

WASTE STREAM	5C18/C	Encapsulated ILW Liquors
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SITE Harwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025		= 15.8	23.4
Future arisings:				0.0
Total future arisings:			0.0	0.0
Total waste volume:			15.8	23.4

Number of waste packages in stock: At 1.4.2025..... 41 packages

Comment on arising rates: All the Stored Legacy ILW liquors (5C18) have been encapsulated. Some of the conditioned liquors have been re-characterised as LLW and consigned to LLWR.

Additional information on quantities: Volume is well defined because all waste is encapsulated in 500L drums.

Uncertainty factors on volumes: Stock (upper): x 1.00 Arisings (upper): x -
Stock (lower): x 1.00 Arisings (lower): x -

WASTE SOURCE Encapsulation of laboratory wastes from development of fuel processing, the fast reactor programme and various radiochemical investigations.

PHYSICAL CHARACTERISTICS

General description: Solid waste made up of primarily cement grouting contaminated with fission products, activation products and actinides.

Changes since waste generated: The waste was acidic with the original liquors having a pH of 0.36 to 0.98. After mixing with neutralising agent and grout it is alkaline.

Bulk density (t/m³): ~ 2.0

Comment on density: This is the mean bulk density at 100% solids (as stored).

CHEMICAL COMPOSITION

General description and components (%wt): Encapsulated solid waste containing liquor (27.23%), Neutralising agent (1.51%), Cement (3:1 BFS/OPC) (71.26%)

Chemical state: Alkali

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	= 0	-	
Other ferrous metals.....	= 0	-	
Iron.....	= 0	-	
Aluminium.....	= 0	-	
Beryllium.....	= 0	-	
Cobalt.....	= 0	-	
Copper.....	= 0	-	
Lead.....	= 0	-	
Magnox/Magnesium.....	= 0	-	
Nickel.....	= 0	-	
Titanium.....	= 0	-	
Uranium.....	= 0	-	
Zinc.....	= 0	-	
Zircaloy/Zirconium.....	= 0	-	
Other metals.....	= 0	Uranium and thorium are present, but are incorporated with grout minerals and so not present as pure metals.	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
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.....	= 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.....	= 100.0	liquor (27.23%), Neutralising agent (1.51%), Cement (3:1 BFS/OPC) (71.26%)	
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	-	

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

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride.....		-
Chloride.....	P	part of the chemical composition of the liquor
Iodide.....		-
Cyanide.....		-
Carbonate.....		-
Nitrate.....	P	part of the chemical composition of the liquor
Nitrite.....		-
Phosphate.....	P	part of the chemical composition of the liquor
Sulphate.....	P	part of the chemical composition of the liquor
Sulphide.....		-

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

Complexing agents (%wt):

Yes		
	(%wt)	Type(s) and comment
EDTA.....	= 0.01	-
DPTA.....		-
NTA.....		-
Polycarboxylic acids.....		-
Other organic complexants.....		The waste contains tributyl phosphate (0.01%)
Total complexing agents.....	= 0.01	-

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		

Comments on planned treatments:

-

Conditioning method:

The waste was treated by neutralising the acidic liquor with a slight excess of Ca(OH)₂ and cementing the resulting sludge with 3:1 BFS:OPC to give a water to cement ratio in the range 0.33 to 0.37.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

-

Further information on the conditioning matrix:

The liquor was immobilised in BFS/OPC, the grout cap was PFA/OPC.

Waste Packaging:

Likely container type:	Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
	500 l drum (pre-cast annular)	100.0	0.39	0.39	41	-

Range in container waste loading: -

Other information on packaging and conditioning: -

Conditioned density (t/m³): = 2.0

Conditioned density comment: Weight of conditioned waste in each drum = 772kg. Volume of conditioned waste in each drum = 386 litres.
Density range 1.95 to 2.03 t/m³.
Mean density 2.01 t/m³, maximum 2.04 t/m³

Management Routes:

Disposal Route	Stream volume %	Raw density t/m³	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland)	100.0		
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			

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: -

Uncertainty: Tritium, mixed fission products, activation products and actinides from MTR operations, laboratory investigations and decontamination operations.

Measurement of radioactivities: The specific activities have been derived measurements of the liquors decayed from 2008 to 2022. Activity data has been reassessed post-2022 UKRWI

Chemical form of radionuclides: H-3: Incorporated in cement grouting
C-14: -
Cl-36: Soluble salts incorporated in cement grouting
Se-79: -
Tc-99: -
I-129: Soluble salts incorporated in cement grouting
Ra: Soluble salts incorporated in cement grouting
Th: Soluble salts incorporated in cement grouting
U: Soluble salts and U235 present as depleted uranium, incorporated in cement grouting
Np: -
Pu: Soluble salts incorporated in cement grouting

WASTE STREAM 5C18/C Encapsulated ILW Liquors									
Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code		Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	6.40E-06	C C 2			Gd 153		8		
Be 10		8			Ho 163		8		
C 14		8			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36		8			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			Ti 204		8		
Mn 54		8			Pb 205		8		
Fe 55	4.57E-06	C C 2			Pb 210	4.87E-05	C C 2		
Co 60	9.50E-06	C C 2			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63	1.08E-03	C C 2			Po 210	4.84E-05	C C 2		
Zn 65		8			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226	6.65E-05	C C 2		
Kr 85		8			Ra 228	2.01E-05	C C 2		
Rb 87		8			Ac 227		8		
Sr 90	1.34E-03	C C 2			Th 227		8		
Zr 93		8			Th 228	2.01E-05	C C 2		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230	2.69E-08	C C 2		
Nb 93m		8			Th 232	2.01E-05	C C 2		
Nb 94		8			Th 234	2.05E-04	C C 2		
Mo 93		8			Pa 231	1.99E-09	C C 2		
Tc 97		8			Pa 233	1.73E-06	C C 2		
Tc 99		8			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	1.72E-04	C C 2		
Ag 108m		8			U 235	5.54E-06	C C 2		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	2.05E-04	C C 2		
Cd 113m		8			Np 237	1.73E-06	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	1.24E-03	C C 2		
Sn 123		8			Pu 239	6.26E-04	C C 2		
Sn 126		8			Pu 240	5.64E-04	C C 2		
Sb 125		8			Pu 241	4.68E-03	C C 2		
Sb 126		8			Pu 242	6.49E-07	C C 2		
Te 125m		8			Am 241	8.20E-03	C C 2		
Te 127m		8			Am 242m		8		
I 129	1.18E-09	C C 2			Am 243		8		
Cs 134		8			Cm 242		8		
Cs 135		8			Cm 243		8		
Cs 137	1.67E-03	C C 2			Cm 244	5.47E-06	C C 2		
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		8			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151		8			Unsp a				
Eu 152	2.98E-06	C C 2			Unsp b/g				
Eu 154	1.52E-06	C C 2			Total a	1.12E-02	*	0	*
Eu 155		8			Total b/g	9.07E-03	*	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 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