WASTE STREAM	9B21	FED Magnox, Gravel and Interface

SITE Bradwell

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Nuclear Restoration Services Ltd (NRS)

WASTE TYPE LLW

WASTE VOLUMES

	Reported (m^3)
Stocks: At 1.4.2025	= 274.0
Future arisings:	
Total future arisings:	**0.0**
Total waste volume:	**274.0**

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: The current stock held at Tradebe awaiting supercompaction and onward disposal is based on a known quantity of drums so uncertainty is low.

Uncertainty factors on volumes:

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

WASTE SOURCE The stream covers a mixture of Gravel, Oxide and Fuel Element Debris (FED) retrieved from the Active Waste Compound Vaults 0B, 1A, 1B, 2A, 2B, 4A, 4B & 5A; and Gravels/Oxide retrieved from Vaults 7A, 7B & 8A.

PHYSICAL CHARACTERISTICS

General description: FED, gravel and interface.

Changes since waste generated: As the materials were retrieved from the vaults, they were sorted into either FED, Gravel or Interface drums. The interface drums arose when the project could no longer separate the FED from the Gravel and so each interface drum consists of a mixture of both FED, Gravel along with some oxides. Best efforts have been made to ensure that the drums do not contain High Dose Rate Items (HDRI), such as nimonic springs or fuel.

Bulk density (t/m^3): = 0.63

Comment on density: The bulk density is based on the stock of 172.8te with a raw volume of 274m3. Following supercompaction this will increase to 1.63t/m3

CHEMICAL COMPOSITION

General description and components (%wt): Magnox metal (type ZR55) (>60%), fission product and actinide contamination. The potential corrosion products present are detailed in the section above. The quantities/ratios of each potential corrosion product is currently unknown. The chemical composition of the chippings is not known. It is likely that either silica or limestone has been used. Fission products, actinides and other activation products will be present as contaminants.

Chemical state: Neutral

Sheet metal proportion / thickness: The thickness of some of the waste will be of the order of a mm or less.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel……	= 0	-	
Other ferrous metals……	= 15.4	FED Drum / filter body	
Iron……	= 0.33	FED Alloy	
Aluminium……	= 0.45	FED Alloy	
Beryllium……	= 0	-	
Cobalt……	TR	FED Alloy	
Copper……	= 0.01	FED Alloy	
Lead……	= 0.05	FED Alloy	
Magnox/Magnesium……	= 70.1	FED Alloy	
Nickel……	= 0.01	FED Alloy	
Titanium……	TR	FED Alloy	
Uranium……		-	
Zinc……	= 0.02	FED Alloy	
Zircaloy/Zirconium……	= 0.03	FED Alloy	
Other metals……	= 0	-	

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	= 0.58	-	
Condensation polymers	= 0.58	Plastic wrapping / PPE	
Others	= 0	-	
Organic ion exchange materials	= 0	-	
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		-	

Other materials (%wt):

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	= 0	-	
Inorganic sludges and flocs	NE	-	
Soil	= 0	-	
Brick/Stone/Rubble	= 12.0	gravel	
Cementitious material	= 0	-	
Sand		-	
Glass/Ceramics	= 0	-	
Graphite	TR	-	
Desiccants/Catalysts		-	
Asbestos	= 0	-	
Non/low friable		-	
Moderately friable		-	
Highly friable		-	
Free aqueous liquids		-	
Free non-aqueous liquids	= 0	-	
Powder/Ash		-	

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

Inorganic anions (%wt):

	(%wt)	Type(s) and comment
Fluoride	= 0	-
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		-
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	P	1491.8m2
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	TR	FED Alloy
Caesium		-
Selenium		-
Chromium	= 0.01	FED Alloy
Molybdenum		-
Thallium		-
Tin		-
Vanadium		-
Mercury compounds		-
Others	= 0.44	Polyurathane foam contained within mild steel FED drum filters (0.03%), Also included in the FED alloy - calcium (0.28%), manganese (0.01%), neodymium (0.10%), silicon (0.02%)

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA		-
DPTA		-
NTA		-
Polycarboxylic acids		-
Other organic complexants		-
Total complexing agents	= 0	-

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)	Off-site	= 96.2
Incineration	Off-site	= 3.8
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: The waste will be supercompacted prior to disposal to increase the packing efficiency in the disposal container.

Conditioning method: -

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
1/2 Height WAMAC IP-2 ISO (TC08)	96.2	25.7	18.8	11	-

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	= 96.2	= 1.6	
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	= 3.8	= 0.40	
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: The source of the waste is the removal of splitters from fuel elements prior to dispatch of the elements for reprocessing. Activation of trace elements in the Magnox and contamination by fission products and actinides will be the main sources of activity.

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. A campaign of sampling was undertaken during the retrieval of the material.

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 compounds or as 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 ($BaCl_2$). Other chlorine 36 may be associated with surface contamination.
Se-79: -
Tc-99: -
I-129: -
Ra: -
Th: -
U: Chemical form of U isotopes has not been determined but may be oxides.
Np: The chemical form of neptunium has not been determined.
Pu: Chemical form of Pu isotopes has not been determined but may be oxides.

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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	2.87E-03	C C 1			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	8.17E-05	C C 1			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26		8			Tm 171		8		
Cl 36	8.00E-06	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		8			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	1.07E-05	C C 1			Pb 210		8		
Co 60	5.40E-05	C C 2			Bi 208		8		
Ni 59		8			Bi 210m		8		
Ni 63	8.46E-04	C C 1			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	3.47E-04	C C 1			Th 227		8		
Zr 93		8			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92		8			Th 230		8		
Nb 93m		8			Th 232		8		
Nb 94		8			Th 234	1.53E-09	C C 2		
Mo 93		8			Pa 231		8		
Tc 97		8			Pa 233		8		
Tc 99		8			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	2.45E-09	C C 2		
Ag 108m	9.03E-05	C C 2			U 235		8		
Ag 110m		8			U 236		8		
Cd 109		8			U 238	1.53E-09	C C 2		
Cd 113m		8			Np 237		8		
Sn 119m		8			Pu 236		8		
Sn 121m		8			Pu 238	4.18E-05	C C 1		
Sn 123		8			Pu 239	8.44E-05	C C 1		
Sn 126		8			Pu 240	8.75E-05	C C 1		
Sb 125		8			Pu 241	5.73E-04	C C 1		
Sb 126		8			Pu 242		8		
Te 125m		8			Am 241	3.48E-04	C C 1		
Te 127m		8			Am 242m		8		
I 129		8			Am 243		8		
Cs 134		8			Cm 242		8		
Cs 135		8			Cm 243	2.15E-07	C C 1		
Cs 137	3.88E-05	C C 2			Cm 244	1.52E-07	C C 1		
Ba 133	9.04E-07	C C 2			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	4.53E-08	C C 1			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	2.31E-06	C C 2			Unsp a				
Eu 152	2.06E-07	C C 2			Unsp b/g				
Eu 154	1.77E-06	C C 2			**Total a**	**5.62E-04**	*	**0**	*
Eu 155	6.14E-07	C C 2			**Total b/g**	**4.93E-03**	*	**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