F-3.4.1-1 Rev 3

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Plant Applicability: ☐ All AP1000 plants except:
☒ Only the following plants: UKP

APPLICABILITY REVIEWER WEC 6.1.pdf J. A. Speer	SIGNATURE / DATE **Electronically Approved*** **
RESPONSIBLE MANAGER* WEC 6.1.pdf P. A. Russ	SIGNATURE / DATE **Electronically Approved*** **

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UK AP1000 NDA Data Sheet Submission

UKP-GW-GL-057, Revision 0

Westinghouse Electric Company LLC
P.O. Box 355
Pittsburgh, PA 15230

REVISION HISTORY

Revision	Description of Change
0	Initial Submittal

TABLE OF CONTENTS

1 EXECUTIVE SUMMARY

This document has been prepared for the Generic Design Assessment (GDA) of the Westinghouse AP1000™* Nuclear Power Plant.

This document contains all the datasheets provided to the Nuclear Decommissioning Authority (NDA) to allow them to perform the Disposability Assessment for the waste generated by the AP1000 Nuclear Power Plant (Reference 1).

The data provided to the NDA represented the best information available at the time of issue. Since the completion of the disposability assessment, more recent data has become available and has been used for other aspects of the AP1000 GDA submission. Because the more recent data represents a general improvement in expected waste characteristics, e.g. reduced activity, the data provided to NDA represent a bounding case.

The datasheets provided to the NDA can be found in appendices 1 – 8 of this document.

* AP1000 is a trademark of Westinghouse Electric Company LLC

2 OBJECTIVES AND SCOPE

The objective and scope of this document is to provide documentary evidence of the datasheets and other supporting information that was provided to the Nuclear Decommissioning Authority (NDA) to support the GD A of the AP1000.

3 BACKGROUND

As part of the (GDA) process it must be shown that all wastes produced from the operation, maintenance, and decommissioning of an AP1000 will be disposable.

To show that the wastes produced throughout the lifecycle of an AP1000 are disposable, the NDA performed a disposability assessment of wastes that were expected to arise.

To facilitate this assessment Westinghouse provided the NDA with information on wastes that are expected to arise over the lifetime of an AP1000.

4 DISCUSSION

For each of the waste streams that the NDA were to assess the following information was provided;

- Datasheet;
- Safety Datasheet;
- Block Flow Diagram.

The appendices to this document have been divided by waste stream and contain the three types of information outlined above. (Note that in preparation of this report there was some reformatting of the datasheets, i.e. location of page breaks. The information contained in the data sheets in this report are the same as that given to the NDA.) The waste streams for which the information was provided to the NDA are:

- Spent Fuel (See Appendix 1);
- Intermediate Level Waste (ILW) Primary Resins (See Appendix 2);
- ILW Filters (See Appendix 3);
- Decommissioning ILW (See Appendix 4);
- Mixed Resins (See Appendix 5);
- Decommissioning Reactor Vessel (See Appendix 6);
- Low Level Waste (LLW) (See Appendix 7);
- Decommissioning LLW (See Appendix 8).

It should be noted that this information was provided to the NDA during November 2008 (and as described in section 1 above) represents a snapshot in time. More recent data became available after NDA completed the disposability assessment. The more recent data shows an improvement in waste characteristics; therefore, the data used by NDA represent a bounding case.

With regards to the Mixed Resin datasheets, this information includes data on Condensate Polishing Resin, which at the time of issue was considered to be ILW. Improved estimates of condensate polishing resin activity have lead to its reclassification as an LLW stream. The term ‘Mixed Resin’ is used to describe the contents of the resin tanks prior to transfer to the encapsulation process and refers strictly to mixed ILW resin. ILW resin and LLW resin will not be mixed.

Decommissioning waste and LLW has not been provided with a Block Flow Diagram (BFD) as this is not an appropriate manner in which to demonstrate the arising of this waste as it comes from multiple sources. No safety datasheet has been produced for LLW, as the risks are deemed to be minimal and also because a Safety datasheet has been produced for Decommissioning LLW that is expected to be of a similar nature.

5 CONCLUSION

The data provided to NDA represented the best information available at the time of issue to NDA. More recent data has described an improvement in expected waste characteristics, and therefore, the data provided to NDA represent a bounding case. The datasheets included in this document allowed NDA to perform the disposability assessment for waste generated by the AP1000 Nuclear Power Plant (Reference 1).

6 REFERENCES

1. LL 10568935. Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the Westinghouse Advanced Passive Pressurised Water Reactor (AP1000).

APPENDIX 1 - SPENT FUEL

Summary of Waste Package Physical / Chemical Parameters

Title: Spent Fuel Assembly	Waste type: High Level Waste
Source of documentation:	Westinghouse Electric Company Design Control Document (DCD) and FISPIN run.
Waste stream identifiers:	
Nature of waste stream:	Spent Fuel Assemblies after 1 year cooling based on a power cycle of 3 x (520 days at power + 27 days shutdown). For a fuel burn-up rate of 50 GWd/te, power = 32.03MW (data stated is for one MPC)
Raw waste volume:	
Proposed matrix:	N/A (Stored in ponds)
Package type:	Multi-Purpose Canister (MPC)
Raw waste per package:	32 fuel assemblies per MPC (264 fuel rods per assembly)
Wasteform density:	Uranium Dioxide = 10.96 gcm^{-3}
Waste package mass:	64.4 tonne (64431 kg) comprising: • 40.8 tonne empty MPC • 19.6 tonne Fuel • 4.0 tonne cladding • 0.031 tonne structure components (spacer rods, guide thimble.) - Stainless Steel items excluded.
Number of packages:	2 MPC's (64 fuel assemblies) every 18 months
Physical/chemical composition:	Metallic Rod Assemblies.

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	FISPIN Computer code
Reference date:	
Total package activity:	2.43E+04 TBq α 2.00E+06 TBq βγ
Waste classification: (based on mass of wasteform)	3.78E+05 GBq/te waste package α 3.11E+07 GBq/te waste package βγ HLW
Package A_2 multiples content[†]:	1.61E+07 A_2 TOTAL PACKAGE
Principal radionuclides contributing at least 1% to total A_2 content (%):	Am-241 2.39%, Cm-242 7.60%, Cm-244 20.58%, Pu-238 26.15%, Pu-239 1.93%, Pu-240 3.25%, Ce-144 10.43%, Cs-134 1.34%, Cs-137 1.12%, Pu-241 13.41%, Ru-106 7.15%, Sr-90 1.58%, Y-90 1.58%
Package heat output:(fuel only)	241kW
Principal radionuclides contributing at least 1% to total heat output (%):	
Soluble radiotoxic radionuclides: (FISPIN data)	Sr-90 7.613E+04 TBq Cs-134 1.511E+05 TBq Cs-137 1.084E+05 TBq
Radiotoxicity from Sr-90 and Cs-137[‡]:	Sv yr^{-1}
Waste container lifetime requirement[‡]:	years
Package fissile/fuel waste inventory (g):	U-233, U-235, U-238, Pu-239, Pu-241
Uranium enrichment (wt% U-235)	

† *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standard Series No. TS-R-1, 2005 Edition.

