SITE Chapelcross

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Magnox Limited

WASTE TYPE LLW

Is the waste subject to

Scottish Policy:

No

WASTE VOLUMES

Comment on volumes: -

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

WASTE SOURCE These (LLW) wastes arise from clean-out of the Chapelcross Processing Plant.

PHYSICAL CHARACTERISTICS

General description: Wastes from CXPP will include drummed soft waste, plastics, wood, approximately 20

boxed metal HEPA filters with aluminium mesh and paper inserts, bird droppings and bird carcasses (birds that get into buildings through open/damaged windows), tacky mats, PVC suits, oils, asbestos, liquid scintillation cocktails, liquid elemental mercury, metallic waste mainly generated from redundant equipment and plant items/tools (including pipework, motors, pumps, tanks, frames, benches, tools, scaffold tubes/fittings, electrical boxes, heaters, ducting, shielding), asphalt/tarmac/bitumen, glass from test equipment and process viewing windows, glazed ceramics from electrical insulation points and connectors and EEE, rubber adhered to redundant plant equipment and hoover bags. Hoover bags could be paper or cotton. Contents will typically include: concrete dust, metal swarf, wood shavings, plastics and asbestos (asbestos enclosure work only). It is estimated there could be approximately 100 kg over hoover bags over the lifetime of the WCH. The expected average bag weight is approximately 5-10kg. For oils, these are likely to be oils drained from machinery, residual grease on metal items and residual oil on rags/PPE. The liquid scintillation cocktails are compounds mixed with water used for the calibration of the CXPP liquid scintillation counters. The CXPP was a tritium processing facility and as such there are two contributing factors to the fingerprint in the building. The first is tritium and the second is the remaining $\alpha/\beta/\gamma$ component originating from the irradiated tritium production

cartridges sent to the CXPP from the reactors. The sampling method took into consideration these two contributing factors. The non-radiological properties of the waste

have been estimated from the materials composition.

Physical components (%wt): 72% metal, 1% concrete, 1% soil, 5% biodegradable, 1% plasterboard, 8 % plastics, 3%

rubber, 4% wood, 1% other organic, 4% others

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): ~1.41

Comment on density: Density calculated from WCH mass divided by volume.

CHEMICAL COMPOSITION

General description and components (%wt):

72% metal, 1% concrete, 1% soil, 5% biodegradable, 1% plasterboard, 8 % plastics, 3% rubber, 4% wood, 1% other organic, 4% others

Chemical state: Neutral

Chemical form of radionuclides:

H-3: Tritium is likely to be in the form of tritiated water absorbed into the concrete.

C-14: The chemical form of carbon 14 has not been determined. Se-79: The chemical form of selenium has not been determined. Tc-99: The chemical form of technetium has not been determined.

Ra: Radium isotope content is expected to be insignificant.

Th: The thorium content is insignificant.

U: Uranium isotope content is expected to be insignificant. Np: Neptunium isotope content is expected to be insignificant.

Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

Metals and alloys (%wt): This waste stream will contain waste of various sizes and thicknesses.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel	7.5	Metals deplanting and legacy metals (pipework, motors, pumps, tanks, frames, benches, tools, scaffold tubes/fittings, electrical boxes, heaters, ducting, shielding)	
Other ferrous metals	62.4	Metals deplanting and legacy metals (pipework, tanks, frames, benches, tools, scaffold tubes/fittings, electrical boxes, heaters, ducting, shielding	
Iron	0.75	Cast iron plant fittings: radiators, lights, brackets	
Aluminium	3.8	Scaffold poles, ladders, walkway sections and HEPA filters	
Beryllium			
Cobalt			
Copper	0		
Lead	0.75	Metals deplanting and legacy metals - lead blocks	
Magnox/Magnesium	0		
Nickel			
Titanium			
Uranium			
Zinc	0.09	Zinc oxide coating on galvanised scafold tubes, floor plates/grates, handrails	
Zircaloy/Zirconium	0		
Other metals	0		
Organics (%wt):			
	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	4.0		,
Paper, cotton	0		
Wood	4.0		
Halogenated plastics	0.45	Tacky mats, PVC Suits	
Total non-halogenated plastics	7.0		
Condensation polymers	7.0	soft wastes. Plastics from controlled area works	
Others	0		
Organic ion exchange materials	0		
Total rubber	3.0		
Halogenated rubber	1.5		
Non-halogenated rubber	1.5		
Hydrocarbons	0.24		
Oil or grease	0.22	radioactive oils	
Fuel			

