WASTE STREAM	9A52	FED Zirconium

SITE Berkeley

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	= 2.2
Future arisings:	
Total future arisings:	**0.0**
Total waste volume:	**2.2**

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: Station operation ceased in March 1989. This waste stream was accumulated between May 1964 and December 1967. The volume quoted is the estimated bulk volume of the waste if separated from other wastes with which it is mixed. The range in the volume of zirconium debris is estimated to be between 2.12m³ and 2.30m³.

Uncertainty factors on volumes:

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

WASTE SOURCE The source of the waste is the removal of graphite struts and associated zirconium and stainless steel bridge pieces from fuel elements prior to the dispatch of the elements to Sellafield.

PHYSICAL CHARACTERISTICS

General description: The waste comprises zirconium support bridges of about 127mm in length. The bridge pieces may still be connected to the graphite struts. Approximately 62% of fuel elements used zirconium top support bridges. All of the fuel elements had bottom support bridges made from zirconium. A zirconium top support bridge weighs approximately 30g and a bottom support bridge weighs approxiamtely 41g. It is unlikely that there will be any large items which will require special handling. The waste is loose in the vaults.

Changes since waste generated: -

Bulk density (t/m³): = 2.2

Comment on density: The average bulk density of 2.2 t/m³ assumes a packing factor to give an overall volume of about three times the displacement volume of the waste. The density can be up to 6.5 t/m³.

CHEMICAL COMPOSITION

General description and components (%wt): Zirconium (>98.3%) and impurities (<1.7%). There may be fission product, actinide and graphite contamination.

Chemical state: Neutral

Sheet metal proportion / thickness: Items are approximately 127 mm x 25 mm x 17 mm.

Metals and alloys (%wt):

	(%wt)	Type(s) / Grades(s) with proportions	% of total C14 activity
Stainless steel……	= 0	-	
Other ferrous metals……	= 0	-	
Iron……		-	
Aluminium……	= 0	-	
Beryllium……	0	-	
Cobalt……		-	
Copper……	= 0	-	
Lead……	= 0	-	
Magnox/Magnesium……	TR	-	
Nickel……		-	
Titanium……		-	
Uranium……		-	
Zinc……	= 0	-	
Zircaloy/Zirconium……	~ 100.0	-	
Other metals……	= 0	The waste is zirconium with impurities incorporated in the zirconium.	

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	= 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	= 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, 9A60 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 zirconium. Contamination by fission products and actinides when the fuel elements were in the fuel pond.

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

Measurement of radioactivities: Specific activity is a function of Station operating history. Values were derived from calculations of induced activity and estimates of likely contamination.

Chemical form of radionuclides:

H-3: Tritium may be incorporated in the zirconium or be present as surface contamination in the form of water, other inorganic or organic compounds.
C-14: Carbon 14 will probably be present as graphite and also, to a minor degree, as impurity within the zirconium.

Cl-36: The chemical form of chlorine 36 has not been determined.
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 **9A52** **FED Zirconium**

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	< 2.18E-01	D 3			Gd 153		8		
Be 10		8			Ho 163		8		
C 14	3.00E-02	D D 2			Ho 166m		8		
Na 22		8			Tm 170		8		
Al 26	< 6.00E-07	D 3			Tm 171		8		
Cl 36	< 2.00E-03	D 3			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	D 3			Pt 193		8		
Mn 53		8			Tl 204		8		
Mn 54		8			Pb 205		8		
Fe 55	< 2.05E-06	D 3			Pb 210		8		
Co 60	< 9.38E-03	D 3			Bi 208		8		
Ni 59	< 6.00E-04	D 3			Bi 210m		8		
Ni 63	1.77E-01	D D 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	3.26E-04	C C 2			Th 227		8		
Zr 93	4.00E-03	C C 2			Th 228		8		
Nb 91		8			Th 229		8		
Nb 92	8.00E-08	C C 2			Th 230		8		
Nb 93m	4.19E-03	C C 2			Th 232		8		
Nb 94	6.00E-08	C C 2			Th 234	7.00E-07	C C 2		
Mo 93	< 4.99E-03	D 3			Pa 231		8		
Tc 97		8			Pa 233	4.25E-08	C C 2		
Tc 99	< 1.00E-03	D 3			U 232		8		
Ru 106		8			U 233		8		
Pd 107		8			U 234	6.05E-07	C C 2		
Ag 108m	9.71E-08	C C 2			U 235	2.00E-08	C C 2		
Ag 110m		8			U 236	5.01E-08	C C 2		
Cd 109		8			U 238	7.00E-07	C C 2		
Cd 113m	< 1.22E-04	D 3			Np 237	4.25E-08	C C 2		
Sn 119m		8			Pu 236		8		
Sn 121m	< 1.58E-02	D 3			Pu 238	6.94E-05	C C 2		
Sn 123		8			Pu 239	2.00E-04	C C 2		
Sn 126	3.04E-09	D D 2			Pu 240	2.00E-04	C C 2		
Sb 125		8			Pu 241	1.27E-03	C C 2		
Sb 126		8			Pu 242	6.00E-08	C C 2		
Te 125m		8			Am 241	4.45E-04	C C 2		
Te 127m		8			Am 242m	3.66E-07	C C 2		
I 129		8			Am 243	7.99E-08	C C 2		
Cs 134	2.19E-08	C C 2			Cm 242	3.02E-07	C C 2		
Cs 135	6.00E-09	C C 2			Cm 243	3.31E-08	C C 2		
Cs 137	3.97E-04	C C 2			Cm 244	2.01E-07	C C 2		
Ba 133	6.43E-08	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	2.48E-04	C C 2			Cf 250		8		
Pm 147		8			Cf 251		8		
Sm 147		8			Cf 252		8		
Sm 151	< 1.74E-02	D 3			Unsp a				
Eu 152	< 1.19E+00	D 3			Unsp b/g				
Eu 154	< 4.67E-01	D 3			**Total a**	**9.17E-04**	*	**0**	*
Eu 155	7.76E-04	C C 2			**Total b/g**	**2.15E+00**	*	**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