

**WASTE STREAM****9B28****Miscellaneous Activated Components - R1**

**SITE** Bradwell  
**SITE OWNER** Nuclear Decommissioning Authority  
**WASTE CUSTODIAN** Magnox Limited  
**WASTE TYPE** ILW; SPD3

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2019.....	81.0 m <sup>3</sup>
Total future arisings:		0 m <sup>3</sup>
Total waste volume:		81.0 m <sup>3</sup>

Comment on volumes: Contents in some accumulation facilities have been estimated from photographs, and the volumes represent upper limits.

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

**WASTE SOURCE** Redundant or defective components and equipment removed from the reactor core and the fuelling machines.

**PHYSICAL CHARACTERISTICS**

General description: Components such as control rods, absorber bars, thermocouples, fuelling machine grabs, and hoist cables. The possibility of large items which may need special handling has not been assessed.

Physical components (%vol): Individual component(s) contribution to % volume/weight has not been estimated.

Sealed sources: -

Bulk density (t/m<sup>3</sup>): ~1

Comment on density: The assumption of 1 t/m<sup>3</sup> average bulk density may be subject to revision.

**CHEMICAL COMPOSITION**

General description and components (%wt): The waste is predominantly steel and boron steel. Other components not assessed.

Chemical state: -

Chemical form of radionuclides: H-3: Chemical form of tritium has not been determined but is probably present as surface contamination.  
 C-14: The chemical form of carbon 14 has not been determined but is probably present as graphite.  
 Cl-36: The chemical form of chlorine 36 has not been determined.  
 U: The chemical form of uranium isotopes has not been determined but may be present as uranium oxides.  
 Np: The neptunium content is insignificant.  
 Pu: The chemical form of plutonium isotopes has not been determined but may be present as plutonium oxides.

Metals and alloys (%wt): Predominantly bulk metal items on average between 5 and 30 mm in thickness.

Stainless steel.....	NE	
Other ferrous metals.....	~90.0	Carbon steel and boronated steel are present.
Iron.....		
Aluminium.....	NE	
Beryllium.....	NE	
Cobalt.....		
Copper.....	NE	
Lead.....	NE	
Magnox/Magnesium.....	NE	
Nickel.....		

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	Titanium.....		
	Uranium.....		
	Zinc.....	NE	
	Zircaloy/Zirconium.....	NE	
	Other metals.....	NE	Not assessed.
Organics (%wt):	The organic content has not been fully assessed.		
	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.....	NE	
Other materials (%wt):	Traces of graphite may be present.		
	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.....	TR	
	Powder/Ash.....	TR	
Inorganic anions (%wt):	Possibly trace quantities.		

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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:

There are no materials identified in the waste likely to represent a fire or other non-radiological hazard.

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
Active particles.....	
Soluble solids as bulk chemical compounds.....	

Hazardous substances / non hazardous pollutants:

-	
Acrylamide.....	
Benzene.....	
Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	
Styrene.....	
Tri-butyl phosphate.....	
Other organophosphates.....	
Vinyl chloride.....	
Arsenic.....	
Barium.....	
Boron.....	

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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): No  
 EDTA.....  
 DPTA.....  
 NTA.....  
 Polycarboxylic acids.....  
 Other organic complexants.....  
 Total complexing agents..... 0

**PACKAGING AND CONDITIONING**

Conditioning method: The waste is not expected to be supercompacted. The treatment envisaged is the placement of the waste in baskets followed by encapsulation. Container choice may be influenced by by Transport Regulations at the time of Final Site Clearance.

Plant Name: None

Location: Bradwell Site

Plant startup date: 2087

Total capacity  
(m<sup>3</sup>/y incoming waste): ~5000.0

Target start date for  
packaging this stream: 2087

Throughput for this stream  
(m<sup>3</sup>/y incoming waste): ~18.0

Other information: The current proposal is to store the waste as at present until reactor dismantling commencing in 2087. All waste is expected to be retrieved and conditioned when the conditioning campaign is undertaken.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m <sup>3</sup> )	Payload (m <sup>3</sup> )	Number of packages
	4m box (100mm concrete shielding)	100.0	12.25	14.3	7

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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: No significant variability is expected.

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

Likely conditioning matrix: Blast Furnace Slag / Ordinary Portland Cement

Other information: The waste is assumed to be encapsulated.

Conditioned density (t/m<sup>3</sup>): ~3.0

Conditioned density comment: The conditioned waste density assumes that 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 ILW wastes may be in the same waste packages. The encapsulation matrix would be likely to be BFS/OPC. The density of the encapsulated waste would probably be about 3 t/m<sup>3</sup>.

Opportunities for alternative disposal routing: No

Treatment	Stream volume (%)	Comment
-	-	-

**RADIOACTIVITY**

Source: Irradiated components that have been removed from the reactor. Absorber bars and control rods are likely to be components of high activity, the majority of the activity coming from their activation products.

Uncertainty: Specific activity is a function of Station operating history. The values quoted are indicative of the activities that might be expected.

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: Estimates are based upon theoretical assessments.

Other information: -

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	<1.53E+00	D 3			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	2.00E-02	CD 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	3E-05	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		8		
Mn 54	1.79E-06	CD 2			Pb 205		8		
Fe 55	4.22E+00	CD 2			Pb 210		8		
Co 60	2.06E+00	CD 2			Bi 208		8		
Ni 59	4E-02	CD 2			Bi 210m		8		
Ni 63	3.68E+00	CD 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	<3.76E-05	D 3			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	4E-05	CD 2			Th 234	<7E-09	D 3		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99	<1E-08	D 3			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	<6.09E-09	D 3		
Ag 108m	3.92E-05	CD 2			U 235		8		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	<7E-09	D 3		
Cd 113m		8			Np 237		8		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	<2.73E-06	D 3		
Sn 123		8			Pu 239	<3E-06	D 3		
Sn 126		8			Pu 240	<4.00E-06	D 3		
Sb 125		8			Pu 241	<5.05E-05	D 3		
Sb 126		8			Pu 242	<2E-09	D 3		
Te 125m		8			Am 241	<8.16E-06	D 3		
Te 127m		8			Am 242m	<1.88E-08	D 3		
I 129		8			Am 243	<6.00E-09	D 3		
Cs 134	<3.55E-08	D 3			Cm 242	<1.55E-08	D 3		
Cs 135		8			Cm 243	<3.80E-09	D 3		
Cs 137	<1.51E-04	D 3			Cm 244	<5.68E-08	D 3		
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	<1.68E-07	D 3			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	<8.20E-07	D 3			Other a				
Eu 152	1.07E-05	CD 2			Other b/g				
Eu 154	7.58E-06	CD 2			<b>Total a</b>	<b>1.80E-05</b>	<b>CD 3</b>	<b>0</b>	
Eu 155		8			<b>Total b/g</b>	<b>1.16E+01</b>	<b>CD 3</b>	<b>0</b>	

**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