WASTE STREAM	9A60	FED Magnox from Post Irradiation Examination

SITE Berkeley

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE ILW

WASTE VOLUMES

	Reported (m^3)
At 1.4.2025	= 0.7
Future arisings:	
Total future arisings:	**0.0**
Total waste volume:	**0.7**

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 further arisings of this waste stream. Some of the debris is in tins and for this debris the volume as contained in the tins is given. Most of the debris is loose and the quoted volume is three times the net volume for this waste.

Uncertainty factors on volumes:

Stock (upper):	x 1.10	Arisings (upper):	x -
Stock (lower):	x 0.90	Arisings (lower):	x -

WASTE SOURCE The waste arose from the programme of post irradiation examination of Magnox fuel elements that was undertaken within the research facilities previously on the site.

PHYSICAL CHARACTERISTICS

General description: The waste is predominantly made up of Magnox metal generated from the post irradiation examination work, although it could include other fuel element components. The largest arisings are believed to be splitter cages. There may be a significant quantity of Magnox fuel canning material contaminated by fuel in the debris. There will also be some Sintox discs, along with graphite, stainless steel and zirconium. The waste may be contaminated with Ternary Eutectic Chloride (TEC) (a fire extinguishant). There were three discharges of loose BTC FED and a posting of 68 mild steel paint tins. The loose waste will be processed with the BPS FED, as it is not possible to separate them. The waste containers will be processed with this waste stream. There are no large items that may require special handling.

Changes since waste generated: -

Bulk density (t/m^3): = 0.35

Comment on density: Density is calculated from the total mass of the loose waste, and the containerised waste (including the containers), and the volume.

CHEMICAL COMPOSITION

General description and components (%wt): The component breakdown of the FED from Berkeley Centre is 98%wt Magnox, 1.6%wt zirconium, 0.1%wt Sintox discs (sintered alumina), 0.23%wt other components (Nimonic springs, graphite, stainless steel) and <<0.1%wt thermocouples. There will also be small amounts of mild steel from the containers, and there may be traces of Ternary Eutectic Chloride present.

Chemical state: Alkali

Sheet metal proportion / thickness: Bulk metal items are not expected to be present. Nearly all of the waste is expected to be only 1 or 2 mm thick.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel	< 0.20	-	
Other ferrous metals	NE	Mild steel will be present as the waste container.	
Iron		-	
Aluminium		-	
Beryllium	~ 0.30	-	
Cobalt		-	
Copper	= 0	-	
Lead	= 0	-	
Magnox/Magnesium	= 98.0	0.8 wt% of this is aluminium.	
Nickel	~ 0.20	Nimonic.	
Titanium		-	
Uranium		-	
Zinc	TR	-	
Zircaloy/Zirconium	= 1.6	Aluminium and zirconium are expected as alloying constituents of the Magnox.	
Other metals	TR	"Other" metals could include thermocouple wires.	

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	TR	-	
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	TR	-	
Inorganic sludges and flocs	= 0	-	
Soil	= 0	-	
Brick/Stone/Rubble	= 0	-	
Cementitious material	= 0	-	
Sand		-	
Glass/Ceramics	= 0	-	
Graphite	TR	-	
Desiccants/Catalysts		-	
Asbestos	= 0	-	
Non/low friable		-	
Moderately friable		-	
Highly friable		-	
Free aqueous liquids	TR	-	
Free non-aqueous liquids	= 0	-	
Powder/Ash	P	-	

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	= 98.0	-
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	= 98.0	-
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		
Polymer encapsulation		
Other physical treatment		
Other chemical treatment		
Containerisation		
Treatment not yet determined		
None		

Comments on planned treatments: -

Conditioning method: This stream will be co-packaged with 9A25, 9A31, 9A39, 9A47, 9A52, and 9A66 in Type VI DCIC containers. Remainder of vault 1 waste streams will be co-packaged together in Concrete boxes (9A61, 9A62, 9A67, 9A32, 9A40, 9A48, 9A53, 9A73) Packages for vault 1 are assigned to 9A25, 9A32 & 9A73.

