ce 144 Pm 145  8	Sb 126				8					8
1 129	Te 125m				8					8
I 129       8       Am 243         Cs 134       8       Cm 242         Cs 135       8       Cm 243         Cs 137       8       Cm 244         Ba 133       8       Cm 245         La 137       8       Cm 246         La 138       6       Cm 248         Ce 144       8       Cf 249         Pm 145       8       Cf 250	Te 127m				8					8
Cs 134     8     Cm 242       Cs 135     8     Cm 243       Cs 137     8     Cm 244       Ba 133     8     Cm 245       La 137     8     Cm 246       La 138     6     Cm 248       Ce 144     8     Cf 249       Pm 145     8     Cf 250					8	Am 243				8
Cs 135     8     Cm 243       Cs 137     8     Cm 244       Ba 133     8     Cm 245       La 137     8     Cm 246       La 138     6     Cm 248       Ce 144     8     Cf 249       Pm 145     8     Cf 250						Cm 242				8
Cs 137 Ba 133 La 137 La 138 Ce 144 Pm 145 Ba 138 Cf 249 Cf 250 Cm 244 Cm 245 Cm 245 Cm 246 Cm 248 Cf 249 Cf 250						Cm 243				8
Ba 133 La 137 La 138 Ce 144 Pm 145 Ba Cm 245 Cm 246 Cm 246 Cm 248 Cf 249 Cf 250						Cm 244				8
La 137 La 138 Ce 144 Pm 145    Cm 246 Cm 248 Cm 248 Cf 249 Cf 250 Cf 250						Cm 245				8
La 138 Ce 144 Pm 145  B Cm 248 Cf 249 Cf 250 Cf 250										8
Ce 144 8 Cf 249 Pm 145 8 Cf 250										8
Pm 145 8 Cf 250										8
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1										8
FIII 147										8
										8
										O
Similar Communication of the c										
Eu 152 8 Other b/g						_	_		_	
Eu 154 8 Total a 0									0	00.5
Eu 155 8 Total b/g 0 7.15E+	Eu 155				8	Total b/g	ļ <sup>0</sup>		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

- Measured activity
   Derived activity (best estimate)
   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