WASTE STREAM	9J23	Bunker Waste

SITE Hunterston A

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m^3)
Stocks: At 1.4.2025	= 595.4
Future arisings:	
Total future arisings:	**0.0**
Total waste volume:	**595.4**

OR

Conditioned (m^3)	Packaged (m^3)

Number of waste packages in stock: At 1.4.2025…… - packages

Comment on arising rates: -

Additional information on quantities: There will be no future arisings of this stream; the bunker is nominally full. The total waste volume is made up of the sum of FED Magnox 563.7m3, FED graphite 4m3, MCI 26.7m3, FED Fuel Channel Components 0.15m3 and MAC 0.8m3

Uncertainty factors on volumes:

Stock (upper):	x 1.20	Arisings (upper):	x -
Stock (lower):	x 0.70	Arisings (lower):	x -

WASTE SOURCE

FED Magnox - Fuel element debris, from the removal of Magnox splitters and buttons from discharged fuel elements.
FED Graphite - Fuel element debris from the removal of graphite sleeves from discharged fuel elements plus reflector sleeves from each fuel channel.
FED Fuel Channel components - The waste consists of components from reactor fuel assemblies.
MAC - The source of the waste is miscellaneous activated in-core components.
MCI - The source of the waste is redundant contaminated equipment and materials.

PHYSICAL CHARACTERISTICS

General description:

FED Magnox - The waste consists of splitters and buttons from discharged fuel elements. Each fuel element comprises a Magnox can with 4 splitter blades. These blades are sheared off. Each piece of Magnox is generally small (75 mm long) with an average mass of 0.1125 kg which includes a percentage of the braces (i.e. mass of Magnox per fuel element is 0.45 kg). Magnox buttons (one per element) each weigh 1.7g. No items require special handling. During initial station operation the desplittering process involved baling Magnox into 150 mm diameter bales.
FED Graphite - Each fuel channel comprised 10 fuel elements (with associated graphite sleeves) and a disposable bottom reflector graphite sleeve. The fuel element sleeve and the reflector have been removed from the fuel and reduced in size in a cracking unit. The resultant graphite pieces have a maximum size of 300 mm and weight of 5.5 kg. Dust from the cracking operation has been accumulated in polythene bags or bottles. There are no large items that may require special handling.
FED Fuel Channel Components - Fuel channel components are metallic and consist of one cast iron support member and ten zirconium `D' bars per fuel channel. There are no large items that may require special handling..
MAC - The waste consists of thermocouple cables, control rod wires, BCD clips, and contact assemblies. There are no large items that may require special handling.
MCI - The waste consists mainly of redundant pond fuel handling equipment, filters, filter dust bags, general metallic waste and incinerator ash bags and some 20-litre cans of sludge. Items must have a dimension less than 1.3 metres to pass through a bunker loading hole. Wastes may be in polythene bags or 180-litre drums. No large items have been identified apart from pond skips which have a volume of 1.2 m3 and weigh 350 kg.

Changes since waste generated: -

Bulk density (t/m^3): = 0.27

Comment on density: Mean bulk density is 0.25 t/m3. This assumes a packing fraction of 1/7 (= 0.143).

CHEMICAL COMPOSITION

General description and components (%wt):

FED Magnox - The waste is comprised of (~100%) Magnox AL80 alloy. The Magnox may be contaminated by fission products and actinides. Some corrosion product, magnesium hydroxide, may be present (<0.3 wt %).
FED Graphite - Graphite (100%), graphite impurities. The waste consists almost entirely of graphite with only trace amounts of activated impurities, fission product and, actinide contaminants and metals. Also trace quantities of polythene.
FED Fuel Channel Components - The waste consists of cast iron and zirconium metal. Cast iron (~44%), zirconium (~56%).
MAC - The waste consists principally of stainless steel, with other unspecified metals.
MCI - The waste consists of metals such as stainless steel, mild steel and aluminium alloys, entrapped graphite dust and other dust, and ceramic material and incinerator ash. Some sludge and ion exchange resin is also present (~4% wt), this contains organic materials including polymers and cellulose (~5 wt%).

Chemical state:

Neutral

Sheet metal proportion / thickness:

FED Magnox - No bulk metal items present.
FED Graphite - No sheet or bulk metal present in this waste stream.
FED Fuel Channel Components - Support members (~44% wt) are 200 mm length x 150 mm diameter.
MAC - Waste is neither in sheet form nor in bulk.
MCI - No sheet metal is expected. Bunker contains 2 pond skips each with an envelope volume 1.2 m3 and mass 350 kg.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	= 0	-	
Other ferrous metals	~ 1.5	MAC - The waste contains steel and other metals. Alloying proportions of tin, nickel, niobium and molybdenum may be present.	
Iron		-	
Aluminium		-	
Beryllium	< 0.03	-	
Cobalt		-	
Copper	= 0	-	
Lead	= 0	-	
Magnox/Magnesium	~ 94.0	FED Magnox - Magnox AL80, which includes 0.8 wt% aluminium as an alloying constituent. There will be impurities, generally at trace levels, incorporated in the Magnox.	
Nickel		-	
Titanium		-	
Uranium		-	
Zinc	TR	-	
Zircaloy/Zirconium	~ 0.01	FED Fuel Channel Components: Zirconium D Bars	
Other metals	= 0	No "other" metals have been identified.	

