

WASTE STREAM	5B325	DFR Ion Exchange Columns
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SITE Dounreay
SITE OWNER Nuclear Decommissioning Authority
WASTE CUSTODIAN Dounreay Site Restoration Limited
WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	1.6 m ³
Future arisings -	1.4.2019 - 31.3.2021.....	0.4 m ³
Total future arisings:		0.4 m ³
Total waste volume:		2.0 m ³

Comment on volumes: It should be noted that the DSRL site programme is under revision and that arisings dates are subject to change.

Uncertainty factors on volumes:	Stock (upper):	x 1.02	Arisings (upper)	x 1.1
	Stock (lower):	x 0.98	Arisings (lower)	x 0.9

WASTE SOURCE The ion-exchange columns were used in a treatment plant to remove radioactivity, mainly Cs-137, from DFR sodium/potassium alloy, which was used as a reactor coolant and primary heat exchanger.

PHYSICAL CHARACTERISTICS

General description: Cs treatment ion exchange columns will be fabricated from 40 mm thick polypropylene to prevent any adverse interaction between the chloride ions in the process liquor and steel components. The column will be completely enclosed in a 3 mm 304L stainless steel container that will provide protection during handling and provide the long-term containment once chloride ions have been flushed from the columns after use.

Physical components (%wt): Stainless steel (55%), polypropylene (21%), Cs Treat resin (24%).

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 0.8

Comment on density: -

CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel (55%), polypropylene (21%), Cs Treat resin (24%).

Chemical state: Neutral

Chemical form of radionuclides: -

Metals and alloys (%wt): Stainless steel is present as the 3 mm thick column skin.

Stainless steel.....	55.0	304L
Other ferrous metals.....	0	
Iron.....		
Aluminium.....		
Beryllium.....	0	
Cobalt.....	0	
Copper.....		
Lead.....	0	
Magnox/Magnesium.....	0	
Nickel.....		
Titanium.....		
Uranium.....	0	
Zinc.....	0	

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	Zircaloy/Zirconium.....	0
	Other metals.....	0
Organics (%wt):	Cs treatment ion exchange columns will be fabricated from 40 mm thick polypropylene to prevent any adverse interaction between the chloride ions in the process liquor and steel components.	
	Total cellulosics.....	0
	Paper, cotton.....	0
	Wood.....	0
	Halogenated plastics	0
	Total non-halogenated plastics.....	21.0
	Condensation polymers.....	0
	Others.....	21.0
	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.....	0
Other materials (%wt):	Cs Treat resin [Potassium Hexacyano Cobalt(II) - Ferrate(II)] is odourless, non-toxic, non-flammable, and has a brown/black granular appearance. Hydrogen cyanide may evolve if heated with strong mineral acids.	
	Inorganic ion exchange materials.	24.0
	Inorganic sludges and flocs.....	0
	Soil.....	0
	Brick/Stone/Rubble.....	0
	Cementitious material.....	0
	Sand.....	0
	Glass/Ceramics.....	
	Graphite.....	0
	Desiccants/Catalysts.....	
	Asbestos.....	0
	Non/low friable.....	
	Moderately friable.....	
	Highly friable.....	
	Free aqueous liquids.....	0
	Free non-aqueous liquids.....	0
	Powder/Ash.....	0
Inorganic anions (%wt):	There are no inorganic anions present.	

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Fluoride.....	0
Chloride.....	0
Iodide.....	0
Cyanide.....	0
Carbonate.....	0
Nitrate.....	0
Nitrite.....	0
Phosphate.....	0
Sulphate.....	0
Sulphide.....	0

Materials of interest for
waste acceptance criteria:

There are no hazardous materials present.