‡ *User Guide to DIQuest Derived Inventory Query and Scenario Toolkit*, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

Package Safeguards summary (g):	U-232	Pu-236
	U-233	Pu-238
	U-234	Pu-239
	U-235	Pu-240
	U-236	Pu-241
	U-238	Pu-242
	Total U	Total Pu
	Th-227	
	Th-228	
	Th-229	
	Th-230	
	Th-232	
	Th-234	
	Total Th	
External gamma dose rates:	$mSv\ hr^{-1}$ at 3m from unshielded package	
	$mSv\ hr^{-1}$ at 1m from package in SWTC-70	
	$mSv\ hr^{-1}$ at 1m from package in SWTC-285	
	*Dose rate given from HOLTEC International for the MPC is 0.00001 $mSv\ hr^{-1}$, following 5 year cooling and at a distance of 100 metres.	

1) FUEL RODS

(Activities, calculated A2 values and Heat values from FISPIN data).

α-emitting Radionuclides

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Ac-225	5.30E-07	8.83E-05	---
Ac-227	2.80E-07	3.11E-03	---
Am-241	3.84E+02	3.84E+05	---
Am-243	1.94E+01	1.94E+04	---
At-215	2.71E-12	---	---
At-217	5.30E-07	---	---
At-218	1.42E-12	---	---
At-219	2.31E-13	---	---
Bi-210m	2.50E-17	1.25E-15	---
Bi-211	6.76E-07	---	---
Bi-212	5.89E-03	9.82E-03	---
Bi-213	5.30E-07	---	---
Cf-249	2.53E-05	3.16E-02	---
Cf-250	2.77E-04	1.39E-01	---
Cf-251	1.95E-06	2.79E-03	---
Cf-252	2.97E-04	9.90E-02	---
Cm-241	5.31E-05	5.31E-05	---
Cm-242	1.22E+04	1.22E+06	---
Cm-243	2.68E+01	2.68E+04	---
Cm-244	6.63E+03	3.31E+06	---
Cm-245	1.00E+00	1.11E+03	---

α-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Cm-246	1.94E-01	2.16E+02	**---**
Cm-247	7.73E-07	7.73E-04	**---**
Cm-248	2.53E-06	8.42E-03	**---**
Cm-250	5.19E-11	---	**---**
Es-253	8.12E-10	---	**---**
Fr-221	5.30E-07	---	**---**
Gd-150	2.68E-15	---	**---**
Gd-152	8.30E-13	---	**---**
Hf-174	---	---	**---**
Nd-144	1.60E-09	---	**---**
Np-237	3.64E-01	1.82E+02	**---**
Os-186	---	---	**---**
Pa-231	5.13E-06	1.28E-02	**---**
Po-209	3.36E-18	---	**---**

α-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Po-210	3.72E-10	1.86E-08	**---**
Po-211	1.84E-09	---	**---**
Po-212	3.76E-03	---	**---**
Po-213	5.19E-07	---	**---**
Po-214	7.10E-09	---	**---**
Po-215	6.79E-07	---	**---**
Po-216	5.92E-03	---	**---**
Po-218	7.12E-09	---	**---**
Pu-236	6.55E-01	2.18E+02	**---**
Pu-238	4.21E+03	4.21E+06	**---**
Pu-239	3.11E+02	3.11E+05	**---**
Pu-240	5.23E+02	5.23E+05	**---**
Pu-242	2.03E+00	2.03E+03	**---**
Pu-244	6.82E-07	6.82E-04	**---**
Ra-223	6.83E-07	9.75E-05	**---**
Ra-224	5.95E-03	2.98E-01	**---**
Ra-226	7.13E-09	2.38E-06	**---**
Rn-217	6.36E-11	---	**---**
Rn-218	1.42E-15	---	**---**
Rn-219	6.81E-07	---	**---**
Rn-220	5.93E-03	---	**---**
Rn-222	7.13E-09	1.78E-06	**---**
Sm-146	9.83E-13	---	**---**

α-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Sm-147	2.62E-06	Unlimited	**---**
Sm-148	6.67E-11	---	**---**
Th-227	2.64E-07	5.29E-05	**---**
Th-228	5.92E-03	5.92E+00	**---**
Th-229	1.72E-07	3.44E-04	**---**
Th-230	5.61E-06	5.61E-03	**---**
Th-232	5.02E-11	Unlimited	**---**
U-232	1.72E-02	1.72E+00	**---**
U-233	5.70E-06	6.34E-05	**---**
U-234	1.39E-01	1.54E+00	**---**
U-235	1.33E-02	Unlimited	**---**
U-236	2.78E-01	Unlimited	**---**
U-238	2.24E-01	Unlimited	**---**
TOTAL α	**2.43E+04**	**1.00E+07**	**1.188E+03 W/te** **23.2 kW per MPC**

1) "--": data not available

2) Uranium A_2 multiples are based on the fast lung absorption data; medium and slow lung absorption data is also available.

βγ-emitting Radionuclides

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Ac-228	9.86E-12	1.97E-11	0.00E+00
Ag-108	1.52E-06	---	**4.00E+01**
Ag-108m	1.75E-05	2.50E-05	
Ag-110	2.17E+01	---	
Ag-110m	1.71E+03	4.27E+03	
Am-242	8.17E+00	---	0.00E+00
Am-242m	8.20E+00	8.20E+03	
Am-245	9.20E-08	---	
Am-246	1.56E-11	---	
AR 37	4.80E-08	1.20E-09	0.00E+00
Ar-39	3.35E-05	1.67E-06	
Ar-42	4.63E-15	---	---
AS 73	7.13E-10	1.78E-11	0.00E+00
AS 74	1.51E-10	1.68E-10	
Ba-133	4.87E-04	1.62E-04	**5.56E+02**
Ba-137M	1.03E+05	---	
Ba-138	---	---	
Ba-140	2.50E-03	8.33E-03	
Be- 7	7.26E-08	3.63E-09	0.00E+00
Be-10	2.27E-04	3.78E-04	
Bi-208	---	---	0.00E+00
Bi-209	---	---	
Bi-210	4.33E-10	7.21E-10	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Bi-214	7.11E-09	---	
Bi-215	2.24E-13	---	
Bk-249	6.34E-03	2.11E-02	0.00E+00
Br-82	1.14E-15	2.85E-15	0.00E+00
C-14	1.34E+00	4.45E-01	0.00E+00
Ca-41	3.75E-26	Unlimited	0.00E+00
Ca-45	---	0.00E+00	
Cd-109	1.14E-03	5.69E-04	0.00E+00
Cd-113	3.75E-14	---	
Cd-113m	3.94E+01	7.88E+01	
Cd-115m	2.91E+00	5.81E+00	
Ce-139	2.58E-03	1.29E-03	**3.06E+02**
Ce-141	4.20E+02	7.01E+02	
Ce-142	6.18E-11	---	
Ce-144	3.36E+05	1.68E+06	
Cf-253	**2.02E-11**	5.06E-10	0.00E+00