Asphalt/Tarmac (cont.coal tar)	TR	Land Remediation	
Asphalt/Tarmac (no coal tar)	0.01	Land Remediation	
Bitumen	0.01	Land Remediation	
Others			
Other organics	2.7	Liquid scintillation cocktail	
Other materials (%wt):			
,			
	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0		
Soil	1.0		
Brick/Stone/Rubble	0		
Cementitious material	~1.0		
Sand			
Glass/Ceramics			
Graphite	0		
Desiccants/Catalysts			
Asbestos	0.84		
Non/low friable	0.84	Asbestos within gaskets, rope seals. Bulk will be Chrysotile (white asbestos) with smaller quantities of Crocidolite (blue) and Amosite (brown).	
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	NE		
Chloride	NE		
lodide	NE		
Cyanide	NE		
Carbonate	NE		
Nitrate	NE		
Nitrite	NE		
Phosphate	NE		
Sulphate	NE		
Sulphide	NE		
Materials of interest for - waste acceptance criteria:			

2022 Inventory

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	5.0	
Putrescible wastes	1.0	
Non-putrescible wastes	4.0	
Corrosive materials	0	
Pyrophoric materials	0	
Generating toxic gases	0	
Reacting with water	Р	2282m2
Higher activity particles		
Soluble solids as bulk chemical compounds		
substances / None expected dous pollutants:		
	(%wt)	Type(s) and comment
Acrylamide	,	,, ,,
Benzene		
Chlorinated solvents		
Formaldehyde		
Organometallics		
Phenol		
Styrene		
Tri-butyl phosphate		
Other organophosphates		
Vinyl chloride		
Arsenic		
Barium		
Boron	TR	Boronsilicate Glass (Boron 0.79kg of 6.04kg total)
Boron (in Boral)		
Boron (non-Boral)		
Cadmium		
Caesium		
Selenium		
Chromium		
Molybdenum		
Thallium		
Tin		

Vanadium		
Mercury compounds	0.36	Liquid Elemental Mercury from pump draining
Others	1.0	Plasterboard
Electronic Electrical Equipment (EEE))	
EEE Type 1	Р	400 Computers
EEE Type 2	Р	250 pumps, motors and electronic capacitators.
EEE Type 3	Р	50 corded drills
EEE Type 4	Р	200 Fluorescent light tubes
EEE Type 5	Р	125 rechargeable batteries
agents (%wt): No		
	(%wt)	Type(s) and comment
EDTA		
DPTA		
NTA		
Polycarboxylic acids		
Other organic complexants		
Total complexing agents	0	

Potential for the waste to contain discrete items:

Complexing

Yes. Large Metal Items (LMIs)/"substantial" thickness items considered

"durable" assumed DIs; Stainless items assumed DIs

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off site	Stream volume %
Low force compaction		
Supercompaction (HFC)		
Incineration	Off-site	62.8
Solidification		
Decontamination		
Metal treatment	Off-site	21.0
Size reduction		
Decay storage		
Recyling / reuse		
Other / various		
None		16.2

Comment on planned treatments:

It is expected that 16.18% of this waste stream will be sent to Landfill as VLLW and 0.04% is unknown at this time.

Disposal Routes:

Disposal Route		Stream	Disposal
	'	volume %	density t/m3
	Expected to be consigned to the LLW Repository		
	Expected to be consigned to a Landfill Facility	16.2	1.4
	Expected to be consigned to an On-Site Disposal Facility		
	Expected to be consigned to an Incineration Facility	62.8	0.40
	Expected to be consigned to a Metal Treatment Facility	21.0	1.4
	Expected to be consigned as Out of Scope		
	Expected to be recycled / reused		
	Disposal route not known	0.04	
	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	21.0	00

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

17 04 07, 17 02 03, 17 06 01*

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

Disposal Route	Stream volume %				
Disposal Notice	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 Opportunity Stream Date that Management Route Management Route volume (%) will be real	at Opportunity iity Confidence Comment
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Waste Packaging for Disposal: (Not applicable to this waste stream)

Container	Stream volume	Waste loading	Number of
	%	m³	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 and contamination of materials.

Uncertainty: Activity values are current best estimates. Specific activity is a function of operating history.

The values are indicative of the activities that would be expected.

