WASTE STREAM 6N06 Shutters

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.....	13.8 m^3
Future arisings -	1.4.2022 - 31.3.2023.....	0.6 m^3
	1.4.2023 - 31.3.2024.....	0.6 m^3
	1.4.2024 - 31.3.2025.....	0.6 m^3
	1.4.2025 - 31.3.2037.....	12.9 m^3
Total future arisings:		14.8 m^3
Total waste volume:		28.6 m^3

Comment on volumes: From 1996 to 2017, 14 waste shutters and beam-line plugs became waste as new beam-lines were opened or the internal collimation/beam-guides were changed to meet changing user requirements. It is hard to predict future arisings but it has been assumed that the rate of arisings will be similar to that experienced thus far. Also, there is a programme to upgrade various beamlines so the predicted arising until 2037 decommissioning date has been increased to account for this programme. Current holdings as at the report date is 15 shutter or beam-line plug sections and 6 shutter location pins. All items are not size reduced nor packaged and the shutters and plugs weigh between 1.5 te to 7 te each, with the steel pins weighing only 20-25kg each. The number of items is well known but the volume uncertainty comes from the assumptions made relating to the density of the iron and concrete shutters.

Uncertainty factors on volumes:				
	Stock (upper):	x 1.2	Arisings (upper)	x 1.5
	Stock (lower):	x 0.8	Arisings (lower)	x 0.5

WASTE SOURCE ISIS neutron spallation source, these components shield users from the neutron beam as samples are changed or plug a gap in the shielding around the neutron source that can be removed to make a new beam-line.

PHYSICAL CHARACTERISTICS

General description:	Large metal and concrete items with narrow face towards the neutrons and of 2 metres in length. It has a beam-guide in the centre that may contain glass and resin material. One face is routinely hit by neutrons when the beam is on and thus becomes highly activated and the other face is lightly activated if at all. Solid, dry metal and concrete items with beam-guide in centre that may contain glass and resin material.
Physical components (%wt):	Approx. mild steel (70%), shot-loaded concrete (25%) and stainless steel (5%), with other materials in beam-guide.
Sealed sources:	The waste does not contain sealed sources.
Bulk density (t/m^3):	~7.8
Comment on density:	Nominal density of steel used for inventory assessment

CHEMICAL COMPOSITION

General description and components (%wt):	-
Chemical state:	-
Chemical form of radionuclides:	H-3: Within steel/concrete matrix
Metals and alloys (%wt):	-

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	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	5.0		
Other ferrous metals	~70.0	Grade unknown	
Iron	0		
Aluminium	TR	Small qauntities of aluminum within some collimators	
Beryllium	0		
Cobalt	0		
Copper	0		
Lead	0		
Magnox/Magnesium	0		
Nickel	0		
Titanium	0		
Uranium	0		
Zinc	0		
Zircaloy/Zirconium	0		
Other metals	TR	Small qauntities of other metals within collimators and vacuum fittings	

Organics (%wt): -

	(%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		

Other materials (%wt): -

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	(%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.....	~25.0	Mixture of steel shot loaded concrete and concreat with steel structure	
Sand.....	0		
Glass/Ceramics.....	NE		
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		

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	

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

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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. Shutters are constructed of robust materials.

TREATMENT, PACKAGING AND DISPOSAL

Waste that is currently ILW: Radioactive decay storage and segregation of higher activity areas Variable, decay storage 15 - 40 years required

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	On-site	100.0
Decay storage	On-site	100.0
Recyling / reuse		
Other / various		
None		

Comment on planned treatments: Activity is highly inhomogeneous within the components. Decay storage and size reduction/segregation to separate and reduce the volume allows minimisation of waste to LLWR. Disposal Route fractions below are rough estimates. Small fraction may require disposal as HAW.

Disposal Routes:

Disposal Route	Stream volume %	Disposal density t/m3
Expected to be consigned to the LLW Repository	~~25.0	NE
Expected to be consigned to a Landfill Facility	~~70.0	~5.0
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	~~5.0	NE

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):

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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: Yes

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
Mixed Management Route	Recycle	NE	-	Low	Refurbishment and re-use of shutters for new experiments may reduce furture waste generation. But highly dependant on experimental schedule

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			

Other information: Not currently assessed

Waste Planned for Disposal at the LLW Repository:

Container voidage: -

-

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 by neutrons

Uncertainty: The activity of the shutters has been calculated from measurement of the dose-rate at the highest spot and calculating the activity across the item as if it where homogeneously activated. This is acknowledged as an over-estimate but tends to caution for initial

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	assessments. One lower activity shutter has been characterised to date and extrapolation from the pattern of the results has confirmed that the initial calculations are considerably high.
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-spectromery, dose rate measurements and analysis of drilled samples
Other information:	-

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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	~1.97E-02	DD 2	~1.97E-02	DD 2	Gd 153				
Be 10					Ho 163				
C 14	~8.05E-05	DD 2	~8.05E-05	DD 2	Ho 166m				
Na 22	~3.08E-03	DD 2	~3.08E-03	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	~5.47E-03	DD 2	~5.47E-03	DD 2	Pb 205				
Fe 55	~7.49E-01	DD 2	~7.49E-01	DD 2	Pb 210				
Co 60	~4.93E-02	DD 2	~4.93E-02	DD 2	Bi 208				
Ni 59					Bi 210m				
Ni 63					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	~9.24E-03	DD 2	~9.24E-03	DD 2	Other b/g				
Eu 154					**Total a**	**0**		**0**	
Eu 155					**Total b/g**	**~8.36E-01**	**DD 2**	**~8.36E-01**	**DD 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