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Cl-36	1.02E-02	1.70E-02	0.00E+00
Cm-249	6.27E-14	---	**2.00E+00**
Co-57	---	0.00E+00	0.00E+00
Co-58	---	0.00E+00	
Co-60	5.82E-11	1.46E-10	
CR 51	---	0.00E+00	---
Cs-134	1.51E+05	2.16E+05	**2.29E+03**
Cs-135	5.40E-01	5.40E-01	
Cs-136	2.17E-04	4.33E-04	
Cs-137	1.08E+05	1.81E+05	
Dy-159	1.52E-05	7.61E-07	0.00E+00
Eu-150	1.61E-09	2.30E-09	**1.57E+02**
Eu-152	8.69E-01	8.69E-01	
Eu-154	1.22E+04	2.03E+04	
Eu-155	4.91E+03	1.64E+03	
Eu-156	1.22E-02	1.74E-02	
Fe-55	---	0.00E+00	0.00E+00
Fe-57	---	---	
Fe-59	1.94E-07	2.15E-07	
Fe-60	2.08E-10	1.04E-09	
Fr-223	3.86E-09	---	0.00E+00
Gd-153	4.04E+01	4.48E+00	0.00E+00
H-3	4.51E+02	1.13E+01	0.00E+00

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Hf-178m	---	---	0.00E+00
Hf-181	2.28E-07	4.57E-07	
Hf-182	3.67E-12	Unlimited	
Hg-203	---	0.00E+00	0.00E+00
Hg-206	8.22E-18	---	
Ho-163	6.88E-08	---	0.00E+00
Ho-166m	3.31E-03	6.62E-03	
I-125	1.82E-10	6.08E-11	0.00E+00
I-129	3.41E-02	Unlimited	
In-114	1.82E-02	---	0.00E+00
In-114m	1.88E-02	3.76E-02	
In-115	1.16E-11	---	
In-115m	2.03E-04	2.03E-04	
Ir-192	---	0.00E+00	---
K-40	3.87E-17	4.30E-17	0.00E+00
K-42	**4.63E-15**	2.32E-14	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Kr-81	4.41E-07	1.10E-08	**2.00E+01**
Kr-85	9.80E+03	9.80E+02	
La-137	3.55E-06	5.92E-07	0.00E+00
La-138	4.37E-11	---	
La-140	2.88E-03	7.19E-03	---
Lu-173	3.63E-10	4.54E-11	0.00E+00
Lu-174	1.31E-08	1.46E-09	
Lu-174m	9.07E-09	9.07E-10	
Lu-175	---	---	
Lu-176	1.45E-17	---	
Lu-177	5.45E-07	7.79E-07	
Lu-177m	2.39E-06	---	
Mn-54	---	0.00E+00	0.00E+00
Mn-55	---	---	
Mo-93	1.89E-13	9.45E-15	0.00E+00
Nb-91	2.51E-11	---	**2.74E+02**
Nb-91m	1.66E-11	---	
Nb-92	7.28E-12	---	
Nb-93m	2.00E-01	6.68E-03	
Nb-94	1.20E-04	1.72E-04	
Nb-95	4.13E+04	4.13E+04	
Nb-95m	2.11E+02	---	
Ni-59	---	---	0.00E+00

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Ni-63	1.08E-04	3.59E-06	
Np-236	5.13E-06	2.57E-06	0.00E+00
Np-238	3.69E-02	---	
Np-239	1.94E+01	4.86E+01	
Np-240	6.81E-07	---	
Os-191	---	0.00E+00	---
P-32	---	0.00E+00	---
Pa-232	8.22E-09	---	0.00E+00
Pa-233	3.64E-01	5.20E-01	
Pa-234	2.27E-01	---	---
Pb-204	---	---	0.00E+00
Pb-205	4.91E-23	Unlimited	
Pb-206	---	---	
Pb-207	---	---	
Pb-208	---	---	
Pb-209	5.30E-07	---	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Pb-210	4.32E-10	8.65E-09	
Pb-211	6.78E-07	---	
Pb-212	5.90E-03	2.95E-02	
Pb-214	7.11E-09	---	
Pd-103	1.04E-13	2.61E-15	0.00E+00
Pd-107	1.19E-01	Unlimited	
Pm-144	2.24E-10	3.20E-10	
Pm-145	1.62E-08	1.62E-09	
Pm-146	1.38E-04	---	**5.00E+01**
Pm-147	9.75E+04	4.88E+04	
Pm-148	3.26E+00	---	
Pm-148m	6.48E+01	9.26E+01	
Pr-143	7.98E-03	1.33E-02	
Pr-144	3.36E+05	---	**3.40E+03**
Pr-144M	5.03E+03	---	
Pt-193	---	0.00E+00	---
Pu-237	5.70E-03	2.85E-04	
Pu-241	1.30E+05	2.16E+06	**6.00E+00**
Pu-243	7.73E-07	---	
Pu-246	1.56E-11	---	
Ra-225	1.72E-07	4.30E-05	0.00E+00
Ra-228	9.85E-12	4.93E-10	
Rb-83	7.23E-05	3.62E-05	0.00E+00

