

<b>WASTE STREAM</b>	<b>6N05</b>	<b>Copper</b>
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**SITE** Rutherford Appleton Laboratory

**SITE OWNER** Minor Waste Producers

**WASTE CUSTODIAN** Minor Waste Producers

**WASTE TYPE** VLLW

Is the waste subject to Scottish Policy: No

**WASTE VOLUMES**

		Reported
Stocks:	At 1.4.2022.....	20.0 m <sup>3</sup>
Future arisings -	1.4.2022 - 31.3.2023.....	0.5 m <sup>3</sup>
	1.4.2023 - 31.3.2024.....	0.5 m <sup>3</sup>
	1.4.2024 - 31.3.2025.....	0.5 m <sup>3</sup>
	1.4.2025 - 31.3.2037.....	6.4 m <sup>3</sup>
Total future arisings:		8.0 m <sup>3</sup>
Total waste volume:		28.0 m <sup>3</sup>

Comment on volumes: Unpacked waste volumes based on weights and densities only. Volumes are not space occupied but the volume calculated from the weight and density of the items. Packing density will depend on packages used for disposal.

Uncertainty factors on volumes: Stock (upper): x 1.2 Arisings (upper) x 2.0  
 Stock (lower): x 0.8 Arisings (lower) x 0.5

**WASTE SOURCE** Large electro-magnet windings, bus bars and cables used at RAL in the ISIS neutron spallation source (currently running) and its predecessor, Nimrod (closed in 1978). Note: electrical insulation but no asbestos.

**PHYSICAL CHARACTERISTICS**

General description: Generally large pieces of metal (up to 1 te) with some size reduced. None  
 Physical components (%wt): Copper (~99%) Some resin, plastic or mica insulation on some pieces (~1%)  
 Sealed sources: The waste does not contain sealed sources.  
 Bulk density (t/m<sup>3</sup>): 8.9  
 Comment on density: Density of copper

**CHEMICAL COMPOSITION**

General description and components (%wt): High purity copper  
 Chemical state: Neutral  
 Chemical form of radionuclides: H-3: Bound within the activated metal.  
 Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	0		
Other ferrous metals.....	0		
Iron.....	0		
Aluminium.....	0		
Beryllium.....	0		
Cobalt.....	0		
Copper.....	100.0		
Lead.....	0		
Magnox/Magnesium.....	0		

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Nickel.....	0
Titanium.....	0
Uranium.....	0
Zinc.....	0
Zircaloy/Zirconium.....	0
Other metals.....	0

Organics (%wt):                      Some resin, plastic or mica insulation on some pieces

	(%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.....	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.....	<0.05	Mica resin	

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		

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Highly friable.....	0
Free aqueous liquids.....	0
Free non-aqueous liquids.....	0
Powder/Ash.....	0

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	

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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
Electronic Electrical Equipment (EEE)	
EEE Type 1.....	0
EEE Type 2.....	0
EEE Type 3.....	0
EEE Type 4.....	0
EEE Type 5.....	0

Complexing agents (%wt):      No

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

Potential for the waste to contain discrete items:      Yes. Some large copper items including dipole coils.

**TREATMENT, PACKAGING AND DISPOSAL**

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

Treatment	On-site / Off site	Stream volume %
Low force compaction	Off-site	<1.0
Supercompaction (HFC)		
Incineration		
Solidification	Off-site	~20.0
Decontamination		
Metal treatment	Off-site	~20.0
Size reduction	On-site	~20.0
Decay storage	On-site	~20.0
Recycling / reuse		NE
Other / various		
None		~39.0

Comment on planned treatments:

Smelting trial underway for very low specific activity material but this is a very small subsection of this wastestream. Delay and decay timescales too long for majority of wastestream given our storage capacity and our EA permit accumulation times.

