WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

SITE Culham

SITE OWNER United Kingdom Atomic Energy Authority

WASTE CUSTODIAN United Kingdom Atomic Energy Authority

WASTE TYPE LLW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m^3
Future arisings -	1.4.2024 - 31.3.2027.....	137.0 m^3
Total future arisings:		137.0 m^3
Total waste volume:		137.0 m^3

Comment on volumes: This waste is from decommissioning so the annual arisings will vary with the plans and progress. These have yet to be developed as the JET facilities are still operational. It is assumed that the JET Experimental Programme is completed at the end of 2023. Decommissioning on this basis starts in 2024. It is planned that decommissioning will be completed at the end of 2033.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 2.0
Stock (lower):	x	Arisings (lower)	x 0.5

WASTE SOURCE The waste arises from JET decommissioning activities.

PHYSICAL CHARACTERISTICS

General description: The waste comprises redundant equipment made from many materials including stainless steel, copper and inconel, associated with the JET experimental machine and surrounding plant. Equipment will be a mix of large and small items, i.e. poloidal field coils, transformer core. All large items will be size reduced in order to be accommodated within ISO waste containers. The proportion and form of the tritium in the components is not currently known. It is expected that waste will be processed on-site as per operational activated LLW by size reduction. Exact processing methods are to be determined.

Physical components (%wt): Poloidal field coils (~11.6 %), transformer core (~72 %), internal mechanical structure (~4.5 %), external mechanical structure (~6.9%), secondary waste (~5%).

Sealed sources: Not yet determined.

Bulk density (t/m^3): ~4

Comment on density: Density range of materials in stream varies from 1.9 to 8.2 t/m^3. The bulk density assumes 50% voidage.

CHEMICAL COMPOSITION

General description and components (%wt): Iron (~67%), stainless steel (~8%), copper (~8%), GGG steel (~6%), secondary waste (~5%), Inconel (~5%), resin (~1%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Mainly outgassed tritium present in the form of tritiated water vapour, and some absorbed into material surfaces.

Metals and alloys (%wt): Metallic content is in the form of equipment and plant items with thicknesses ranging from a few mm to metres. There might be some sheet material from ventilation ducting.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~8.0	316 ~75%, other grades ~25%.	
Other ferrous metals.....	~63.0	GGG Steel.	
Iron.....	~10.0		
Aluminium.....	P		
Beryllium.....	<0.10		
Cobalt.....	TR	As part of specialist alloys.	

WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

Copper	~8.0	
Lead	TR	
Magnox/Magnesium	TR	As part of specialist alloys.
Nickel	~5.0	Inconel 600, Inconel 625.
Titanium	TR	
Uranium	0	
Zinc	P	
Zircaloy/Zirconium	TR	Not expected but may be present as part of specialist alloys.
Other metals	TR	Small quantities of silver and other metals may be present.

Organics (%wt): The organic materials will include cable insulation and rubber hoses and insulation, epoxy resins and wood (roof panels in the torus hall). The extent of organic materials is not estimated. This stream will contain secondary waste from the decommissioning operational work. Total organics and other materials ~~6% including secondary waste arisings.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	P		
Paper, cotton	P		
Wood	P		
Halogenated plastics	P		
Total non-halogenated plastics	P		
Condensation polymers	P		
Others	P		
Organic ion exchange materials	P		
Total rubber	P		
Halogenated rubber	P		
Non-halogenated rubber	P		
Hydrocarbons	TR		
Oil or grease	TR		
Fuel	0		
Asphalt/Tarmac (cont.coal tar)	0		
Asphalt/Tarmac (no coal tar)	0		
Bitumen	0		
Others	0		
Other organics	P		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	P		
Soil	0		
Brick/Stone/Rubble	P		
Cementitious material	P		
Sand	P		
Glass/Ceramics	P		

WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

Graphite	P	
Desiccants/Catalysts	TR	
Asbestos	TR	May be present in individual packages at trace levels.
Non/low friable	TR	
Moderately friable	TR	
Highly friable	TR	
Free aqueous liquids	0	
Free non-aqueous liquids	0	
Powder/Ash	0	

Inorganic anions (%wt): The inorganic anion content will be assessed more accurately in future although no significant quantities are expected.

	(%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: Beryllium dust is typically present at < 0.1% by weight, solid beryllium may be present in individual packages above 0.1%. Low flash point liquids may be present in trace amounts from specific experiments.

	(%wt)	Type(s) and comment
Combustible metals	0	
Low flash point liquids	P	
Explosive materials	0	
Phosphorus	0	
Hydrides	0	
Biological etc. materials	0	
Biodegradable materials	0	
Putrescible wastes	P	
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	

WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

Hazardous substances / non hazardous pollutants: The existence of toxic metals will be assessed in the future. The JET machine uses beryllium so it is likely that some of the waste contains beryllium. There might also be lead from the diagnostics if it becomes contaminated. Be/ Pb content will need to be assessed.

