WASTE STREAM	5G304	DRAGON Reactor Decommissioning ILW

SITE Winfrith

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

		Reported (m^3)
Stocks:	At 1.4.2025	= 0
Future arisings:	1.4.2026 - 31.3.2037	= 22.0
Total future arisings:		**22.0**
Total waste volume:		**22.0**

OR

Conditioned (m^3)	Packaged (m^3)

Number of waste packages in stock: At 1.4.2025…… - packages

Comment on arising rates: -

Additional information on quantities: -

Uncertainty factors on volumes:

Stock (upper):	x -	Arisings (upper):	x 1.50
Stock (lower):	x -	Arisings (lower):	x 0.80

WASTE SOURCE Winfrith Dragon reactor core decommissioning operations

PHYSICAL CHARACTERISTICS

General description: Pressure vessel (excluding neck) 11'6" dia x ~32', up to 2" thick

Plenum chamber 6'2" dia x 11'4", 0.5" thick
Upper neutron shield 10'5" dia x5'7", 0.75" plate
Other items of similar dimensions that will require size reduction

Changes since waste generated: -

Bulk density (t/m³): ~ 3.5

Comment on density: -

CHEMICAL COMPOSITION

General description and components (%wt): Mild steel 44.6%, Marwe-426 14.5%, Stainless steel 2.7%, Graphite 36.6%, Nimonic-75 1.5%, Monel-400 0.1%, Boron carbide <0.1%

Chemical state: Neutral

Sheet metal proportion / thickness: Plate thicknesses are ~2" for the pressure vessel, ½" for the nimonic plenum. The other waste items are mainly smaller plant items and fittings. It should be noted that the material will be sized reduced to allow it to be packed into the WAGR boxes.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	= 2.7	A typical AISI 321 stainless steel composition is an appropriate assumption for stainless steel within the Dragon RPV with the exception of the inner live reflector block top fittings which had Niobium stabilised stainless steel in their top fittings.	
Other ferrous metals	= 59.1	Mild steel 44.6%, Marwe-426 14.5%,	
Iron		-	
Aluminium	= 0	-	
Beryllium	= 0	-	
Cobalt		-	
Copper	= 0	-	
Lead	= 0	-	
Magnox/Magnesium	= 0	-	
Nickel	= 1.6	The monel material used was reported to be monel-400. The nimonic material used was nimonic-75. (Nimonic-75 1.5%, Monel-400 0.1%,)	
Titanium		-	
Uranium	TR	-	
Zinc		-	
Zircaloy/Zirconium	= 0	-	
Other metals		None	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
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		-	
Oil or grease		-	
Fuel		-	
Asphalt/Tarmac (cont.coal tar)		-	
Asphalt/Tarmac (no coal tar)		-	
Bitumen		-	
Others		-	
Other organics	= 0	-	

Other materials (%wt):

	(%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	= 36.6	-	
Desiccants/Catalysts		-	
Asbestos	TR	-	
Non/low friable		-	
Moderately friable		-	
Highly friable		-	
Free aqueous liquids	= 0	-	
Free non-aqueous liquids	= 0	-	
Powder/Ash	= 0	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
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:

	(%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	0	-
Putrescible wastes	= 0	-
Non-putrescible wastes		-
Corrosive materials	= 0	-
Pyrophoric materials	= 0	-
Generating toxic gases	= 0	-
Reacting with water	= 0	-
Higher activity particles		-
Soluble solids as bulk chemical compounds		-

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide		-
Benzene		-
Chlorinated solvents		-
Formaldehyde		-
Organometallics		-
Phenol		-
Styrene		-
Tri-butyl phosphate		-
Other organophosphates		-
Vinyl chloride		-
Arsenic		-
Barium		-
Boron	0	-
Boron (in Boral)		-
Boron (non-Boral)		-
Cadmium		-
Caesium		-
Selenium		-
Chromium		-
Molybdenum		-
Thallium		-
Tin		-
Vanadium		-
Mercury compounds		-
Others		-