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Rb-84	4.27E-05	4.27E-05	
Rb-86	2.61E-03	5.22E-03	
Rb-87	2.12E-05	Unlimited	
Re-187	2.90E-19	Unlimited	0.00E+00
Rh-101	9.02E-10	3.01E-10	
Rh-102	2.14E-05	4.28E-05	
Rh-102M	1.51E-05	7.55E-06	**3.05E+03**
Rh-103M	1.65E+03	4.13E+01	
Rh-106	2.30E+05	---	
Ru-103	1.67E+03	8.36E+02	**2.70E+01**
Ru-106	2.30E+05	1.15E+06	
S-35	7.23E-01	2.41E-01	0.00E+00
Sb-124	2.14E+01	3.57E+01	
Sb-125	1.06E+04	1.06E+04	**4.70E+01**
Sb-126	1.71E-01	4.27E-01	
Sb-126m	2.92E-01	---	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Sc-46	---	0.00E+00	---
Se-75	1.25E-10	4.17E-11	0.00E+00
Se-79	3.80E-02	1.90E-02	
Se-82	1.14E-15	---	
Si-32	---	0.00E+00	---
Sm-149	3.83E-12	---	0.00E+00
Sm-151	3.68E+02	3.68E+01	
Sn-117m	1.68E-07	4.20E-07	**2.00E+00**
Sn-119m	8.00E+00	2.67E-01	
Sn-121	2.06E+01	---	
Sn-121m	2.65E+01	2.94E+01	
Sn-123	5.46E+02	9.10E+02	
Sn-126	4.22E-01	1.05E+00	
Sr-85	8.77E-06	4.39E-06	**1.37E+02**
Sr-89	3.21E+03	5.35E+03	
Sr-90	7.61E+04	2.54E+05	
Ta-182	2.58E-08	5.16E-08	0.00E+00
Tb-157	1.24E-05	3.10E-07	0.00E+00
Tb-158	1.00E-04	1.00E-04	
Tb-160	4.14E+01	6.89E+01	
Tc-97	2.12E-10	Unlimited	0.00E+00
Tc-97m	8.65E-06	8.65E-06	
Tc-98	8.77E-09	1.25E-08	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Tc-99	1.37E+01	1.52E+01	
Te-121	5.67E-06	2.83E-06	**6.00E+00**
Te-121m	5.70E-06	1.90E-06	
Te-123	1.61E-12	---	
Te-123m	9.01E-05	9.01E-05	
Te-125m	2.65E+03	2.94E+03	
Te-127	1.06E+03	1.51E+03	
Te-127m	1.08E+03	2.16E+03	
Te-129	2.11E+01	3.52E+01	
Te-129M	3.06E+01	7.64E+01	
Th-231	1.33E-02	6.67E-01	0.00E+00
Th-234	2.24E-01	7.46E-01	
Tl-204	---	0.00E+00	0.00E+00
Tl-206	5.99E-16	---	
Tl-207	6.73E-07	---	
Tl-208	2.11E-03	---	

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W/te)
Tl-209	1.14E-08	---	
Tl-210	1.49E-12	---	
Tm-168	1.94E-08	---	0.00E+00
Tm-170	1.02E-05	1.70E-05	
Tm-171	6.69E-01	1.67E-02	
U-235m	3.11E+02	---	0.00E+00
U-237	3.17E+00	---	
U-240	6.81E-07	---	
V-50	---	---	---
W-181	---	0.00E+00	0.00E+00
W-185	5.80E-09	7.24E-09	
Xe-131M	8.49E-06	2.12E-07	0.00E+00
Y-88	5.87E-04	1.47E-03	**6.26E+02**
Y-89M	3.09E-01	---	
Y-90	7.61E+04	2.54E+05	
Y-91	9.00E+03	1.50E+04	
Zn-65	---	0.00E+00	0.00E+00
Zr-93	1.86E+00	Unlimited	**1.32E+02**
Zr-95	1.91E+04	2.39E+04	
TOTAL βγ	**2.00E+06**	**6.08E+06**	**1.113E+04 W/te** **218 kW per MPC**

"--": data not available

2) FUEL CLADDING

(Activities, calculated A_2 values and Heat values from FISPIN data).

Material used for the fuel cladding is ZIRLO which is assumed to be similar to Zircaloy-4

α-em itting Radionuclides

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
Hf-174	2.09E-15	---	---
Os-186	1.32E-14	---	---
Bi-210m	2.07E-12	1.04E-10	---
U-235	1.34E-09	Unlimited	---
U-236	1.50E-08	---	---
U-234	2.30E-08	2.55E-07	---
U-238	3.85E-08	Unlimited	---
Po-210	1.71E-06	8.56E-05	---
TOTAL α	**1.79E-06**	**8.59E-05**	---

1) "--": data not available

2) Uranium A_2 multiples are based on the fast lung absorption data; medium and slow lung absorption data is also available.

βγ-emitting Radionuclides

Isotope	Activity (TBq)	A2 multiples	Heat (W)
Ag-108	4.19E-09	---	---
Ag-108m	4.81E-08	6.87E-08	---
Ag-110	1.13E-07	---	---
Ag-110m	8.93E-06	2.23E-05	---
AR 37	7.97E-09	1.99E-10	---
Ar-39	8.69E-03	4.35E-04	---
Ar-42	2.68E-12	---	---
Ba-133	1.05E-25	3.51E-26	---
Ba-137M	2.95E-26	---	---
Ba-140	1.26E-43	4.21E-43	---
Be-10	3.20E-09	5.34E-09	---
Bi-208	9.86E-12	---	---
C-14	3.66E-02	1.22E-02	---
Ca-41	8.87E-05	Unlimited	---
Ca-45	3.62E-02	3.62E-02	---
Cd-109	5.85E-04	2.92E-04	---
Cd-113	1.89E-19	---	---
Cd-113m	8.97E-03	1.79E-02	---
Cd-115m	1.08E-04	2.15E-04	---
Ce-141	7.91E-39	1.32E-38	---
Ce-142	4.86E-55	---	---
Ce-144	2.08E-46	1.04E-45	---
Cl-36	1.70E-03	2.83E-03	---

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W)
Co-57	3.70E-05	3.70E-06	---
Co-58	1.63E-03	1.63E-03	---
Co-60	7.76E+01	1.94E+02	---
Cs-134	5.73E-16	8.19E-16	---
Cs-135	3.02E-23	3.02E-23	---
Cs-136	9.28E-27	1.86E-26	---
Cs-137	3.12E-26	5.20E-26	---
Fe-55	1.67E+01	4.18E-01	---
Fe-59	6.24E-03	6.93E-03	---
Fe-60	8.34E-11	4.17E-10	---
H-3	1.45E-05	3.62E-07	---
Hf-181	2.42E-01	4.83E-01	---
Hf-182	2.76E-07	Unlimited	---
HG203	2.03E-24	2.03E-24	---
I-129	6.21E-15	Unlimited	---
In-114	5.57E-06	---	---