	(%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	P	Potentially present in trace amounts as arsenides in specialist semiconductors / electronics.
Barium	0	
Boron	P	Included as boronated concrete.
Boron (in Boral)	0	
Boron (non-Boral)	P	
Cadmium	P	Potentially present in trace amounts in specialist semiconductors / electronics / solders.
Caesium	0	
Selenium	0	
Chromium	P	Included in specialist steels.
Molybdenum	P	Included in specialist steels.
Thallium	0	
Tin	P	Included in solders.
Vanadium	P	Included in specialist steels.
Mercury compounds	0	
Others	P	
Electronic Electrical Equipment (EEE)		
EEE Type 1	P	
EEE Type 2	P	
EEE Type 3	P	
EEE Type 4	0	
EEE Type 5	P	

Complexing agents (%wt): Not yet determined

	(%wt)	Type(s) and comment
EDTA	0	
DPTA	0	
NTA	0	
Polycarboxylic acids	TR	

Other organic complexants.....	TR	None expected from the primary waste stream but there may be some from secondary waste (e.g. protective clothing, swabs, cleaning materials).
Total complexing agents.....	TR	

Potential for the waste to contain discrete items: Yes.

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	On-site	~~5.0
Supercompaction (HFC)		~~15.0
Incineration		
Solidification		
Decontamination		
Metal treatment		
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		~~80.0

Comment on planned treatments: Treatment methods will depend on the exact nature of the waste which is not known at this stage. It is expected that the majority of secondary waste and organics will be compacted on-site prior to disposal for incineration.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~~15.0	
Expected to be consigned to a Landfill Facility	~~78.0	
Expected to be consigned to an On-Site Disposal Facility		
Expected to be consigned to an Incineration Facility	~~7.0	
Expected to be consigned to a Metal Treatment Facility		
Expected to be consigned as Out of Scope		
Expected to be recycled / reused		
Disposal route not known		

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

Upcoming (2022/23-2024/25) Waste Routing (if expected to change from above):

Disposal Route	Stream volume %		
	2022/23	2023/24	2024/25
Expected to be consigned to the LLW Repository			
Expected to be consigned to a Landfill Facility			
Expected to be consigned to an On-Site Disposal Facility			
Expected to be consigned to an Incineration Facility			
Expected to be consigned to a Metal Treatment Facility			
Expected to be consigned as Out of Scope			
Expected to be recycled / reused			
Disposal route not known			

Opportunities for alternative disposal routing: -

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

Waste Packaging for Disposal:

Container	Stream volume %	Waste loading m³	Number of packages
1/3 Height IP-1 ISO 2/3 Height IP-2 ISO 1/2 Height WAMAC IP-2 ISO 1/2 Height IP-2 Disposal/Re-usable ISO 2m box (no shielding) 4m box (no shielding) Other	~~15.0	~~14.5	2

Other information: -

Waste Planned for Disposal at the LLW Repository:

Container voidage: Expected to be <10%. No data available.

Waste Characterisation Form (WCH): It is not yet determined if the waste meets LLWR's Waste Acceptance Criteria (WAC).

Waste consigned for disposal to LLWR in year of generation: Yes.

Non-Containerised Waste for In-Vault Grouting: (Not applicable to this waste stream)

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

RADIOACTIVITY

Source: Source of radioactivity is activation from neutron irradiation and contamination from tritium.

Uncertainty: This waste will come from a plant which is still operational so the detailed information is not available.

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: Calculated with the FISPACT code and validated by sampling and analysis. Specific tritium cannot be determined until the end of the JET project. Sampling and measurement will be used to characterise this waste.

Other information: -

WASTE STREAM 5H304 JET Decommissioning Tritiated Activated LLW

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3				7	Gd 153				
Be 10					Ho 163				
C 14			~3.1E-06	A D 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			6.4E-06	A D 2	Pb 205				
Fe 55			1.7E-02	A D 2	Pb 210				
Co 60			7.7E-03	A D 2	Bi 208				
Ni 59			1.2E-03	A D 2	Bi 210m				
Ni 63			6.3E-03	A D 2	Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					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					U 233				
Pd 107					U 234				
Ag 108m			7.7E-05	A D 2	U 235				
Ag 110m			1.7E-06	A D 2	U 236				
Cd 109					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					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g			3.1E-06	A D 2
Eu 154					**Total a**	**0**		**NE**	**8**
Eu 155					**Total b/g**	**0**		**3.23E-02**	**A D 2**

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