

WASTE STREAM	6N07	Mixed Metallic
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SITE Rutherford Appleton Laboratory

SITE OWNER Minor Waste Producers

WASTE CUSTODIAN Minor Waste Producers

WASTE TYPE LLW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	121.0 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	7.6 m ³
	1.4.2023 - 31.3.2024.....	7.6 m ³
	1.4.2024 - 31.3.2025.....	7.6 m ³
	1.4.2025 - 31.3.2037.....	90.7 m ³
Total future arisings:		113.4 m ³
Total waste volume:		234.4 m ³

Comment on volumes: 7.56m3 per year arising rate for operational wastes (2013-2020). Arisings during 2021/22 have been omitted due to a long shutdown producing greater volumes of waste in this category. Assumed that rate of arising will be the same as 2013-2020. Volumes are from material densities; wastes are currently not packaged nor significantly processed.

Uncertainty factors on volumes: Stock (upper): x 1.5 Arisings (upper) x 2.0
 Stock (lower): x 0.8 Arisings (lower) x 0.5

WASTE SOURCE ISIS neutron spallation source and its predecessor, Nimrod.

PHYSICAL CHARACTERISTICS

General description: Failed and redundant components used to speed-up, guide and shield from high-energy proton beam and associated neutrons. Solid, dry metals.

Physical components (%wt): Electromagnets, ferrous metal shielding blocks, structural components (frames, trolleys etc.), cooling water pipes and mixed other components (100%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~7.7

Comment on density: Bulk density is that of iron/steel, which dominates the waste stream. Bulk density of waste packages will be substantially lower.

CHEMICAL COMPOSITION

General description and components (%wt): -

Chemical state: Neutral

Chemical form of radionuclides: H-3: Produced within metal during activation and some ingress into metals of pipes and storage barrels from tritiated water.

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~~40.0	304	
Other ferrous metals.....	~~30.0		
Iron.....	~~29.7		
Aluminium.....	~~0.10		
Beryllium.....	0		
Cobalt.....	0		
Copper.....	~~0.10		
Lead.....	~~0.01		

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Magnox/Magnesium.....	0
Nickel.....	<0.01
Titanium.....	0
Uranium.....	0
Zinc.....	P
Zircaloy/Zirconium.....	0
Other metals.....	~~0.01

Organics (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics.....	0		
Paper, cotton.....	0		
Wood.....	0		
Halogenated plastics	P		
Total non-halogenated plastics.....	0.05		
Condensation polymers.....	0		
Others.....	~~0.05		
Organic ion exchange materials....	0		
Total rubber.....	0		
Halogenated rubber	0		
Non-halogenated rubber.....	P		
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.....	P		
Graphite.....	P		
Desiccants/Catalysts.....	0		
Asbestos.....	0		
Non/low friable.....	0		

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Moderately friable.....	0
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	

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Formaldehyde.....	0	
Organometallics.....	0	
Phenol.....	0	
Styrene.....	0	
Tri-butyl phosphate.....	0	
Other organophosphates.....	0	
Vinyl chloride.....	0	
Arsenic.....	0	
Barium.....	0	
Boron.....	P	Wax containing boric acid inside steel blocks
Boron (in Boral).....		
Boron (non-Boral).....		
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.....	0	
DPTA.....	0	
NTA.....	0	
Polycarboxylic acids.....	0	
Other organic complexants.....	0	
Total complexing agents.....		

Potential for the waste to contain discrete items: Yes. Robust material items

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TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction Supercompaction (HFC) Incineration Solidification Decontamination Metal treatment Size reduction Decay storage Recycling / reuse Other / various None	On-site	~100.0

Comment on planned treatments:

Not assessed.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~~20.0	~~7.7
Expected to be consigned to a Landfill Facility	~~80.0	~~7.7
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		

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		~40.0	~20.0
Expected to be consigned to a Landfill Facility	~100.0	~60.0	~80.0
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:

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Container	Stream volume %	Waste loading m ³	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: Not yet determined

Waste Planned for Disposal at the LLW Repository:

Container voidage: Not yet determined

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

Not yet determined

Waste consigned for disposal to LLWR in year of generation: No. Decay period before consignment.

Non-Containerised Waste for In-Vault Grouting:

Stream volume (%): -

Waste stream variation: -

Bounding cuboidal volume:

Inaccessible voidage: -

Other information: -

RADIOACTIVITY

Source: Activation by high-energy protons and neutrons.

Uncertainty: Wastes are largely uncharacterised but the current holding are dominated by old wastes (>35 years old) which have mainly Co-60 in the fingerprint and the more recent arisings show higher specific activities and a greater abundance of radionuclides.

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-spectrometry and selected destructive analysis of sub-samples.

Other information: -

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Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	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	~-2.33E-05	AB 2	~-1.57E-05	AC 3	Gd 153				
Be 10					Ho 163				
C 14	4.32E-07	AB 2			Ho 166m				
Na 22	~-1.74E-04	DD 2	~-5E-04	DD 2	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	~-2.94E-05	DA 2	~-8.79E-04	DA 3	Pb 205				
Fe 55	~-4.02E-03	BA 2	~-7.59E-03	BA 3	Pb 210				
Co 60	~-2.48E-04	AA 2	~-2.48E-04	AA 3	Bi 208				
Ni 59					Bi 210m				
Ni 63	~-2.55E-04	DD 2	~-5E-04	DD 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					U 235				
Ag 110m					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				
Eu 154					Total a				
Eu 155					Total b/g	~-4.75E-03	CA 2	~-9.73E-03	DD 3

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