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W)
In-114m	5.77E-06	1.15E-05	---
In-115	5.41E-17	---	---
Ir-192	6.17E-04	1.03E-03	---
K-40	2.39E-14	2.66E-14	---
K-42	2.68E-12	1.34E-11	---
Kr-81	7.47E-51	1.87E-52	---
La-140	1.46E-43	3.64E-43	---
Lu-176	7.07E-12	---	---
Mn-54	2.64E+00	2.64E+00	---
Mo-93	5.77E-04	2.89E-05	---
Nb-93m	2.57E-03	8.55E-05	---
Nb-94	1.14E+00	1.63E+00	---
Nb-95	3.18E+02	3.18E+02	---
Nb-95m	1.62E+00	---	---
Ni-59	1.22E-03	Unlimited	---
Ni-63	1.74E-01	5.81E-03	---
Os-191	3.32E-09	1.66E-09	---
P-32	2.08E-08	4.15E-08	---
Pb-204	6.28E-16	---	---
Pb-205	2.25E-08	Unlimited	---
Pd-107	7.27E-19	Unlimited	---
Pm-147	4.57E-52	2.28E-52	---
Pr143	2.90E-49	4.83E-49	---

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W)
Pr144	2.05E-46	---	---
Pt-193	3.48E-06	8.70E-08	---
Re-187	1.34E-08	Unlimited	---
Rh-106	3.12E-14	---	---
Ru-103	1.04E-06	5.22E-07	---
Ru-106	3.12E-14	1.56E-13	---
S-35	1.20E-01	4.00E-02	---
Sb-124	6.12E-02	1.02E-01	---
Sb-125	1.10E+02	1.10E+02	---
Sb-126	1.29E-07	3.22E-07	---
Sb-126m	2.09E-07	---	---
Sc-46	5.65E-04	1.13E-03	---
Se-79	1.13E-40	5.66E-41	---
SI 32	1.44E-10	2.89E-10	---
Sn-117m	3.81E-07	9.53E-07	---
Sn-119m	1.79E+01	5.98E-01	---
Sn-121	7.35E-02	---	---

βγ-emitting Radionuclides (continued)

Isotope	Activity (TBq)	A2 multiples	Heat (W)
Sn-121m	9.47E-02	1.05E-01	---
Sn-123	2.35E+00	3.92E+00	---
Sn-126	3.03E-07	7.57E-07	---
Ta-182	2.85E+01	5.71E+01	---
Tc-99	9.29E-06	1.03E-05	---
Te-123	9.36E-14	---	---
Te-125m	2.75E+01	3.06E+01	---
Te-127	5.14E-04	7.35E-04	---
Te-127m	5.25E-04	1.05E-03	---
Te-129	3.50E-12	5.83E-12	---
Te-129M	5.07E-12	1.27E-11	---
Tl-204	7.59E-25	1.08E-24	---
Tl-206	2.07E-12	---	---
V-50	1.63E-16	---	---
W-181	1.06E-01	3.52E-03	---
W-185	1.27E+00	1.58E+00	---
Xe-131M	1.15E-19	2.86E-21	---
Zn-65	1.45E-02	7.26E-03	---
TOTAL	**6.06E+02**	**7.21E+02**	---

"--": data not available

3) FUEL ZIRLO components (mainly fuel Guide)

(Activities, calculated A_2 values and Heat values from FISPIN data).

α-emitting Radionuclides

Isotope	Activity TBq	A_2 multiples	Heat (W)
Bi-210m	6.59E-14	3.30E-12	---
Hf-174	6.63E-17	---	---
Os-186	4.19E-16	---	---
Po-210	5.45E-08	2.72E-06	---
U-234	7.30E-10	8.12E-09	---
U-235	4.25E-11	---	---
U-236	4.78E-10	---	---
U-238	1.22E-09	---	---
TOTAL α	***5.69E-08***	***2.73E-06***	---

1) "--": data not available
2) Uranium A_2 multiples are based on the fast lung absorption data; medium and slow lung absorption data is also available.

βγ-emitting Radionuclides

Isotope	Activity TBq	A_2 multiples	Heat (W)
Ag-108	1.33E-10	---	---
Ag-108m	1.53E-09	2.18E-09	---
Ag-110	3.61E-09	---	---
Ag-110m	2.84E-07	7.10E-07	---
AR 37	2.53E-10	6.34E-12	---
Ar-39	1.78E-07	8.92E-09	---
Ar-42	2.50 E-17	---	---
Ba-133	3.35E-27	1.12E-27	---
Ba-137M	9.39E-28	---	---
Ba-140	4.02E-45	1.34E-44	---
Be-10	1.02E-10	1.70E-10	---
Bi-208	3.14E-13	---	---
C-14	1.16E-03	3.88E-04	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A_2 multiples	Heat (W)
Ca-45	1.15E-03	1.15E-03	---
Ca-41	2.82E-06	---	---
Cd-109	1.86E-05	9.29E-06	---
Cd-113	6.00E-21	---	---
Cd-113m	2.85E-04	5.70E-04	---
Cd-115m	3.43E-06	6.85E-06	---
Ce-141	2.52E-40	4.19E-40	---
Ce-142	1.55E-56	---	---
Ce-144	6.61E-48	3.31E-47	---
Cl-36	5.39E-05	8.98E-05	---
Co-57	1.18E-06	1.18E-07	---
Co-58	5.19E-05	5.19E-05	---
Co-60	2.47E+00	6.17E+00	---
Cs-134	1.82E-17	2.60E-17	---
Cs-135	9.60E-25	9.60E-25	---
Cs-136	2.95E-28	5.90E-28	---
Cs-137	9.93E-28	1.65E-27	---
Fe-55	5.31E-01	1.33E-02	---
Fe-59	1.98E-04	2.20E-04	---
Fe-60	2.65E-12	1.33E-11	---
H-3	4.61E-07	1.15E-08	---
Hf-175	1.71E-03	5.69E-04	---
Hf-181	7.68E-03	1.54E-02	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A_2 multiples	Heat (W)
Hf-182	8.78E-09	---	---
Hg-203	6.47E-26	6.47E-26	---
I-129	1.98E-16	---	---
In-114	1.77E-07	---	---
In-114m	1.84E-07	3.67E-07	---
In-115	1.72E-18	---	---
Ir-192	1.96E-05	3.27E-05	---
K-40	2.09E-19	2.32E-19	---
K-42	2.50E-17	1.25E-16	---
Kr-81	2.38E-52	5.94E-54	---
La-140	4.63E-45	1.16E-44	---
Lu-176	2.25E-13	---	---
Mn-54	8.38E-02	8.38E-02	---
Mo-93	1.84E-05	9.18E-07	---
Nb-93m	8.16E-05	2.72E-06	---
Nb-94	3.63E-02	5.19E-02	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A2 multiples	Heat (W)
Nb-95	1.01E+01	1.01E+01	---
Nb-95m	5.14E-02	---	---
Ni-59	3.89E-05	---	---
Ni-63	5.54E-03	1.85E-04	---
Os-191	1.06E-10	5.28E-11	---
P 32	6.60E-10	1.32E-09	---
Pb-204	2.00E-17	---	---
Pb-205	7.17E-10	---	---
Pd-107	2.31E-20	---	---
Pm-147	1.45E-53	7.26E-54	---
Pr-143	9.21E-51	1.54E-50	---
Pr-144	6.51E-48	---	---
Pt-193	1.11E-07	2.76E-09	---
Re-187	4.25E-10	---	---
Rh-106	9.91E-16	---	---
Ru-103	3.32E-08	1.66E-08	---
Ru-106	9.91E-16	4.96E-15	---
S-35	3.82E-03	1.27E-03	---
Sb-124	1.95E-03	3.25E-03	---
Sb-125	3.50E+00	3.50E+00	---
Sb-126	4.10E-09	1.02E-08	---
Sb-126m	6.66E-09	---	---
Sc-46	1.80E-05	3.59E-05	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A_2 multiples	Heat (W)
Se-79	3.60E-42	1.80E-42	---
Si-32	4.59E-12	9.18E-12	---
Sn-117m	1.21E-08	3.03E-08	---
Sn-119m	5.70E-01	1.90E-02	---
Sn-121	2.34E-03	---	---
Sn-121m	3.01E-03	3.34E-03	---
Sn-123	7.47E-02	1.25E-01	---
Sn-126	9.62E-09	2.40E-08	---
Ta-182	9.08E-01	1.82E+00	---
Tc-99	2.95E-07	3.28E-07	---
Te-123	2.98E-15	---	---
Te-125m	8.75E-01	9.72E-01	---
Te-127	1.64E-05	2.34E-05	---
Te-127m	1.67E-05	3.34E-05	---
Te-129	1.11E-13	1.86E-13	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A2 multiples	Heat (W)
Te-129M	1.61E-13	4.03E-13	---
Tl-204	2.41E-26	3.45E-26	---
Tl-206	6.59E-14	---	---
V-50	5.19E-18	---	---
W-181	3.36E-03	1.12E-04	---
W-185	4.03E-02	5.03E-02	---
Xe-131M	3.64E-21	9.10E-23	---
Zn-65	4.61E-04	2.31E-04	---
Zr-93	8.18E-04	---	---
Zr-95	4.67E+00	5.83E+00	---
TOTAL βγ	***2.39E+01***	***2.88E+01***	

