WASTE STREAM 2D202/C Dragon Fuel from Winfrith

SITE Sellafield

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Sellafield Limited

WASTE TYPE ILW

WASTE VOLUMES

		Conditioned	Packaged
Stocks:	At 1.4.2019.....	3.5 m^3	4.0 m^3
Total future arisings:		0 m^3	0 m^3
Total waste volume:		3.5 m^3	4.0 m^3
Number of waste packages in stock:	At 1.4.2019.....	7 package(s)	

Comment on volumes: The Dragon fuel was stored at Winfrith, but has since been repacked into stainless steel containers 1/3 the length of the original containers before being transferred to Harwell. These are refered to as third length containers (TLC). The waste occupies 251 TLCs. A single TLC is placed into a 500L drum at MEP and grouted before transferred to the Encaps Store. The TLC has been classed as part of that weight. A single non-active dummy drum was also produced during MEP commissioning hence 252 waste packages will exist across streams 2D202/C (7 packages) and 5C50 (245 packages).

Uncertainty factors on volumes:

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

WASTE SOURCE Dragon reactor irradiated fuel.

PHYSICAL CHARACTERISTICS

General description: Fuel consists of uranium and uranium/thorium fuel (oxide or carbide) kernels, also including graphite and (some) ZrC, covered with carbon and SiC layers to give 0.1-0.25 mm particles. Most of the fuel particles are mixed with graphite and compressed into compacts.

Physical components (%wt): ~94% of U235 as fuel compacts (mostly 35mm od x 35mm or 45mm od x 45mm), ~6% as fuel particles. MEP/WPS/04/02 used to recalculate waste in 500L drum.

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m^3): ~2

Comment on density: The density of fuel compacts varies between ~1.7 and 2.1 t/m3.

CHEMICAL COMPOSITION

General description and components (%wt): Waste comprises graphite/pyrocarbon (91%), heavy metal oxides and carbides (U/Th/Zr) (~5%), stainless steel TLC (~4%). Conditioned product contains ~6% waste and ~94% cement.

Chemical state: Neutral

Chemical form of radionuclides: C-14: Present in the form of graphite and pyrolytic carbon.
U: Uranium oxide and uranium carbide.
Pu: Plutonium oxide and plutonium carbide.

Metals and alloys (%wt): -

Stainless steel.....	3.8	TLC.
Other ferrous metals.....	0	
Iron.....	0	
Aluminium.....	0	
Beryllium.....	0	
Cobalt.....	0	
Copper.....	0	
Lead.....	0	
Magnox/Magnesium.....	0	

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	Nickel	0	
	Titanium		
	Uranium	0	
	Zinc	0	
	Zircaloy/Zirconium	0	
	Other metals	0.11	Uranium, thorium and zinc are present as only oxides and carbides, but not in elemental form.
Organics (%wt):	The waste contains no organic materials.		
	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	0	
	Oil or grease	0	
	Fuel	0	
	Asphalt/Tarmac (cont.coal tar)	0	
	Asphalt/Tarmac (no coal tar)	0	
	Bitumen	0	
	Others	0	
	Other organics	0	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	0	
	Inorganic sludges and flocs	0	
	Soil	0	
	Brick/Stone/Rubble	0	
	Cementitious material	94.4	
	Sand	0	
	Glass/Ceramics	0	
	Graphite	1.8	
	Desiccants/Catalysts		
	Asbestos	0	
	Non/low friable	0	
	Moderately friable	0	
	Highly friable	0	
	Free aqueous liquids	0	

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	Free non-aqueous liquids	0
	Powder/Ash	TR
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	0
	Putrescible wastes	0
	Non-putrescible wastes	0
	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.....

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

Container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
500 l drum	100.0	0.5	0.5	7

Container type comment: 500 l drum for Dragon Fuel has a centralised frame, 0.5m3.

Range in container waste volume: -

Other information on containers: Waste per container is 0.034 m3.

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

RADIOACTIVITY

Source: Irradiation of enriched uranium and U/Th compact fuels.

Uncertainty: Total alpha and beta/gamma activities vary by about three orders of magnitude between

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	cans, and some individual isotopes by more than this.
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:	Maximum and minimum activities of each radionuclide in individual cans determined by FISPIN. Average inventories for each isotope assigned to each can transferred, and total divided by the estimated volume of drum payload. Exception U235 and daughters where can-specific activities assigned.
Other information:	-

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2016	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2016	Bands and Code	Future arisings	Bands and Code
H 3	1.47E-02	B B 2			Gd 153				
Be 10	6.31E-08	B B 2			Ho 163				
C 14	3.12E-06	B B 2			Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210	3.39E-10	B B 2		
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63	5.04E-09	B B 2			Po 210	3.25E-10	B B 2		
Zn 65					Ra 223	4.31E-06	B B 2		
Se 79	1.26E-05	B B 2			Ra 225	2.79E-06	B B 2		
Kr 81					Ra 226	1.18E-09	B B 2		
Kr 85					Ra 228	2.29E-06	B B 2		
Rb 87					Ac 227	4.33E-06	B C 2		
Sr 90	1.15E+01	B B 2			Th 227	4.25E-06	B B 2		
Zr 93	6.15E-04	B B 2			Th 228	1.09E-03	B C 2		
Nb 91					Th 229	2.82E-06	B B 2		
Nb 92					Th 230	9.35E-08	B B 2		
Nb 93m	3.01E-04	B B 2			Th 232	2.68E-06	B B 2		
Nb 94	2.01E-08	B B 2			Th 234	8.37E-06	B B 2		
Mo 93					Pa 231	1.08E-05	B B 2		
Tc 97					Pa 233	7.72E-05	B B 2		
Tc 99	4.42E-03	B B 2			U 232	1.10E-03	B B 2		
Ru 106	1.72E-10	B B 2			U 233	4.96E-03	B B 2		
Pd 107	1.33E-05	B B 2			U 234	1.90E-04	B B 2		
Ag 108m					U 235	5.20E-05	B B 2		
Ag 110m					U 236	8.29E-09	B B 2		
Cd 109					U 238	8.37E-06	B B 2		
Cd 113m					Np 237	7.72E-05	B B 2		
Sn 119m					Pu 236				
Sn 121m	6.91E-04	B B 2			Pu 238	3.33E-01	B B 2		
Sn 123					Pu 239	6.99E-02	B B 2		
Sn 126	7.37E-05	B B 2			Pu 240	4.66E-02	B B 2		
Sb 125					Pu 241	4.12E+00	B B 2		
Sb 126	1.03E-05	B B 2			Pu 242	2.22E-04	B B 2		
Te 125m					Am 241	7.59E-01	B B 2		
Te 127m					Am 242m	7.67E-06	B B 2		
I 129	8.70E-06	B B 2			Am 243	1.99E-03	B C 2		
Cs 134	7.13E-05	B B 2			Cm 242	6.31E-06	B C 2		
Cs 135	2.50E-04	B B 2			Cm 243	9.78E-04	B C 2		
Cs 137	1.33E+01	B B 2			Cm 244	6.12E-02	B C 2		
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147	2.38E-03	B B 2			Cf 251				
Sm 147					Cf 252				
Sm 151	1.83E-01	B B 2			Other a				
Eu 152	1.02E-04	B B 2			Other b/g				
Eu 154	6.29E-02	B B 2			**Total a**	**1.28E+00**	**B B 2**	**0**	
Eu 155	2.87E-03	B B 2			**Total b/g**	**2.91E+01**	**B B 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