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA		-
DPTA		-
NTA		-
Polycarboxylic acids		-
Other organic complexants		-
Total complexing agents	= 0	-

Physical components:

	Number	Type(s) and comment
Sources		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1		-
EEE Type 2		-
EEE Type 3		-
EEE Type 4		-
EEE Type 5		-

TREATMENT, PACKAGING AND DISPOSAL

Planned on-site / off-site treatment(s):

Treatment	On-site / Off-site	Stream volume %
Size reduction Decay storage Low force compaction Supercompaction (HFC) Incineration Drying/dewatering/liquid separation Tie down/fixatives/strippable coating/painting application Decontamination Metal treatment Recycling / reuse Thermal treatment, including vitrification Encapsulation Polymer encapsulation Other physical treatment Other chemical treatment Containerisation Treatment not yet determined None	On-site	100.0

Comments on planned treatments: -

Conditioning method: A dedicated plant will be constructed at the reactor site The waste will be packaged into 6m3 boxes and encapsulated with cement

Conditioning plants:

Plant Name	Location
WIN encapsulation station	Winfrith

Likely conditioning matrix: Unknown

Further information on the conditioning matrix: 3:1 PFA/OPC with w/s of 0.42.

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m^3)	Payload (m^3)	Number of packages	Estimated start date for packaging
6 m^3 concrete box (HD)	100.0	0.89	5.8	25	-

Range in container waste loading: -

Other information on packaging and conditioning: -

Conditioned density (t/m^3): ~ 2.3
Conditioned density comment: -

Management Routes:

Disposal Route	Stream volume %	Raw density t/m^3	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland) Expected to be Non-NSD HAW managed under Scottish Government's policy Expected to be disposed to LLW Vaults NRS Dounreay Expected to be consigned to the Geological Disposal Facility Expected to be consigned to a Near Surface Disposal Facility Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be disposed On-Site Expected to be managed by In-Situ Disposal Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be Out of Scope Expected to be recycled / reused Disposal route not known	100.0		

Classification codes for waste expected to be consigned to a landfill facility:

Opportunities for alternative disposal routing: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: Neutron activation of primary vessel and components within. Fuel and fission product contamination has not been calculated for inclusion. Although present, activity associated with contamination is believed to be negligible in comparison to activity associated with activation.

Uncertainty: The main source of uncertainty is the elemental uncertainties in the material compositions. The uncertainties relate to the trace elements present within the material used to manufacture the Dragon reactor core components. Wherever possible specific compositions and trace element data was used for each component in the activation modelling.
The uncertainty presented by the flux modelling is regarded to be much less than that presented by the elemental uncertainties. Further, the modelling approach used upper bound precursor data which will mean that the inventory derived for Dragon core component materials will also be upper bounding values.

Measurement of radioactivities: -

Chemical form of radionuclides:

H-3: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

C-14: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

Cl-36: Radionuclide are present as trace elements in the activated waste materials.
Se-79: Radionuclide are present as trace elements in the activated waste materials.
Tc-99: Radionuclide are present as trace elements in the activated waste materials.
I-129: Radionuclide are present as trace elements in the activated waste materials.
Ra: Radionuclide are present as trace elements in the activated waste materials. Possible presence from contamination.
Th: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