Organics (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	= 0.09	-	
Paper, cotton	~ 0.09	-	
Wood	= 0	-	
Halogenated plastics	= 0	-	
Total non-halogenated plastics	= 0.18	-	
Condensation polymers	~ 0.18	-	
Others	TR	-	
Organic ion exchange materials	~ 0.18	-	
Total rubber	= 0	-	
Halogenated rubber	= 0	-	
Non-halogenated rubber	= 0	-	
Hydrocarbons		-	
Oil or grease		-	
Fuel		-	
Asphalt/Tarmac (cont.coal tar)		-	
Asphalt/Tarmac (no coal tar)		-	
Bitumen		-	
Others		-	
Other organics	TR	-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	= 0	-	
Inorganic sludges and flocs	~ 0.90	-	
Soil	= 0	-	
Brick/Stone/Rubble	= 0	-	
Cementitious material	= 0	-	
Sand		-	
Glass/Ceramics	= 0	-	
Graphite	~ 1.9	-	
Desiccants/Catalysts		-	
Asbestos	TR	-	
Non/low friable		-	
Moderately friable		-	
Highly friable		-	
Free aqueous liquids	TR	-	
Free non-aqueous liquids	= 0	-	
Powder/Ash	TR	-	

COMPONENTS OF MATERIALS, WASTE PROPERTIES, MATERIALS NOT CONTRIBUTING TO MASS

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride	TR	-
Chloride	TR	-
Iodide	= 0	-
Cyanide	= 0	-
Carbonate	TR	-
Nitrate	TR	-
Nitrite	TR	-
Phosphate	TR	-
Sulphate	TR	-
Sulphide	= 0	-

Materials of interest for waste acceptance criteria:

	(%wt)	Type(s) and comment
Combustible metals	~ 94.0	-
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		-
Corrosive materials	= 0	-
Pyrophoric materials	= 0	-
Generating toxic gases	= 0	-
Reacting with water	~ 94.0	-
Higher activity particles		-
Soluble solids as bulk chemical compounds		-

Hazardous substances / non hazardous pollutants: -

	(%wt)	Type(s) and comment
Acrylamide		-
Benzene		-
Chlorinated solvents		-
Formaldehyde		-
Organometallics		-
Phenol		-
Styrene		-
Tri-butyl phosphate		-
Other organophosphates		-
Vinyl chloride		-
Arsenic		-
Barium		-
Boron	0	-
Boron (in Boral)		-
Boron (non-Boral)		-
Cadmium		-
Caesium		-
Selenium		-
Chromium		-
Molybdenum		-
Thallium		-
Tin		-
Vanadium		-
Mercury compounds		-
Others		-

Complexing agents (%wt): Yes

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

Physical components:

	Number	Type(s) and comment
Sources		-
Electronic & Electrical Equipment (EEE)		-
EEE Type 1		-
EEE Type 2		-
EEE Type 3		-
EEE Type 4		-
EEE Type 5		-

TREATMENT, PACKAGING AND DISPOSAL

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

Treatment	On-site / Off-site	Stream volume %
Size reduction		
Decay storage		
Low force compaction		
Supercompaction (HFC)		
Incineration		
Drying/dewatering/liquid separation		
Tie down/fixatives/strippable coating/painting application		
Decontamination		
Metal treatment		
Recycling / reuse		
Thermal treatment, including vitrification		
Encapsulation	On-site	100.0
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments: -

Conditioning method: All solid wastes in the bunker would be encapsulated together in a BFS/OPC matrix and packaged in 3m3 Stainless Steel Box. There is no intention to first supercompact the waste. Any powdered waste is expected to be encapsulated separately in a 9:1 BFS/OPC matrix and would be packaged in 3m3 Drum as 9J62.

Conditioning plants:

Plant Name	Location
HNA SILWE	Hunterston A

Likely conditioning matrix: Unknown

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m³)	Payload (m³)	Number of packages	Estimated start date for packaging
3 m³ box (side lifting)	100.0	1.9	2.9	317	-

Range in container waste loading: No significant variability is expected.

Other information on packaging and conditioning: The 3m3 box is expected to be made from stainless steel. The proposed method has changed from dissolution to encapsulation in BFS/OPC, in a 3m3 box. The wastes in the bunker will probably be encapsulated together, but possibly excluding any ash and dusts (9J62). The waste is a mixture of historic waste streams 9J18, 9J26, 9J35 and 9J40 in addition to 9J23. Any of the Magnox waste that has degraded from metal to powder will be encapsulated in a 3m3 drum with a conditioning factor of about 3 as 9J62.