"--": data not available

4) FUEL IN-718 components (mainly fuel structure)

(Activities, calculated A_2 values and Heat values from FISPIN data).

α-emitting Radionuclides

Isotope	Activity TBq	A_2 multiples	Heat (W)
Bi-210m	2.33E-16	1.16E-14	---
Os-186	7.28E-18	---	---
Po-210	1.92E-10	9.61E-09	---
TOTAL α	***1.92E-10***	***9.62E-09***	---

βγ-emitting Radionuclides

Isotope	Activity TBq	A_2 multiples	Heat (W)
Ag-108	8.64E-42	---	---
Ag-108m	9.93E-41	1.42E-40	---
Ag-110	3.29E-35	---	---
Ag-110m	2.59E-33	6.47E-33	---
Ar-37	1.42E-15	3.55E-17	---
Ar-39	6.91E-15	3.45E-16	---
Ar-42	5.50E-25	---	---
Be-10	2.22E-10	3.70E-10	---
Bi-208	1.11E-15	---	---
C-14	9.34E-09	3.11E-09	---
Ca-41	2.91E-36	---	---
Cd-109	1.01E-39	5.07E-40	---
Cd-113	3.86E-56	---	---
Cd-113m	1.41E-40	2.83E-40	---
Cd-115m	4.27E-45	8.53E-45	---
Cl-36	5.37E-10	8.94E-10	---
Co-57	6.52E-04	6.52E-05	---
Co-58	2.88E-02	2.88E-02	---
Co-60	8.72E+01	2.18E+02	---
Cr-51	7.64E-03	2.55E-04	---
Fe-55	5.59E+00	1.40E-01	---
Fe-59	2.24E-03	2.49E-03	---
Fe-60	3.00E-11	1.50E-10	---

βγ-emitting Radionuclides (continued)

Isotope	Activity TBq	A2 multiples	Heat (W)
H-3	6.50E-07	1.62E-08	---
Hg-203	2.29E-28	2.28E-28	---
In-114	3.95E-45	---	---
In-114m	4.09E-45	8.18E-45	---
Ir-192	8.93E-11	1.49E-10	---
K-40	4.38E-27	4.86E-27	---
K-42	5.50E-25	2.75E-24	---
Kr-81	5.05E-52	1.26E-53	---
Mn-54	8.79E-01	8.79E-01	---
Mo-93	1.73E-12	8.66E-14	---
Nb-94	1.11E-02	1.59E-02	---
Nb-95	1.01E-02	1.01E-02	---
Ni-59	2.16E-02	---	---
Ni-63	3.06E+00	1.02E-01	---
Os-191	8.91E-16	4.45E-16	---
P-32	3.23E-10	6.46E-10	---
Pb-204	7.05E-20	---	---
Pb-205	2.53E-12	---	---
Pd-107	1.57E-33	---	---
Pt-193	1.64E-13	4.09E-15	---
Re-187	4.07E-15	---	---
Rh-106	2.45E-28	---	---
Ru-103	5.30E-20	2.65E-20	---
Ru-106	2.45E-28	1.22E-27	---
S-35	8.65E-05	2.88E-05	---
Se-79	7.66E-42	3.83E-42	---
Si-32	1.42E-11	2.84E-11	---
Ta-182	1.57E-01	3.14E-01	---
Tc-99	3.62E-14	4.02E-14	---
Tl--204	8.52E-29	1.22E-28	---
Tl-206	2.33E-16	---	---
W-185	2.07E-03	2.59E-03	---
Zn-65	9.80E-04	4.90E-04	---
TOTAL βγ	***9.69E+01***	***2.19E+02***	---