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.....	0
Corrosive materials.....	0
Pyrophoric materials.....	0
Generating toxic gases.....	0
Reacting with water.....	0
Active particles.....	NE
Soluble solids as bulk chemical compounds.....	0

Hazardous substances /
non hazardous pollutants:

Acrylamide.....	
Benzene.....	NE
Chlorinated solvents.....	
Formaldehyde.....	
Organometallics.....	
Phenol.....	NE
Styrene.....	
Tri-butyl phosphate.....	NE
Other organophosphates.....	
Vinyl chloride.....	NE
Arsenic.....	NE
Barium.....	
Boron.....	NE

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Cadmium..... NE
 Caesium.....
 Selenium..... NE
 Chromium..... NE
 Molybdenum..... NE
 Thallium.....
 Tin..... NE
 Vanadium..... NE
 Mercury compounds.....
 Others..... NE
 Electronic Electrical Equipment (EEE)
 EEE Type 1.....
 EEE Type 2.....
 EEE Type 3.....
 EEE Type 4.....
 EEE Type 5.....

Complexing agents (%wt): No
 EDTA.....
 DPTA.....
 NTA.....
 Polycarboxylic acids.....
 Other organic complexants.....
 Total complexing agents..... 0

PACKAGING AND CONDITIONING

Conditioning method: The columns will be immobilised by first filling with polymer to immobilise the ion exchange material, then by cementing into a 500 litre drum.
 Plant Name: -
 Location: Dounreay
 Plant startup date: -
 Total capacity (m³/y incoming waste): NE
 Target start date for packaging this stream: 2021
 Throughput for this stream (m³/y incoming waste): ~2.2
 Other information: -

Likely container type:	Container	Waste packaged (%vol)	Waste loading (m ³)	Payload (m ³)	Number of packages
	500 l drum	100.0	0.2	0.5	10

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Likely container type comment: The conditioning factor will be 2.5 if a single column is immobilised in each 500 litre drum.

Range in container waste volume: -

Other information on containers: -

Likely conditioning matrix: Cement

Other information: -

Conditioned density (t/m³): 2.4

Conditioned density comment: Density is if waste is grouted directly into 500 litre drums.

Other information on conditioning: -

Opportunities for alternative disposal routing: No

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source: The activity arises from the decontamination of DFR NaK coolant by ion-exchange. The activity is predominantly caesium.

Uncertainty: Specific Activity data was taken from the DFR IXC LoC (both stocks and arisings). Data are best estimates.

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: Ion exchange columns will be a maximum of 200 TBq Cs137.

Other information: Specific activities have been revised since the 2016 UK Inventory.

WASTE STREAM 5B325 DFR Ion Exchange Columns

Nuclide	Mean radioactivity, TBq/m ³				Nuclide	Mean radioactivity, TBq/m ³			
	Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code		Waste at 1.4.2019	Bands and Code	Future arisings	Bands and Code
H 3					Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22	7.06E-06	CC 2	2.05E-05	CC 2	Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40	1.48E-02	CC 2	1.48E-02	CC 2	Hf 182				
Ca 41					Pt 193				
Mn 53					Tl 204				
Mn 54					Pb 205				
Fe 55					Pb 210				
Co 60					Bi 208				
Ni 59					Bi 210m				
Ni 63					Po 210				
Zn 65					Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90	4.86E-03	CC 2	5.35E-03	CC 2	Th 227				
Zr 93					Th 228				
Nb 91					Th 229				
Nb 92					Th 230				
Nb 93m					Th 232				
Nb 94					Th 234				
Mo 93					Pa 231				
Tc 97					Pa 233				
Tc 99					U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m					U 235	8E-08	CC 2	8E-08	CC 2
Ag 110m					U 236				
Cd 109					U 238	1.44E-07	CC 2	1.45E-07	CC 2
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238	2.96E-05	CC 2	3.06E-05	CC 2
Sn 123					Pu 239	1.32E-03	CC 2	1.32E-03	CC 2
Sn 126					Pu 240				
Sb 125					Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134	5.9E-06	CC 2	2.26E-05	CC 2	Cm 242				
Cs 135	3.2E-03	CC 2	3.2E-03	CC 2	Cm 243				
Cs 137	1.44E+02	CC 2	1.58E+02	CC 2	Cm 244				
Ba 133					Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g				
Eu 154					Total a	1.35E-03	CC 2	1.35E-03	CC 2
Eu 155					Total b/g	1.44E+02	CC 2	1.58E+02	CC 2

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