

WASTE STREAM	5G25	DRAGON High Active Components
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SITE Winfrith
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Magnox Limited
WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	0.2 m ³
Total future arisings:		0 m ³
Total waste volume:		0.2 m ³
Comment on volumes:	Volumes based on assessment (ILW/LLW) of individual items.	
Uncertainty factors on volumes:	Stock (upper): x 1.2	Arisings (upper) x
	Stock (lower): x 0.8	Arisings (lower) x

WASTE SOURCE This waste consists of the fuel spikes from the Dragon reactor.

PHYSICAL CHARACTERISTICS

General description: Fuel spikes removed from the Dragon reactor core. The fuel elements were placed on the fuel spikes which were housed within the Dragon core base plate. The spikes contained a cyclone which served the purpose of collecting dust from the purge gasses. The spikes will therefore be highly contaminated and activated as a result of the cyclone and their position within the core.

Physical components (%wt): Stainless Steel. Constituents taken from Dragon activation model. Fe (67%), Cr (17%), Ni (9.1%), Mn (1.5%), Others (5.4%)

Sealed sources: -

Bulk density (t/m³): 7.9

Comment on density: Density taken from iLoC submission.

CHEMICAL COMPOSITION

General description and components (%wt): Stainless Steel. Constituents taken from Dragon activation model. Fe (67%), Cr (17%), Ni (9.1%), Mn (1.5%), Others (5.4%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Tritium isotope present as trace element in the activated materials.
C-14: Carbon-14 isotope present as trace element in the activated materials.
Cl-36: Chlorine-36 isotope present as trace element in the activated materials.
Se-79: Selenium-79 isotope present as trace element in the activated materials.
Tc-99: Technetium-99 isotope present as trace element in the activated materials.
I-129: Iodine-129 isotope present as trace element in the activated materials.
Ra: Radium isotopes present as trace elements in the activated materials.
Th: Thorium isotopes present as trace elements in the activated materials.
U: Uranium isotopes present as trace elements in the activated materials.
Np: Neptunium isotopes present as trace elements in the activated materials.
Pu: Plutonium isotopes present as trace elements in the activated materials.

Metals and alloys (%wt): -

Stainless steel.....	100.0	Fe (67%), Cr (17%), Ni (9.1%), Mn (1.5%), Others (5.4%)
Other ferrous metals.....		
Iron.....		
Aluminium.....		
Beryllium.....	0	
Cobalt.....		
Copper.....	0	
Lead.....	0	
Magnox/Magnesium.....		

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	Nickel.....	
	Titanium.....	
	Uranium.....	
	Zinc.....	0
	Zircaloy/Zirconium.....	
	Other metals.....	
Organics (%wt):	-	
	Total cellulose.....	0
	Paper, cotton.....	0
	Wood.....	0
	Halogenated plastics	
	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):	-	
	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.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0

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Inorganic anions (%wt):

-	
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:

-	
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:

none expected	
Acrylamide.....	
Benzene.....	
Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	
Styrene.....	
Tri-butyl phosphate.....	
Other organophosphates.....	
Vinyl chloride.....	
Arsenic.....	
Barium.....	

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Boron.....
 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: Cement encapsulation at Harwell WEP

Plant Name: Waste Encapsulation Plant (WEP)

Location: Harwell

Plant startup date: -

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: -

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

Other information: The fuel spikes will be loaded into 12 cans (11 with 3 spikes and one can with 4 spikes). These will then be sent to Harwell in flasks for intermediate storage. Final conditioning will be undertaken at Harwell into 500l drums, as 5C52.

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages

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Likely container type comment:

-

Range in container waste volume:

-

Other information on containers:

-

Likely conditioning matrix:

Pulverised Fly Ash / Ordinary Portland Cement

Other information:

3:1 PFA/OPC at a 0.42 w/s ratio

Conditioned density (t/m³):

~2.0

Conditioned density comment:

The density will vary according to the nature of individual drum contents

Other information on conditioning:

-

Opportunities for alternative disposal routing:

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:

Contamination and activation from location in core and purpose of waste

Uncertainty:

Activity based on Dragon activation model [RET0458 Issue B]

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:

A 3D model of the reactor was used to calculate the neutron fluxes utilising the Monte Carlo code MCNP4C2. The flux calculations of the Monte-Carlo model were then input into a series of FISPACT calculations.