"---": data not available

Safety Assessment Input Data Sheet

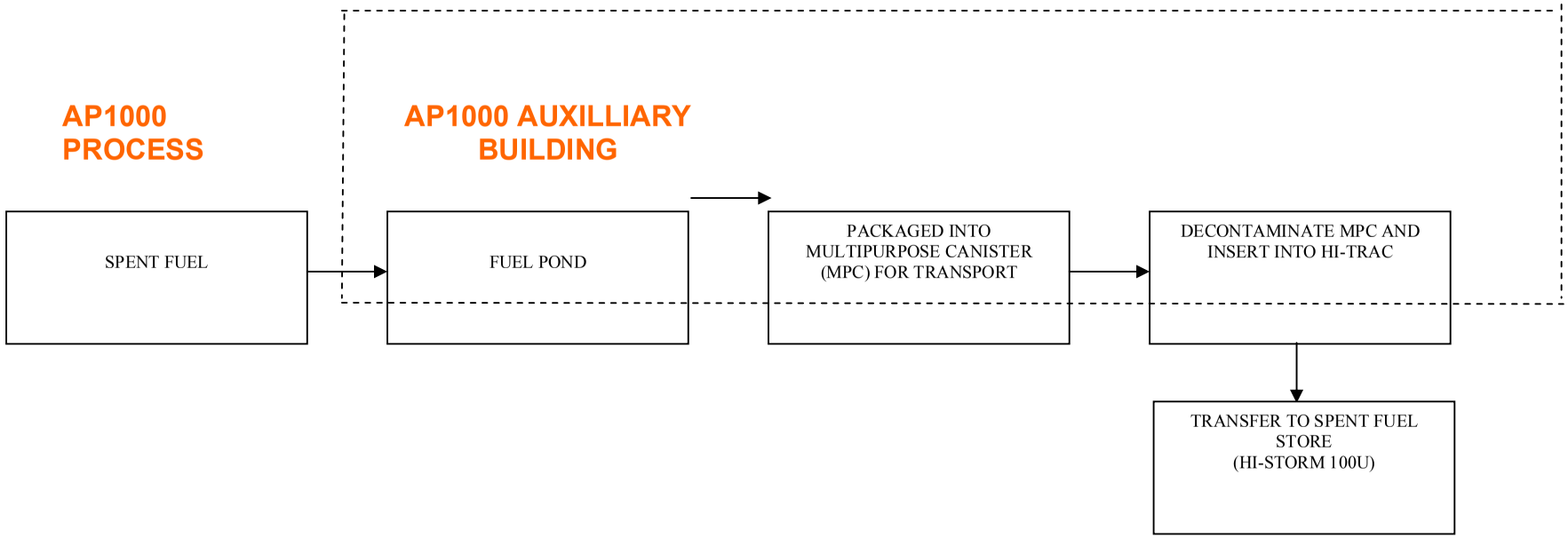
Title	Spent Fuel
File reference	
Document reference	63000333-000-00-111-D-201 Rev.3

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	N/A		
Submission available?	Yes		
Nature & Quantity evaluation available?	Yes		
Verified and agreed datasheets available?	Yes		
Basic package data			
Package mass	64.4 tonne (64,431 kg)		
Package type	Multi-Purpose Canister (MPC)		
Number of packages	2 MPC's per 18 months		
Average package Inventory	1.61E+07 A_2 (see datasheet for details)		
• waste stream type (shielded or unshielded)	shielded		
• organic materials	not significant		
• chemotoxic inventory	not significant		
• fissile content (see datasheet for details)	g average (U-235+Pu-239) g maximum (U-235+Pu-239)		
• other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	A_2 (per MPC) (see datasheet for details)		
Enrichment			
Heat generation	241 kW average ± kW maximum (per MPC)		
Dose rates (mSv/hr)	Dose rate given from HOLTEC International for the MPC is 0.00001 mSv hr^{-1}, following 5 year cooling and at a distance of 100 metres.		
• at 3m from a bare waste package:	mSv/hr average mSv/hr maximum		

• at 1m from SWTC-70 with four packages	mSv/hr average mSv/hr maximum		
• contact dose for SWTC-70	mSv/hr average mSv/hr maximum		
• at 1m from SWTC-285 with four packages	mSv/hr average mSv/hr maximum		
• contact dose for SWTC-285	mSv/hr average mSv/hr maximum		
Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	Yes		
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	Yes		To be provided
Source of gas generation rates	SMOGG calculation		
• bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
• tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
• C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
• radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
• radionuclide volatility group fire RF values $<1x10^{-5}$ (Pending further evaluation of waste packages)[1]	I –	II –	III –
	IV –	V –	VI –
• non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
• impact RF values	10m drop –		
	25m drop –		

Other issues		
Is the inventory considered in the national inventory?	No	-
Interim storage proposals	Yes	ILW Store to be located on site
Compatibility with Concept (*eg* any special emplacement requirements)	No	-
Previous Assessment Reports		
Pre-conceptual stage	Yes	
Conceptual stage	Current assessment is Conceptual stage	
Interim stage	-	
Final stage	-	
Comments		
[1] Data Reference taken from Magnox document ES-ET-G-069, Radiological Consequences Assessment Methodology and Guidance Document (issue1, March 04).		

Waste Stream Assessment – High Level Process Block Flow Diagram



APPENDIX 2 - ILW PRIMARY RESINS

Summary of Waste Package Physical / Chemical Parameters

Title: Primary Resins	Waste type: Intermediate Level Waste
Source of documentation:	Mass balance (Rev.3) and WEC Safety Security & Environment Report (SSER)
Waste stream identifiers:	
Nature of waste stream:	Organic Resins including CVCS Mixed Bed Resin, CVCS Cation Bed, SFS demineralizer, WLS units 2,3,4. Inorganic Resin from WLS unit 1 [4].
Raw waste volume:	7.79 m^3 per year (expected) 15.58 m^3 per year (maximum)[3].
Proposed matrix:	Cementitious Grout
Package type:	3 m^3 drum (reference 1 - T/WPS/320)
Raw waste per package:	0.75 m^3 (based on previous formulation trials at Sizewell B of 25% loading)
Wasteform density:	1.148 tem^{-3} (assumed)
Waste package mass:	4,640kg (4.64 te) comprising: • 583 kg empty 3 m^3 drum and lid • 3561 kg grouted waste (assuming 2.39 m^3 with density 1490 kgm^{-3}). • 495 kg capping grout (assuming 0.3 m^3 with density 1650 kgm^{-3}).
Number of packages:	11 drums per year (expected) 21 drums per year (maximum)[3].
Physical/chemical composition:	The waste in an average package is expected to comprise: • Spherical bead/ resin compound

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-111-C-0008)			
Reference date:	As generated.			
Total package activity:	0 TBq α 2.51 TBq βγ			
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 5,402 GBq t^{-1} βγ ILW			
Package A_2 multiples content [1] :	3.02 A_2			
Principal radionuclides contributing at least 1% to total A_2 content (%):	Cs-134 Cs-137 Cs-136 Co-60	30% 33% 8% 1%	I-131 I-132 I-135	17% 1% 1%
Package heat output:	2.01 W			
Principal radionuclides contributing at least 1% to total heat output (%):	Cs-134 Cs-137	87% 9%	Co-60	3%
Soluble radiotoxic radionuclides:	Sr-90 Cs-134 Cs-137	7.22E-03 TBq 6.34 TBq 6.05 TBq		
Radiotoxicity from Sr-90 and Cs-137[2]:	Sv yr^{-1}			
Waste container lifetime requirement[‡]:	- years (This is a Nirex compliant package)			
Package fissile/fuel waste inventory (g):	U-233 U-235 U-238	N/A	Pu-239 Pu-241	N/A
Uranium enrichment (wt% U-235)	N/A			

Package Safeguards summary (g):	U-232 U-233 U-234 U-235 U-236 U-238	N/A	Pu-236 Pu-238 Pu-239 Pu-240 Pu-241 Pu-242	N/A
	Total U		Total Pu	
	Th-227 Th-228 Th-229 Th-230 Th-232 Th-234	N/A		
	Total Th			
External gamma dose rates:	0.00178 mSv hr^{-1} at 3m from unshielded package			
	6.918 mSv hr^{-1} at 1m from package in SWTC-70			
	0.001069 mSv hr^{-1} at 1m from package in SWTC-285			
	Note 4:			

Notes:

1. Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standard Series No. TS R 1, 2005 Edition.

