WASTE STREAM 5B354 PFR SDP Ion Exchange Columns

SITE Dounreay

SITE OWNER Nuclear Decommissioning Authority

WASTE CUSTODIAN Dounreay Site Restoration Limited

WASTE TYPE ILW

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2019.....	3.8 m³
Future arisings -	1.4.2019 - 31.3.2028.....	0.4 m³
Total future arisings:		0.4 m³
Total waste volume:		4.2 m³

Comment on volumes: It should be noted that the DSRL Site Programme is under review and that arisings dats are subject to change. Each 200 litre drum has an internal volume of 0.2 m³ hosting within it a carbon steel ion exchange column filled with approximately 57 litres of ion exchange media.

Uncertainty factors on volumes:

Stock (upper):	x 1.02	Arisings (upper)	x 1.02
Stock (lower):	x 0.98	Arisings (lower)	x 0.98

WASTE SOURCE The Sodium Disposal Plant (SDP) was used to dispose of bulk sodium from the PFR primary and secondary circuits. Initially sodium was reacted with water to produce NaOH that was treated with HCl to produce NaCl. The caesium removal plant removed radioactive contaminants from the brine by passing the solution through ion exchange columns.

PHYSICAL CHARACTERISTICS

General description: The carbon steel and lead, forming the actual physical structure of the ion exchange columns, will form the bulk of the waste. Steel from the Z6033 drum. The resin used makes up the balance.

Physical components (%vol): Stainless Steel (29.8%), Lead (34.3%), Other Plastic (2.3%), Inorganic ion-exchange resin (33.6%)

Sealed sources: The waste does not contain sealed sources.

Bulk density (t/m³): 2.5

Comment on density: Based on sample of 18 PFR CRP drums. Density includes all parts of the columns and drums; lead being extremely dense.

CHEMICAL COMPOSITION

General description and components (%wt): Steel (56.6%), lead (32%), inorganic ion-exchange resin (11.4%).

Chemical state: Neutral

Chemical form of radionuclides: -

Metals and alloys (%wt): The steel will be present as ion exchange column housings.

Stainless steel.....	56.6	Probably M316.
Other ferrous metals.....	0	
Iron.....		
Aluminium.....		
Beryllium.....	0	
Cobalt.....	0	
Copper.....		
Lead.....	32.0	
Magnox/Magnesium.....	0	
Nickel.....		

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	Titanium	
	Uranium	0
	Zinc	0
	Zircaloy/Zirconium	0
	Other metals	0
Organics (%wt):	-	
	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	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):	Two resins are available for use: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.KniFC-PAN resin [Potassium-Nickel Hexacyanoferrate in a Polyacrylonitrile binding matrix] consists of odourless, non-flammable green/brown beads.	
	Inorganic ion exchange materials.	11.4
	Inorganic sludges and flocs	0
	Soil	0
	Brick/Stone/Rubble	0
	Cementitious material	0
	Sand	0
	Glass/Ceramics	
	Graphite	0
	Desiccants/Catalysts	0
	Asbestos	0
	Non/low friable	
	Moderately friable	
	Highly friable	
	Free aqueous liquids	0

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Free non-aqueous liquids	0
Powder/Ash	0
Inorganic anions (%wt):	-
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: The waste should be stored in a dark cool area. Hydrogen cyanide may evolve if heated with strong mineral acids.

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	
Reacting with water	0
Active particles	NE
Soluble solids as bulk chemical compounds	0

Hazardous substances / non hazardous pollutants: The waste will contain 3.2 te of lead.

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

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Arsenic	NE
Barium	
Boron	NE
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 reference position is that the columns will be immobilised by first filling with polymer to immobilise the ion exchange material, then by cementing into a 500 litre drum. This strategy will be reviewed.
Plant Name:	-
Location:	Dounreay
Plant startup date:	TBD
Total capacity (m^3/y incoming waste):	NE
Target start date for packaging this stream:	-
Throughput for this stream (m^3/y incoming waste):	NE
Other information:	-

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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	22

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:	Not Specified
Other information:	The choice of polymer matrix for filling the columns will require development work.
Conditioned density (t/m^3):	~2.0
Conditioned density comment:	The conditioned waste density is expected to be about 2 te/m^3.
Other information on conditioning:	-
Opportunities for alternative disposal routing:	No

Treatment	Stream volume (%)	Comment
-	-	-

RADIOACTIVITY

Source:	The activity of the ion exchange columns is based on the entire inventory of the PFR primary coolant assuming that it is completely absorbed onto the ion exchanger. The radionuclide inventory for the PFR sodium coolant has been derived from sampling of the PFR coolant. Radiation measurements and Microshield calculations have been used for Consignors records.
Uncertainty:	Within a factor of three.
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:	Consignors records for all the drums were used to generate a specific activity.
Other information:	The activities quoted are for the 'as stored' volumes ie 200 litre drums.Specific Activity has been re-evaluated since 2016.

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Nuclide	Mean radioactivity, TBq/m³				Nuclide	Mean radioactivity, TBq/m³			
	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	9.37E-04	B B 2	3.90E-02	B B 2	Tm 170				
Al 26					Tm 171				
Cl 36					Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40					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					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				
Ag 110m					U 236				
Cd 109					U 238				
Cd 113m					Np 237				
Sn 119m					Pu 236				
Sn 121m					Pu 238				
Sn 123					Pu 239				
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	1.99E-05	B B 2	2.19E-03	B B 2	Cm 242				
Cs 135					Cm 243				
Cs 137	2.21E-01	B B 2	3.05E-01	B B 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**	**0**		**0**	
Eu 155					**Total b/g**	**2.22E-01**	**B B 2**	**3.46E-01**	**B B 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