WASTE STREAM 2D09.1 MSSS Compartment 7

SITE	Sellafield
SITE OWNER	Nuclear Decommissioning Authority
WASTE CUSTODIAN	Sellafield Limited
WASTE TYPE	ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	~603.0 m³
Total future arisings:		0 m³
Total waste volume:		603.0 m³

Comment on volumes: There are no future arisings to this stream. Waste volume includes swarf/sludge, miscellaneous beta/gamma waste, aggregate and associated water.

Uncertainty factors on volumes:

Stock (upper):	x 1.5	Arisings (upper)	x
Stock (lower):	x 0.66	Arisings (lower)	x

WASTE SOURCE Swarf from Magnox decanning; some miscellaneous beta/gamma, mainly from Windscale, some from other sites.

PHYSICAL CHARACTERISTICS

General description: Magnox cladding, much of which has been converted to a magnesium hydroxide sludge. Some miscellaneous beta/gamma wastes (MBGW) are also present: these include tins/cans, filters, tools, pipework, pumps, valves, plastic items. The waste also includes some uranium most of which has corroded to oxides of uranium. A small volume of limestone aggregate is present at the bottom of the compartment. Swarf from Magnox decanning has reacted with the storage cover water to form corrosion products. Some degradation of miscellaneous components waste will have occurred.

Physical components (%wt): Magnox swarf (9.23%), Magnox sludge (39.55%), Al/Al(OH)3 (0.49%), U/UO2/U3O8 (2.16%), MBGW (scrap, filters, cans, etc.) (8.21%), aggregate (limestone) (1.31%), water (37.8%), others (1.25%).

Sealed sources: Not yet determined.

Bulk density (t/m³): ~1.7

Comment on density: Average decanning debris is ~1.5 t/m³. Average MBGW ~3.2 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Magnox swarf (9.23%), Magnox sludge (39.55%), Al/Al(OH)3 (0.49%), U/UO2/U3O8 (2.16%), MBGW (scrap, filters, cans, etc.) (8.21%), aggregate (limestone) (1.31%), water (37.8%), others (1.25%).

Chemical state: Neutral

Chemical form of radionuclides:
H-3: Present in elemental and reacted forms.
C-14: Present in elemental and reacted forms.
Cl-36: Present in elemental and reacted forms.
Se-79: Present in elemental and reacted forms.
Tc-99: Present in elemental and reacted forms.
I-129: Present in elemental and reacted forms.
Ra: Ra isotopes are present in less than trace amounts in fuel.
Th: Present in elemental and reacted forms.
U: Present in metallic and reacted forms (oxides and possibly hydride).
Np: Present in elemental and reacted forms.
Pu: Present in metallic and mixed oxide forms.

Metals and alloys (%wt): No significant quantities of sheet metal, although small quantities of fabricated items are present, e.g. paint tins, HEPA filters. Small pieces of Magnox metal present.

Stainless steel.....	~1.2
Other ferrous metals.....	~5.2
Iron.....	P
Aluminium.....	~0.49
Beryllium.....	NE

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	Cobalt	P	
	Copper	TR	
	Lead	TR	
	Magnox/Magnesium	~9.2	Predominantly Magnox.
	Nickel	TR	
	Titanium	NE	
	Uranium	~2.2	
	Zinc	TR	
	Zircaloy/Zirconium	~0.04	
	Other metals	~0.06	
Organics (%wt):	The organic content of the waste is low.		
	Total cellulosics	~0.18	
	Paper, cotton		
	Wood		
	Halogenated plastics	~0.08	
	Total non-halogenated plastics	~0.05	
	Condensation polymers		
	Others		
	Organic ion exchange materials	NE	
	Total rubber	NE	
	Halogenated rubber		
	Non-halogenated rubber		
	Hydrocarbons		
	Oil or grease	<0.01	
	Fuel	NE	
	Asphalt/Tarmac (cont.coal tar)	NE	
	Asphalt/Tarmac (no coal tar)	NE	
	Bitumen	NE	
	Others	NE	
	Other organics	<0.01	
Other materials (%wt):	-		
	Inorganic ion exchange materials.	NE	
	Inorganic sludges and flocs	~39.5	
	Soil	NE	
	Brick/Stone/Rubble	~1.3	
	Cementitious material	NE	
	Sand	NE	
	Glass/Ceramics	~0.39	
	Graphite	~0.86	
	Desiccants/Catalysts	NE	
	Asbestos	NE	
	Non/low friable		
	Moderately friable		

