

WASTE STREAM	6N01	Neutron Targets
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SITE Rutherford Appleton Laboratory

SITE OWNER UK Research and Innovation

WASTE CUSTODIAN UK Research and Innovation

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m ³)	OR	Conditioned (m ³)	Packaged (m ³)
Stocks:	At 1.4.2025	= 0.2		
Future arisings:	1.4.2025 - 31.3.2026	= 0		
	1.4.2026 - 31.3.2027	= 0.4		
	1.4.2027 - 31.3.2028	= 0		
	1.4.2028 - 31.3.2045	~ 1.2		
Total future arisings:		1.6		
Total waste volume:		1.8		

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

Comment on arising rates: 3x TS2 targets (0.01m3 unprocessed) will be added to the inventory during 2026. Currently the new TS1 target which has been in use since 2022 is working well, predicted removal during 2027 so have accounted for that in 2027/28.

Additional information on quantities: Good certainty of TS2 targets as they fail around every 2 years. Uncertainty on the duration of the new TS1 target.

Uncertainty factors on volumes: Stock (upper): x 1.00 Arisings (upper): x 10.00
Stock (lower): x 0.10 Arisings (lower): x 0.10

WASTE SOURCE ISIS is a government-funded, working pulsed neutron spallation source which provides neutron (and muon) beams for research work. The neutrons are produced by bombarding a tantalum-clad tungsten target with protons. This waste stream is the waste neutron spallation targets from both of the ISIS target stations.

PHYSICAL CHARACTERISTICS

General description: Intact tungsten metal neutron spallation sources with tantalum metal cladding, disconnected from their cooling-water circuits and drained of the cooling water.

Changes since waste generated: This material is essentially the same as it was pre-irradiation other than the presence of activation products. Solid metallic tungsten with smaller quantities of tantalum metal.

Bulk density (t/m³): ~ 1.1

Comment on density: Calculated taking into account the 0.2 m3 canister and not based on the density of tungsten as previous years, average of the three types of target- old TS1, new TS1 and TS2.

CHEMICAL COMPOSITION

General description and components (%wt): -

Chemical state: -

Sheet metal proportion / thickness: -

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel.....	~ 68.0	Mainly 304 grade plus 316 grade	
Other ferrous metals.....	0	-	
Iron.....	0	-	
Aluminium.....	~ 0.10	Al alloy 5083	
Beryllium.....	0	-	
Cobalt.....	0	-	
Copper.....	0	-	
Lead.....	0	-	
Magnox/Magnesium.....	0	-	
Nickel.....	0	-	
Titanium.....	0	-	
Uranium.....	0	-	
Zinc.....	0	-	
Zircaloy/Zirconium.....	0	-	
Other metals.....	~ 31.9	Tungsten and tantalum	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulotics.....	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):

	(%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.....	0	-	
Glass/Ceramics.....	0	-	
Graphite.....	0	-	
Desiccants/Catalysts.....	0	-	
Asbestos.....	0	-	
Non/low friable.....	0	-	
Moderately friable.....	0	-	
Highly friable.....	0	-	
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.....	0	-
Corrosive materials.....	0	-
Pyrophoric materials.....	0	-
Generating toxic gases.....	0	-
Reacting with water.....	0	-
Higher activity particles.....	0	-
Soluble solids as bulk chemical compounds.....	0	-

Hazardous substances / non hazardous pollutants:

-

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

Complexing agents (%wt):

No

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

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:

-

Conditioning plants:

Plant Name	Location

Likely conditioning matrix:

None

Further information on the conditioning matrix:

-

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
MBGWS box	100.0	1.8	1.8	1	-

Range in container waste loading:

Other information on packaging and conditioning:

-

Conditioned density (t/m³):

-

Conditioned density comment:

-

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)			
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: Proton beam colliding with metals in the targets.
Future arisings are average of TS1/TS2 activation calculations

Uncertainty: All activities are calculated not measured. Volumes of waste are very small but there is a large % uncertainty on the exact volume of each waste target used for these calculations. The targets do not exceed 200 litres as one TS1 current and new design target fits into a 200 litre can for transport and 3 x TS2 targets will fit into another 200 litre can. The minimum volumes may be as low as TS1 target 20 litres and TS2 targets 10 litres.

Measurement of radioactivities: Calculations from MCNPX and CINDER90 programs. The specific activities for target arisings from the 2 target stations are different, but for this submission have been blended into one fingerprint. Current holdings based on the last former TS1 target which was removed in 2021.

Chemical form of radionuclides: H-3: Bound into the metal
C-14: -
Cl-36: -
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: -
Np: -
Pu: -

WASTE STREAM 6N01 Neutron Targets									
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	1.26E+02	C C 2	9.27E+01	C C 2	Gd 153	5.64E-01	C C 2	2.64E+01	C C 2
Be 10					Ho 163	5.47E-02	C C 2	2.96E-02	C C 2
C 14					Ho 166m				
Na 22	6.18E-02	C C 2	4.89E-02	C C 2	Tm 170	5.58E-04	C C 2	1.02E+00	C C 2
Al 26					Tm 171	4.96E-02	C C 2	1.49E-01	C C 2
Cl 36					Lu 174	3.94E+00	C C 2	5.72E+00	C C 2
Ar 39	1.26E-02	C C 2			Lu 176				
Ar 42					Hf 178n				
K 40					Hf 182				
Ca 41					Pt 193				
Mn 53					Ti 204				
Mn 54	3.17E+00	C C 2	2.42E+01	C C 2	Pb 205				
Fe 55	4.66E+01	C C 2	4.17E+01	C C 2	Pb 210				
Co 60	1.13E+00	C C 2	8.37E-01	C C 2	Bi 208				
Ni 59					Bi 210m				
Ni 63	9.54E-01	C C 2	4.01E-01	C C 2	Po 210				
Zn 65	2.63E-03	C C 2	1.02E-01	C C 2	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85	8.29E-02	C C 2	1.45E-01	C C 2	Ra 228				
Rb 87					Ac 227				
Sr 90	1.39E-02	C C 2	1.20E-02	C C 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106	1.90E-03	C C 2	9.94E-03	C C 2	U 233				
Pd 107					U 234				
Ag 108m					U 235				
Ag 110m					U 236				
Cd 109	6.34E-03	C C 2	3.63E-02	C C 2	U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
Sn 126					Pu 240				
Sb 125					Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134					Cm 242				
Cs 135					Cm 243				
Cs 137					Cm 244				
Ba 133	5.86E-01	C C 2	4.97E-01	C C 2	Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145	5.60E+00	C C 2	3.79E+00	C C 2	Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Unsp a	2.10E+00	C C 2	2.48E+00	C C 2
Eu 152	1.02E-01	C C 2	1.57E-01	C C 2	Unsp b/g	1.63E+02	C C 2	2.04E+04	C C 2
Eu 154	3.32E-02	C C 2	4.75E-02	C C 2	Total a	2.10E+00	*	2.48E+00	*
Eu 155					Total b/g	3.52E+02	*	2.06E+04	*

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