

WASTE STREAM	6N04	Near Beam Metallic
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SITE Rutherford Appleton Laboratory

SITE OWNER Minor Waste Producers

WASTE CUSTODIAN Minor Waste Producers

WASTE TYPE ILW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	~6.9 m ³
Future arisings -	1.4.2022 - 31.3.2023.....	~1.7 m ³
	1.4.2023 - 31.3.2024.....	0.5 m ³
	1.4.2024 - 31.3.2025.....	0.5 m ³
	1.4.2025 - 31.3.2037.....	6.4 m ³
Total future arisings:		9.1 m ³
Total waste volume:		16.0 m ³

Comment on volumes: Arising rates taken from average of arisings between the years 2013 and 2019 (incl.). 2020-2022 not included due to a long shutdown increase of arising which is not typical of ISIS. 2022/23 arisings include known formation of additional 1.7m³ of waste. Volumes are from weights and densities so the true, unprocessed and unpackaged volumes will be considerably higher. These wastes remain uncharacterised by measurement as many are difficult to access due to dose rates associated with the wastes. The data reported are from modelling.

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

WASTE SOURCE ISIS neutron spallation activation from areas close to the target and the high-energy proton beam.

PHYSICAL CHARACTERISTICS

General description: Mixed highly activated metal components. Mostly structural steel components. Very small contribution of graphite from intermediate targets used for muon production. These are a separately stored sub-wastestream. Metallic solids

Physical components (%wt): stainless steel (75.5%), other ferrous metals (20%), copper (2%), aluminium (2%) and other metals (phosphor bronze) (0.5%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~7.8

Comment on density: Mostly steel.

CHEMICAL COMPOSITION

General description and components (%wt): -

Chemical state: Neutral

Chemical form of radionuclides: H-3: produced within metals
C-14: produced within metals

Metals and alloys (%wt): -

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~75.5	304	
Other ferrous metals.....	~20.0	unknown	
Iron.....	0		
Aluminium.....	~2.0	5083	
Beryllium.....	0		

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Cobalt.....	0
Copper.....	~~2.0
Lead.....	0
Magnox/Magnesium.....	0
Nickel.....	P
Titanium.....	0
Uranium.....	0
Zinc.....	0
Zircaloy/Zirconium.....	0
Other metals.....	~~0.50 Phosphor bronze

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.....	0.01		
Halogenated rubber	0		
Non-halogenated rubber.....	0.01	EPDM rubber seals & Silicon-rubber seals	
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.....	~~0.50	ceramic insulators	
Graphite.....	<0.01		

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Desiccants/Catalysts.....	0
Asbestos.....	TR
Non/low friable.....	TR
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	

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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.....	~0.01	
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.....		

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Potential for the waste to contain discrete items: Yes. Various stainless steel (resistant) components which are of irregular design.

PACKAGING AND CONDITIONING

Conditioning method: Not yet assessed

Plant Name: -

Location: -

Plant startup date: -

Total capacity (m³/y incoming waste): -

Target start date for packaging this stream: -

Throughput for this stream (m³/y incoming waste): -

Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	Not specified	NE	NE	NE	NE

Likely container type comment: -

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix: -

Other information: -

Conditioned density (t/m³): -

Conditioned density comment: -

Other information on conditioning: -

Opportunities for alternative disposal routing: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Disposal at a Geological Disposal Facility	Disposal at a Near Surface / Near Site Disposal Facility	NE	-	Low	-
Disposal at a Geological Disposal Facility	Disposal at LLWR	NE		High	Potential for decay storage to divert fraction of waste away from GDF. Currently limited by EA permit compliance.

RADIOACTIVITY

Source: Activation

Uncertainty: Uncertainty arises due to a range of possible activation identified by activation calculations and there is ongoing work to improve estimates.

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Definition of total alpha and total beta/gamma:

Not all nuclides present in the fingerprint are listed.

Measurement of radioactivities:

Activity concentration of a subset of the wastes measured and taken to be representative of total waste stream. Co-60 measured through dose rate measurements, remaining nuclides modelled and inferred through the Co-60 assessment based on dose rate.

Other information:

Other nuclides >1% concentration include Cr-51, Co-56, Co-58, V-49, Ce-141, Sc-46, W-185 and Be-7.

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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	1.16E+01	DB 2	1.16E+01	DB 2	Gd 153		8		8
Be 10		4		4	Ho 163		4		4
C 14		6		6	Ho 166m		4		4
Na 22		8		8	Tm 170		4		4
Al 26		4		4	Tm 171		4		4
Cl 36		4		4	Lu 174		4		4
Ar 39		4		4	Lu 176		4		4
Ar 42		4		4	Hf 178n		4		4
K 40		4		4	Hf 182		4		4
Ca 41		4		4	Pt 193		4		4
Mn 53		4		4	Tl 204		4		4
Mn 54	1.8E+02	DC 2	1.8E+02	DC 2	Pb 205		4		4
Fe 55	4.42E+02	DC 2	4.42E+02	DC 2	Pb 210		4		4
Co 60	4.25E+01	AA 2	4.25E+01	AA 2	Bi 208		4		4
Ni 59		4		4	Bi 210m		4		4
Ni 63	4.55E+00	DC 2	4.55E+00	DC 2	Po 210		4		4
Zn 65	1.15E+01	DC 2	1.15E+01	DC 2	Ra 223		4		4
Se 79		4		4	Ra 225		4		4
Kr 81		4		4	Ra 226		4		4
Kr 85		4		4	Ra 228		4		4
Rb 87		4		4	Ac 227		4		4
Sr 90		4		4	Th 227		4		4
Zr 93		4		4	Th 228		4		4
Nb 91		4		4	Th 229		4		4
Nb 92		4		4	Th 230		4		4
Nb 93m		4		4	Th 232		4		4
Nb 94		4		4	Th 234		4		4
Mo 93		4		4	Pa 231		4		4
Tc 97		4		4	Pa 233		4		4
Tc 99		4		4	U 232		4		4
Ru 106		4		4	U 233		4		4
Pd 107		4		4	U 234		4		4
Ag 108m		8		8	U 235		4		4
Ag 110m		8		8	U 236		4		4
Cd 109		4		4	U 238		4		4
Cd 113m		4		4	Np 237		4		4
Sn 119m		4		4	Pu 236		4		4
Sn 121m		4		4	Pu 238		4		4
Sn 123		4		4	Pu 239		4		4
Sn 126		4		4	Pu 240		4		4
Sb 125		4		4	Pu 241		4		4
Sb 126		4		4	Pu 242		4		4
Te 125m		4		4	Am 241		4		4
Te 127m		4		4	Am 242m		4		4
I 129		4		4	Am 243		4		4
Cs 134		4		4	Cm 242		4		4
Cs 135		4		4	Cm 243		4		4
Cs 137		4		4	Cm 244		4		4
Ba 133		4		4	Cm 245		4		4
La 137		4		4	Cm 246		4		4
La 138		4		4	Cm 248		4		4
Ce 144		4		4	Cf 249		4		4
Pm 145		4		4	Cf 250		4		4
Pm 147		4		4	Cf 251		4		4
Sm 147		4		4	Cf 252		4		4
Sm 151		4		4	Other a		8		8
Eu 152		4		4	Other b/g	9.9E+01	DC 2	9.9E+01	DC 2
Eu 154		4		4	Total a	0	8	0	8
Eu 155		4		4	Total b/g	7.92E+02	DC 2	7.92E+02	DC 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