Other information:

-

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DRAGON High Active Components

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	8.04E-01	CC 2			Gd 153		8		
Be 10	4.08E-08	CC 2			Ho 163	2.16E-06	CC 2		
C 14	3.48E-01	CC 2			Ho 166m	2.76E-05	CC 2		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171	8.76E-08	CC 2		
Cl 36	5.16E-05	CC 2			Lu 174		8		
Ar 39	9.36E-04	CC 2			Lu 176		8		
Ar 42	5.64E-07	CC 2			Hf 178n	1.56E-03	CC 2		
K 40	2.16E-08	CC 2			Hf 182	1.12E-09	CC 2		
Ca 41	3.12E-04	CC 2			Pt 193	5.64E-03	CC 2		
Mn 53		8			Tl 204	1.92E-03	CC 2		
Mn 54		8			Pb 205	1.12E-08	CC 2		
Fe 55	1.56E-01	CC 2			Pb 210		8		
Co 60	4.68E+00	CC 2			Bi 208		8		
Ni 59	2.16E+00	CC 2			Bi 210m	4.44E-09	CC 2		
Ni 63	2.16E+02	CC 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	3.48E-07	CC 2			Ra 225	8.52E-08	CC 2		
Kr 81	3.36E-06	CC 2			Ra 226		8		
Kr 85	3.48E-04	CC 2			Ra 228	1.13E-08	CC 2		
Rb 87	4.32E-09	CC 2			Ac 227		8		
Sr 90	1.92E-03	CC 2			Th 227		8		
Zr 93	1.56E-07	CC 2			Th 228	3.84E-07	CC 2		
Nb 91	6.36E-07	CC 2			Th 229	8.52E-08	CC 2		
Nb 92		8			Th 230	2.04E-09	CC 2		
Nb 93m	2.76E-03	CC 2			Th 232	1.13E-08	CC 2		
Nb 94	4.44E-03	CC 2			Th 234	1.92E-08	CC 2		
Mo 93	1.8E-03	CC 2			Pa 231		8		
Tc 97	3.84E-09	CC 2			Pa 233	2.64E-09	CC 2		
Tc 99	3.48E-04	CC 2			U 232	3.6E-07	CC 2		
Ru 106		8			U 233	1.19E-05	CC 2		
Pd 107	3.36E-09	CC 2			U 234	6.36E-07	CC 2		
Ag 108m	2.04E-04	CC 2			U 235		8		
Ag 110m		8			U 236	3.24E-09	CC 2		
Cd 109		8			U 238	1.92E-08	CC 2		
Cd 113m	2.88E-06	CC 2			Np 237	2.64E-09	CC 2		
Sn 119m		8			Pu 236		8		
Sn 121m	1.68E-04	CC 2			Pu 238	7.68E-05	CC 2		
Sn 123		8			Pu 239	1.03E-05	CC 2		
Sn 126	7.8E-09	CC 2			Pu 240	4.92E-05	CC 2		
Sb 125	2.28E-06	CC 2			Pu 241	8.64E-04	CC 2		
Sb 126	1.09E-09	CC 2			Pu 242	2.04E-07	CC 2		
Te 125m	5.4E-07	CC 2			Am 241	2.04E-04	CC 2		
Te 127m		8			Am 242m	5.04E-07	CC 2		
I 129	1.2E-09	CC 2			Am 243	4.32E-07	CC 2		
Cs 134	3E-07	CC 2			Cm 242	4.2E-07	CC 2		
Cs 135	1.44E-07	CC 2			Cm 243	2.28E-07	CC 2		
Cs 137	1.92E-03	CC 2			Cm 244	3E-06	CC 2		
Ba 133	4.68E-05	CC 2			Cm 245		8		
La 137	1.92E-06	CC 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	1.32E-05	CC 2			Cf 250		8		
Pm 147	1.68E-07	CC 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	3.12E-04	CC 2			Other a				
Eu 152	9.12E-07	CC 2			Other b/g				
Eu 154	2.4E-03	CC 2			Total a	3.58E-04	CC 2	0	
Eu 155	1.8E-05	CC 2			Total b/g	2.24E+02	CC 2	0	

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