**Disposal Routes:**

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~54.0	~8.9
Expected to be consigned to a Landfill Facility		
Expected to be consigned to an On-Site Disposal Facility	3.0	~8.9
Expected to be consigned to an Incineration Facility		
Expected to be consigned to a Metal Treatment Facility	43.0	~8.9
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 Packaging for Disposal:** (Not applicable to this waste stream)

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Container	Stream volume %	Waste loading m <sup>3</sup>	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			

Other information: -

**Waste Planned for Disposal at the LLW Repository:** (Not applicable to this waste stream)

Container voidage: -

Waste Characterisation Form (WCH): -

Waste consigned for disposal to LLWR in year of generation: -

**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: Activation of copper components by high energy protons and neutrons.

Uncertainty: Activation is often non-homogenous for many components and thus averaged values are quoted. The specific activity of small portions could be 1000's of times higher than the average.

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: Gamma-spec and sampling followed by destructive analysis for Ni-63

Other information: -

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Nuclide	Mean radioactivity, TBq/m <sup>3</sup>				Nuclide	Mean radioactivity, TBq/m <sup>3</sup>			
	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	~4.8E-05	BB 2	~4.8E-05	BB 2	Gd 153				4
Be 10		4		4	Ho 163				4
C 14		4		4	Ho 166m				4
Na 22		4		4	Tm 170				4
Al 26		4		4	Tm 171				4
Cl 36		4		4	Lu 174				4
Ar 39		4		4	Lu 176				4
Ar 42		4		4	Hf 178n				4
K 40		4		4	Hf 182				4
Ca 41		4		4	Pt 193				4
Mn 53		4		4	Tl 204				4
Mn 54		5		5	Pb 205				4
Fe 55	~2.4E-05	BB 2	~2.4E-05	BB 2	Pb 210				4
Co 60	~1.2E-04	BB 2	~1.2E-04	BB 2	Bi 208				4
Ni 59		4		4	Bi 210m				4
Ni 63	~1.8E-03	BB 2	~1.8E-03	BB 2	Po 210				4
Zn 65		4		4	Ra 223				4
Se 79		4		4	Ra 225				4
Kr 81		4		4	Ra 226				4
Kr 85		4		4	Ra 228				4
Rb 87		4		4	Ac 227				4
Sr 90		4		4	Th 227				4
Zr 93		4		4	Th 228				4
Nb 91		4		4	Th 229				4
Nb 92		4		4	Th 230				4
Nb 93m		4		4	Th 232				4
Nb 94		4		4	Th 234				4
Mo 93		4		4	Pa 231				4
Tc 97		4		4	Pa 233				4
Tc 99		4		4	U 232				4
Ru 106		4		4	U 233				4
Pd 107		4		4	U 234				4
Ag 108m		4		4	U 235				4
Ag 110m		4		4	U 236				4
Cd 109		4		4	U 238				4
Cd 113m		4		4	Np 237				4
Sn 119m		4		4	Pu 236				4
Sn 121m		4		4	Pu 238				4
Sn 123		4		4	Pu 239				4
Sn 126		4		4	Pu 240				4
Sb 125		4		4	Pu 241				4
Sb 126		4		4	Pu 242				4
Te 125m		4		4	Am 241				4
Te 127m		4		4	Am 242m				4
I 129		4		4	Am 243				4
Cs 134		4		4	Cm 242				4
Cs 135		4		4	Cm 243				4
Cs 137		4		4	Cm 244				4
Ba 133		4		4	Cm 245				4
La 137		4		4	Cm 246				4
La 138		4		4	Cm 248				4
Ce 144		4		4	Cf 249				4
Pm 145		4		4	Cf 250				4
Pm 147		4		4	Cf 251				4
Sm 147		4		4	Cf 252				4
Sm 151		4		4	Other a				4
Eu 152		4		4	Other b/g				4
Eu 154		4		4	<b>Total a</b>	<b>0</b>	<b>8</b>	<b>0</b>	<b>8</b>
Eu 155		4		4	<b>Total b/g</b>	<b>~1.99E-03</b>	<b>BB 2</b>	<b>1.99E-03</b>	<b>BB 2</b>

**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