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	Highly friable.....		
	Free aqueous liquids.....	~37.8	
	Free non-aqueous liquids.....	NE	
	Powder/Ash.....	NE	
Inorganic anions (%wt):	Hydroxides and carbonates are present.		
	Fluoride.....	TR	
	Chloride.....	TR	Alkali metal and alkaline earth chlorides.
	Iodide.....	TR	
	Cyanide.....	NE	
	Carbonate.....	~0.04	
	Nitrate.....	TR	
	Nitrite.....	TR	
	Phosphate.....	TR	
	Sulphate.....	TR	
	Sulphide.....	TR	
Materials of interest for waste acceptance criteria:	Waste contains uranium, Magnox and traces of uranium hydride. Cellulosics are present as putrescible waste.		
	Combustible metals.....	P	
	Low flash point liquids.....	0	
	Explosive materials.....	0	
	Phosphorus.....	0	
	Hydrides.....	P	Trace, passivated.
	Biological etc. materials.....	0	
	Biodegradable materials.....	P	
	Putrescible wastes.....	P	Celluosics.
	Non-putrescible wastes.....	P	Organics - plastics and rubbers.
	Corrosive materials.....	0	
	Pyrophoric materials.....	0	
	Generating toxic gases.....	0	
	Reacting with water.....	P	<5%.
	Active particles.....	P	Radioactive sludges and solids.
	Soluble solids as bulk chemical compounds.....	P	Elemental and hydroxides, oxides and carbonates.
Hazardous substances / non hazardous pollutants:	-		
	Acrylamide.....		
	Benzene.....	0	
	Chlorinated solvents.....		
	Formaldehyde.....		
	Organometallics.....		
	Phenol.....	0	
	Styrene.....		

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Tri-butyl phosphate	0	
Other organophosphates		
Vinyl chloride	0	
Arsenic	0	
Barium		
Boron	NE	Traces - elemental and borates.
Cadmium	0	
Caesium		
Selenium	0	
Chromium	P	In steels.
Molybdenum	P	In steels.
Thallium		
Tin	P	Traces.
Vanadium	P	In steels.
Mercury compounds		
Others	NE	
Electronic Electrical Equipment (EEE)		
EEE Type 1		
EEE Type 2		
EEE Type 3		
EEE Type 4		
EEE Type 5		

Complexing agents (%wt):	Not yet determined
EDTA	
DPTA	
NTA	
Polycarboxylic acids	
Other organic complexants	
Total complexing agents	

PACKAGING AND CONDITIONING

Conditioning method:	The waste will be retrieved from MSSS and stored in an unconditioned state for a period of 70 years. Following the period of storage it will be retrieved (from storage) and conditioned for ultimate disposal to the GDF.
Plant Name:	TBD
Location:	Sellafield
Plant startup date:	2070-2090
Total capacity (m^3/y incoming waste):	-
Target start date for packaging this stream:	-
Throughput for this stream (m^3/y incoming waste):	-
Other information:	The plant has not yet been designed. Hence, throughputs & capacities cannot be quoted at this time.

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Likely container type:

Container	Waste packaged (%vol)	Waste loading (m^3)	Payload (m^3)	Number of packages
Sellafield enhanced 3m^3 box	100.0	0.940	2.15	642

Likely container type comment:	1 skip of retrieved waste (max 1,400 litres) in = 1 package out.
Range in container waste volume:	There will be considerable variability in unconditioned waste volume per package due to variations in skip loading and content. The actual number of packages produced will be different to that reported in the table since the raw volumes reported include waste and compartment liquor. The actual number of packages produced is identified in the 2018 Sellafield Decommissioning Product and Secondary Waste Plan.
Other information on containers:	Stainless Steel.
Likely conditioning matrix:	BFS/OPC;PFA/OPC
Other information:	-
Conditioned density (t/m^3):	~2.0
Conditioned density comment:	Density of conditioned waste will be fairly uniform.
Other information on conditioning:	Waste matrix (as retrieved) will be in-filled with grout. A second pour of capping grout will be added. Void spaces between Skip wall and Box wall will be filled with grout.
Opportunities for alternative disposal routing:	No