Conditioned density (t/m³): ~ 2.0

Conditioned density comment: The density of the conditioned waste will probably be about 2 t/m3.

Management Routes:

Disposal Route	Stream volume %	Raw density t/m^3	Start date
Expected to be consigned to a Near Site, Near Surface Disposal Facility (Scotland) Expected to be Non-NSD HAW managed under Scottish Government's policy Expected to be disposed to LLW Vaults NRS Dounreay Expected to be consigned to the Geological Disposal Facility Expected to be consigned to a Near Surface Disposal Facility Expected to be consigned to the LLW Repository Expected to be consigned to a Landfill Facility Expected to be disposed On-Site Expected to be managed by In-Situ Disposal Expected to be consigned to an Incineration Facility Expected to be consigned to a Metal Treatment Facility Expected to be Out of Scope Expected to be recycled / reused Disposal route not known			

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

Opportunities for alternative disposal routing: No

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Opportunity Confidence	Comment
-	-	-	-	-

RADIOACTIVITY

Source: Predominantly activation products with possible contamination by fission products and actinides.

Uncertainty: The values quoted are indicative of activities that might be expected.

Measurement of radioactivities: Activities have been estimated from activation calculations with assumptions for contamination.

Chemical form of radionuclides:

H-3: Tritium is expected to be present as surface contamination, possibly as water but perhaps in the form of other inorganic or organic compounds.
C-14: Carbon 14 will be present as graphite.
Cl-36: Chlorine 36 incorporated in the Magnox may be associated with barium impurity (barium chloride). Other chlorine 36 may be associated with surface contamination.
Se-79: The chemical form of selenium has not been determined.
Tc-99: The chemical form of technetium has not been determined.
I-129: -
Ra: Radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: Chemical form of uranium isotopes may be uranium oxides.
Np: The chemical form of neptunium has not been determined.
Pu: Chemical form of plutonium isotopes may be plutonium oxides.

WASTE STREAM **9J23** **Bunker Waste**

Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2025	Bands and Code	Future Arisings	Bands and Code
H 3	1.44E-02	C C 2			Gd 153		8		
Be 10	1.15E-07	C C 2			Ho 163		8		
C 14	1.67E-04	C C 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26	5.59E-05	C C 2			Tm 171		8		
Cl 36		8			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	1.91E-05	C C 2			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	3.33E-05	C C 2			Pb 210		8		
Co 60	4.96E-04	C C 2			Bi 208		8		
Ni 59	7.37E-05	C C 2			Bi 210m		8		
Ni 63	5.47E-03	C C 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79		8			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	6.82E-04	C C 2			Th 227		8		
Zr 93	2.58E-06	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	2.59E-06	C C 2			Th 232		8		
Nb 94	7.90E-08	C C 2			Th 234	7.98E-08	C C 2		
Mo 93	2.51E-06	C C 2			Pa 231		8		
Tc 97		8			Pa 233	5.80E-09	C C 2		
Tc 99	8.28E-07	C C 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	7.10E-08	C C 2		
Ag 108m	3.45E-06	C C 2			U 235	1.89E-09	C C 2		
Ag 110m		8			U 236	6.54E-09	C C 2		
Cd 109		8			U 238	7.98E-08	C C 2		
Cd 113m	2.68E-05	C C 2			Np 237	5.81E-09	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	1.64E-04	C C 2			Pu 238	1.56E-05	C C 2		
Sn 123		8			Pu 239	2.34E-05	C C 2		
Sn 126	4.83E-09	C C 2			Pu 240	2.79E-05	C C 2		
Sb 125	8.75E-08	C C 2			Pu 241	2.04E-04	C C 2		
Sb 126		8			Pu 242	1.02E-08	C C 2		
Te 125m	2.19E-08	C C 2			Am 241	4.80E-05	C C 2		
Te 127m		8			Am 242m	7.27E-08	C C 2		
I 129		8			Am 243	2.10E-08	C C 2		
Cs 134		8			Cm 242	6.00E-08	C C 2		
Cs 135	1.02E-08	C C 2			Cm 243	1.11E-08	C C 2		
Cs 137	6.92E-04	C C 2			Cm 244	9.70E-08	C C 2		
Ba 133	1.77E-05	C C 2			Cm 245		8		
La 137	3.79E-06	C C 2			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145	4.28E-07	C C 2			Cf 250		8		
Pm 147	7.19E-06	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	5.13E-06	C C 2			Unsp a				
Eu 152	2.40E-05	C C 2			Unsp b/g				
Eu 154	7.64E-05	C C 2			**Total a**	**1.15E-04**	*	**0**	*
Eu 155	3.75E-07	C C 2			**Total b/g**	**2.26E-02**	*	**0**	*

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 the 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
* Total calculated from the 114 declared radionuclides