Conditioning plants:

Plant Name	Location

Likely conditioning matrix: -

Further information on the conditioning matrix: -

Waste Packaging:

Likely container type:

Container	Waste packaged (vol%)	Waste loading (m^3)	Payload (m^3)	Number of packages	Estimated start date for packaging
-	-	-	-	-	-

Range in container waste loading: -

Other information on packaging and conditioning: -

Conditioned density (t/m^3): -
Conditioned density comment: -

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: Activation when the associated fuel elements were irradiated, of nuclides incorporated in the Magnox and other materials, contamination by fission products and actinides during fuel element examination at Berkeley Technology Centre.

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

Measurement of radioactivities: Values were derived from measurements, calculations of induced activity and estimates of likely 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 probably be present as graphite.
Cl-36: Chlorine 36 incorporated in the Magnox may be associated with barium impurity (barium chloride).

Se-79: The selenium content is insignificant.
Tc-99: The technetium content is insignificant.
I-129: -
Ra: Radium isotope content is insignificant.
Th: The thorium isotope content is insignificant.
U: Chemical form of U isotopes has not been determined but may be oxides.
Np: The neptunium content is insignificant.
Pu: Chemical form of plutonium isotopes has not been determined but may be plutonium oxides.

WASTE STREAM **9A60** **FED Magnox from Post Irradiation Examination**

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	2.91E-03	C C 2			Gd 153		8		
Be 10	2.00E-07	C C 2			Ho 163		8		
C 14	9.99E-05	C C 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26	6.00E-05	C C 2			Tm 171		8		
Cl 36	2.00E-04	C C 2			Lu 174		8		
Ar 39		8			Lu 176		8		
Ar 42		8			Hf 178n		8		
K 40		8			Hf 182		8		
Ca 41	< 3.00E-05	C 3			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	6.16E-08	C C 2			Pb 210		8		
Co 60	< 7.50E-04	C 3			Bi 208		8		
Ni 59	1.00E-02	C C 2			Bi 210m		8		
Ni 63	8.82E-01	C C 2			Po 210		8		
Zn 65		8			Ra 223		8		
Se 79	3.45E-08	C C 2			Ra 225		8		
Kr 81		8			Ra 226		8		
Kr 85		8			Ra 228		8		
Rb 87		8			Ac 227		8		
Sr 90	1.30E-02	C C 2			Th 227		8		
Zr 93	2.00E-06	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m	1.07E-06	C C 2			Th 232		8		
Nb 94		8			Th 234	3.00E-06	C C 2		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233	1.18E-07	C C 2		
Tc 99	1.00E-05	C C 2			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	2.01E-06	C C 2		
Ag 108m	3.88E-06	C C 2			U 235	6.00E-08	C C 2		
Ag 110m		8			U 236	3.00E-07	C C 2		
Cd 109		8			U 238	3.00E-06	C C 2		
Cd 113m	< 4.06E-05	C 3			Np 237	1.18E-07	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	< 3.16E-04	C 3			Pu 238	3.48E-04	C C 2		
Sn 123		8			Pu 239	9.00E-04	C C 2		
Sn 126	3.04E-07	C C 2			Pu 240	9.99E-04	C C 2		
Sb 125	2.14E-09	C C 2			Pu 241	8.43E-03	C C 2		
Sb 126	4.26E-08	C C 2			Pu 242	6.00E-07	C C 2		
Te 125m		8			Am 241	3.29E-03	C C 2		
Te 127m		8			Am 242m	3.66E-06	C C 2		
I 129	2.00E-08	C C 2			Am 243	9.99E-07	C C 2		
Cs 134		8			Cm 242	3.02E-06	C C 2		
Cs 135	7.00E-07	C C 2			Cm 243	3.96E-07	C C 2		
Cs 137	1.98E-02	C C 2			Cm 244	4.02E-06	C C 2		
Ba 133	< 1.53E-05	C 3			Cm 245		8		
La 137		8			Cm 246		8		
La 138		8			Cm 248		8		
Ce 144		8			Cf 249		8		
Pm 145		8			Cf 250		8		
Pm 147	3.44E-08	C C 2			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	1.74E-04	C C 2			Unsp a				
Eu 152	7.88E-07	C C 2			Unsp b/g				
Eu 154	1.87E-05	C C 2			**Total a**	**5.55E-03**	*	**0**	*
Eu 155	7.76E-07	C C 2			**Total b/g**	**9.38E-01**	*	**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