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	Irradiated fuel, fuel components, reactor components and miscellaneous items contaminated with fuel residues.
Uncertainty:	Accuracy is generally good for fuel based residues, based on decanning records arisings and fuel carry over evaluations. For miscellaneous waste items, where records are incomplete, the accuracy is worse.
Definition of total alpha and total beta/gamma:	FISPIN generates data for approximately 2500 radionuclides. Only a proportion of these are considered in the UK inventory for this waste stream.
Measurement of radioactivities:	Isotopic specific activity (TBq/m^3) is derived by dividing the estimated total activity of the isotope by the total volume of the waste. Calculation performed Feb 2019.
Other information:	Short-lived daughters are included in the "other" beta/gamma activity.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3	2.66E-01	A B 2			Gd 153	1.09E-21	A A 2		
Be 10	3.47E-07	A A 2			Ho 163	2.33E-11	A A 2		
C 14	3.01E-02	A B 2			Ho 166m	1.73E-07	A A 2		
Na 22					Tm 170	3.62E-40	A A 2		
Al 26					Tm 171	6.24E-11	A A 2		
Cl 36	2.43E-07	A B 2			Lu 174				
Ar 39	1.29E-05	A B 2			Lu 176				
Ar 42					Hf 178n				
K 40	1.37E-08	A B 2			Hf 182	4.50E-16	A A 2		
Ca 41	1.52E-04	A B 2			Pt 193				
Mn 53	3.66E-11	A B 2			Tl 204	5.65E-06	A A 2		
Mn 54					Pb 205				
Fe 55	2.04E-03	A A 2			Pb 210	1.07E-09	A A 2		
Co 60	2.40E-01	A A 2			Bi 208				
Ni 59	4.77E-02	A A 2			Bi 210m	4.03E-23	A A 2		
Ni 63	4.57E+00	A A 2			Po 210	1.04E-09	A A 2		
Zn 65					Ra 223	3.52E-08	A A 2		
Se 79	2.11E-05	A A 2			Ra 225	3.36E-11	A A 2		
Kr 81					Ra 226	3.17E-09	A A 2		
Kr 85	2.54E-01	A A 2			Ra 228				
Rb 87	3.10E-11	A A 2			Ac 227	1.39E-08	A A 2		
Sr 90	1.01E+01	A A 2			Th 227	1.36E-08	A A 2		
Zr 93	6.58E-04	A A 2			Th 228	6.46E-07	A A 2		
Nb 91					Th 229	3.36E-11	A A 2		
Nb 92	2.69E-15	A A 2			Th 230	3.31E-07	A A 2		
Nb 93m	6.14E-04	A A 2			Th 232	1.10E-12	A A 2		
Nb 94	9.39E-05	A A 2			Th 234	9.08E-04	A A 2		
Mo 93	8.09E-05	A A 2			Pa 231	2.70E-08	A A 2		
Tc 97					Pa 233	4.00E-05	A A 2		
Tc 99	5.31E-03	A B 2			U 232	6.31E-07	A A 2		
Ru 106	1.44E-10	A A 2			U 233	1.03E-08	A A 2		
Pd 107	3.75E-05	A A 2			U 234	8.12E-04	A A 2		
Ag 108m	5.80E-09	A A 2			U 235	2.36E-05	A A 2		
Ag 110m	5.93E-19	A A 2			U 236	8.70E-05	A A 2		
Cd 109	4.53E-15	A A 2			U 238	9.08E-04	A A 2		
Cd 113m	6.62E-05	A A 2			Np 237	4.02E-05	A A 2		
Sn 119m					Pu 236	5.02E-10	A A 2		
Sn 121m	5.08E-07	A A 2			Pu 238	1.03E-01	A A 2		
Sn 123					Pu 239	3.83E-01	A A 2		
Sn 126	2.79E-04	A A 2			Pu 240	3.86E-01	A A 2		
Sb 125	1.61E-04	A A 2			Pu 241	5.27E+00	A A 2		
Sb 126	3.91E-05	A A 2			Pu 242	1.99E-04	A A 2		
Te 125m	3.92E-05	A A 2			Am 241	1.06E+00	A A 2		
Te 127m					Am 242m	1.45E-03	A A 2		
I 129	1.16E-05	A B 2			Am 243	3.81E-04	A A 2		
Cs 134	1.51E-05	A A 2			Cm 242	1.20E-03	A A 2		
Cs 135	2.92E-04	A A 2			Cm 243	1.63E-04	A A 2		
Cs 137	1.48E+01	A B 2			Cm 244	1.97E-03	A A 2		
Ba 133	4.48E-07	A A 2			Cm 245	2.24E-07	A A 2		
La 137					Cm 246	1.91E-08	A A 2		
La 138	3.31E-14	A A 2			Cm 248				
Ce 144	9.69E-14	A A 2			Cf 249	8.31E-14	A A 2		
Pm 145					Cf 250	6.05E-14	A A 2		
Pm 147	2.07E-03	A A 2			Cf 251	1.98E-15	A A 2		
Sm 147					Cf 252	8.81E-18	A A 2		
Sm 151	1.36E-01	A A 2			Other a				
Eu 152	6.69E-04	A A 2			Other b/g				
Eu 154	3.29E-02	A A 2			**Total a**	**1.93E+00**	**A B 2**	**0**	
Eu 155	2.87E-03	A A 2			**Total b/g**	**3.58E+01**	**A 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