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:

Activity data taken from waste stream WCH - $1MXN-1CHA-0-WCH-0-4687\ V7$ (activity ref date of 2020) with stocks decayed two years and future arisings three years for RWI 2022

Other information:

	Mean radioactivity, TBq/m³				Mean radioactivity, TBq/m³				
Nuclide	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3	3.46E-03	CC 1	3.27E-03	CC 1	Gd 153		8		8
Be 10		8		8	Ho 163		8		8
C 14	5.86E-05	CC 1	5.86E-05	CC 1	Ho 166m		8		8
Na 22		8		8	Tm 170		8		8
Al 26		8		8	Tm 171		8		8
CI 36	6.4E-08	CC 1	6.4E-08	CC 1	Lu 174		8		8
Ar 39		8		8	Lu 176		8		8
Ar 42		8		8	Hf 178n		8		8
K 40		8		8	Hf 182		8		8
Ca 41		8		8	Pt 193		8		8
Mn 53		8		8	TI 204		8		8
Mn 54		8		8	Pb 205		8		8
Fe 55	1.02E-05	CC 1	7.9E-06	CC 1	Pb 210		8		8
Co 60	1.15E-05	CC 2	1.01E-05	CC 2	Bi 208		8		8
Ni 59		8		8	Bi 210m		8		8
Ni 63	2.21E-05	CC 1	2.19E-05	CC 1	Po 210		8		8
Zn 65		8		8	Ra 223		8		8
Se 79		8		8	Ra 225		8	1.11E-09	CC 2
Kr 81		8		8	Ra 226		8		8
Kr 85		8		8	Ra 228		8		8
Rb 87		8		8	Ac 227		8		8
Sr 90	1.29E-06	CC 1	1.26E-06	CC 1	Th 227		8		8
Zr 93		8		8	Th 228	2.01E-07	CC 2	2.57E-07	CC 2
Nb 91		8		8	Th 229		8	1.13E-09	CC 2
Nb 92		8		8	Th 230		8		8
Nb 93m		8		8	Th 232		8		8
Nb 94		8		8	Th 234	3.56E-07	CC 2	3.56E-07	CC 2
Mo 93		8		8	Pa 231		8		8
Tc 97		8		8	Pa 233	2.12E-05	CC 2	2.12E-05	CC 2
Tc 99	8.05E-06	CC 1	8.05E-06	CC 1	U 232	3.86E-07	CC 2	3.82E-07	CC 2
Ru 106	2.26E-09	CC 2	1.14E-09	CC 2	U 233	3.99E-06	CC 2	3.99E-06	CC 2
Pd 107		8		8	U 234	1.5E-07	CC 2	1.5E-07	CC 2
Ag 108m		8		8	U 235	2.3E-08	CC 2	2.3E-08	CC 2
Ag 110m		8		8	U 236		8		8
Cd 109	1.22E-08	CC 2	7.07E-09	CC 2	U 238	3.56E-07	CC 2	3.56E-07	CC 2
Cd 113m		8		8	Np 237	2.12E-05	CC 2	2.12E-05	CC 2
Sn 119m		8		8	Pu 236		8		8
Sn 121m		8		8	Pu 238	6.7E-07	CC 1	6.65E-07	CC 1
Sn 123		8		8	Pu 239	6.43E-09	CC 1	6.43E-09	CC 1
Sn 126		8		8	Pu 240	8.55E-09	CC 1	8.58E-09	CC 1
Sb 125	4.36E-07	CC 2	3.39E-07	CC 2	Pu 241	5.83E-05	CC 1	5.56E-05	CC 1
Sb 126		8		8	Pu 242	4.69E-07	CC 2	4.69E-07	CC 2
Te 125m	1.09E-07	CC 2	8.5E-08	CC 2	Am 241	2.78E-06	CC 1	2.86E-06	CC 1
Te 127m		8		8	Am 242m		8		8
I 129	1.2E-05	CC 2	1.2E-05	CC 2	Am 243		8		8
Cs 134	2.85E-08	CC 2	2.04E-08	CC 2	Cm 242		8		8
Cs 135		8		8	Cm 243	1.56E-08	CC 1	1.52E-08	CC 1
Cs 137	1.17E-05	CC 2	1.14E-05	CC 2	Cm 244	3.19E-07	CC 1	3.07E-07	CC 1
Ba 133	2.04E-06	CC 2	1.91E-06	CC 2	Cm 245		8		8
La 137		8		8	Cm 246		8		8
La 138		8		8	Cm 248		8		8
Ce 144		8		8	Cf 249		8		8
Pm 145		8		8	Cf 250		8		8
Pm 147	6.9E-07	CC 1	5.29E-07	CC 1	Cf 251		8		8
Sm 147		8		8	Cf 252		8		8
Sm 151	5.23E-07	CC 1	5.19E-07	CC 1	Other a				
Eu 152	1.26E-07	CC 2	1.2E-07	CC 2	Other b/g				
Eu 154	3.16E-08	CC 2	2.91E-08	CC 2	Total a	3.06E-05	CC 2	3.07E-05	CC 2
Eu 155	7.36E-07	CC 2	6.38E-07	CC 2	Total b/g	3.68E-03	CC 2	3.48E-03	CC 2
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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