U: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

Np: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

Pu: Radionuclide are present as trace elements in the activated waste materials. Also present from contamination.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3			< 1.61E-01	B 3	Gd 153				8
Be 10			< 1.58E-06	B 3	Ho 163			< 2.80E-07	B 3
C 14			< 3.51E-02	B 3	Ho 166m			< 2.15E-05	B 3
Na 22				8	Tm 170				8
Al 26				8	Tm 171			< 2.80E-09	B 3
Cl 36			< 2.44E-04	B 3	Lu 174				8
Ar 39			< 1.85E-04	B 3	Lu 176				8
Ar 42			< 8.42E-08	B 3	Hf 178n			< 1.23E-04	B 3
K 40			< 9.07E-09	B 3	Hf 182				8
Ca 41			< 1.55E-04	B 3	Pt 193			< 7.83E-04	B 3
Mn 53				8	Tl 204			< 2.06E-03	B 3
Mn 54				8	Pb 205			< 2.66E-09	B 3
Fe 55			< 7.65E-03	B 3	Pb 210				8
Co 60			< 2.77E-01	B 3	Bi 208				8
Ni 59			< 9.14E-02	B 3	Bi 210m				8
Ni 63			< 8.56E+00	B 3	Po 210				8
Zn 65				8	Ra 223			< 1.54E-09	B 3
Se 79			< 1.26E-07	B 3	Ra 225			< 1.20E-07	B 3
Kr 81			< 3.80E-05	B 3	Ra 226				8
Kr 85			< 4.44E-04	B 3	Ra 228			< 2.41E-08	B 3
Rb 87			< 2.65E-07	B 3	Ac 227			< 1.55E-09	B 3
Sr 90			< 1.98E-03	B 3	Th 227			< 1.52E-09	B 3
Zr 93			< 1.40E-07	B 3	Th 228			< 6.14E-07	B 3
Nb 91			< 2.18E-07	B 3	Th 229			< 1.20E-07	B 3
Nb 92				8	Th 230			< 1.71E-09	B 3
Nb 93m			< 8.33E-04	B 3	Th 232			< 2.52E-08	B 3
Nb 94			< 4.35E-04	B 3	Th 234			< 4.92E-08	B 3
Mo 93			< 2.74E-04	B 3	Pa 231			< 2.08E-09	B 3
Tc 97			< 4.86E-09	B 3	Pa 233				8
Tc 99			< 4.22E-05	B 3	U 232			< 5.84E-07	B 3
Ru 106				8	U 233			< 1.51E-05	B 3
Pd 107			< 1.78E-09	B 3	U 234			< 9.40E-07	B 3
Ag 108m			< 1.45E-05	B 3	U 235			< 2.04E-09	B 3
Ag 110m				8	U 236			< 1.35E-09	B 3
Cd 109				8	U 238			< 4.92E-08	B 3
Cd 113m			< 2.43E-05	B 3	Np 237				8
Sn 119m				8	Pu 236				8
Sn 121m			< 7.33E-06	B 3	Pu 238			< 1.88E-05	B 3
Sn 123				8	Pu 239			< 1.17E-05	B 3
Sn 126			< 6.13E-09	B 3	Pu 240			< 1.52E-05	B 3
Sb 125			< 9.26E-08	B 3	Pu 241			< 2.15E-04	B 3
Sb 126				8	Pu 242			< 6.80E-08	B 3
Te 125m			< 2.32E-08	B 3	Am 241			< 5.15E-05	B 3
Te 127m				8	Am 242m			< 8.88E-08	B 3
I 129			< 1.19E-09	B 3	Am 243			< 3.47E-07	B 3
Cs 134			< 2.50E-06	B 3	Cm 242			< 7.33E-08	B 3
Cs 135			< 1.46E-07	B 3	Cm 243			< 9.09E-08	B 3
Cs 137			< 1.76E-03	B 3	Cm 244			< 5.69E-06	B 3
Ba 133			< 2.76E-04	B 3	Cm 245			< 1.49E-09	B 3
La 137			< 9.71E-07	B 3	Cm 246				8
La 138				8	Cm 248				8
Ce 144				8	Cf 249				8
Pm 145			< 5.77E-06	B 3	Cf 250				8
Pm 147			< 1.33E-07	B 3	Cf 251				8
Sm 147				8	Cf 252				8
Sm 151			< 2.69E-04	B 3	Unsp a				
Eu 152			< 7.64E-03	B 3	Unsp b/g				
Eu 154			< 1.27E-03	B 3	**Total a**	**0**	*	**1.21E-04**	*
Eu 155			< 1.15E-05	B 3	**Total b/g**	**0**	*	**9.15E+00**	*

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 the 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
* Total calculated from the 114 declared radionuclides