2. User Guide to DIQuest Derived Inventory Query and Scenario Toolkit, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

3. The maximum spent resin production rate has been assumed to occur every 5 years due to fuel defects leading to an increase in spent ion-exchnage resin production.

4. Primary resin is the bounding case, the results of which indicate the packages are within the design limits.

Waste Package βγ-emitting Radionuclides as generated (maximum annual)

Isotope	TBq	A_2 Multiple	Watts
I-129	2.28E-06	Unlimited	2.88E-08
Fe-55	7.55E-02	1.89E-03	6.94E-05
Fe-59	3.87E-03	4.30E-03	9.20E-05
Cs-137	6.05E+00	1.01E+01	1.82E-01
Sr-90	7.22E-03	2.41E-02	2.27E-04
Mn-54	7.82E-02	7.82E-02	1.05E-02
Co-60	1.62E-01	4.06E-01	6.76E-02
Cs-134	6.34E+00	9.06E+00	1.75E+00
Ag-108m	--	--	--
Ag-110	--	--	--
Ag-110m	--	--	--
Am-242m	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
Ba-133	--	--	--
Ba-136m	--	--	--
Ba-137m	5.74E+00	--	--
Ba-140	7.88E-03	2.63E-02	--
Be-10	--	--	--
Bi-208	--	--	--
Br-83	4.66E-03	--	--
Br-84	2.27E-04	--	--
Br-85	2.48E-06	--	--
C-14	--	--	--
Ca-41	--	--	--
Cd-109	--	--	--
Cd-113m	--	--	--
Ce-141	--	--	--
Ce-143	--	--	--
Ce-144	--	--	--
Cl-36	--	--	--
Co-58	2.01E-01	2.01E-01	--
Cr-51	2.62E-02	8.72E-04	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A_2 Multiple	Watts
Cs-135	--	--	--
Cs-136	1.14E+00	2.28E+00	--
Cs-138	7.02E-03	--	--
Eu-152	--	--	--
Eu-154	--	--	--
Eu-155	--	--	--
Gd-153	--	--	--
H-3	--	--	--
Hf-178m	--	--	--
Hf-182	--	--	--
Ho-163	--	--	--
Ho-166m	--	--	--
I-130	5.96E-03	--	--
I-131	3.61E+00	5.16E+00	--
I-132	1.30E-01	3.26E-01	--
I-133	1.10E+00	1.83E+00	--
I-134	4.84E-03	1.61E-02	--
I-135	2.52E-01	4.21E-01	--
K-40	--	--	--
Kr-81	--	--	--
Kr-83m	--	--	--
Kr-85	--	--	--
Kr-85m	--	--	--
La-137	--	--	--
La-138	--	--	--
La-140	7.09E-03	1.77E-02	--
Lu-176	--	--	--
Mn-56	3.15E-02	1.05E-01	--
Mo-93	--	--	--
Mo-99	xx	--	--
Na-24	--	--	--
Nb-91	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) - continued

Isotope	TBq	A_2 Multiple	Watts
Nb-92	--	--	--
Nb-93m	--	--	--
Nb-94	--	--	--
Nb-95	xx	--	--
Nb-95m	--	--	--
Ni-59	--	--	--
Ni-63	--	--	--
Pa-233	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Pd-107	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Pr-143	--	--	--
Pr-144	--	--	--
Pt-193	--	--	--
Pu-241	--	--	--
Ra-225	--	--	--
Ra-228	--	--	--
Rb-86	1.97E-02	3.93E-02	--
Rb-87	--	--	--
Rb-88	1.67E-02	--	--
Rb-89	6.51E-04	--	--
Rh-106	xx	--	--
Ru-103	xx	--	--
Ru-106	xx	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Se-79	--	--	--
Sm-151	--	--	--
Sn-119m	--	--	--
Sn-121m	--	--	--
Sn-123	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) – continued

Isotope	TBq	A_2 Multiple	Watts
Sn-126	--	--	--
Sr-89	3.02E-02	5.03E-02	--
Sr-91	7.68E-04	2.56E-03	--
Sr-92	6.60E-05	2.20E-04	--
Tc-97	--	--	--
Tc-99	xx	--	--
Tc-99m	xx	--	--
Te-125m	xx	--	--
Te-127	xx	--	--
Te-127m	xx	--	--
Te-129	xx	--	--
Te-129m	xx	--	--
Te-131	--	--	--
Te-131m	xx	--	--
Te-132	xx	--	--
Th-232	--	--	--
Th-234	--	--	--
Tl-204	--	--	--
Tm-170	--	--	--
U-238	xx	--	--
Xe-131m	--	--	--
Xe-133	--	--	--
Xe-135	--	--	--
Y-90	7.09E-03	2.36E-02	--
Y-91	3.63E-04	6.05E-04	--
Y-91m	2.31E-04	1.81E-04	--
Y-92	2.78E-05	--	--
Y-93	6.01E-08	2.00E-07	--
Zn-65	xx	--	--
Zr-93	xx	--	--
Zr-95	xx	--	--

Waste Package α-emitting Radionuclides as generated (maximum annual)

Isotope	TBq	A2 Multiple	Watts
Ac-227	--	--	--
Am-241	--	--	--
Am-243	--	--	--
Bi-210m	--	--	--
Cf-249	--	--	--
Cf-250	--	--	--
Cf-251	--	--	--
Cf-252	--	--	--
Cm-242	--	--	--
Cm-243	--	--	--
Cm-244	--	--	--
Cm-245	--	--	--
Cm-246	--	--	--
Cm-248	--	--	--
Np-237	--	--	--
Pa-231	--	--	--
Po-210	--	--	--
Pu-236	--	--	--
Pu-238	--	--	--
Pu-239	--	--	--
Pu-240	--	--	--
Pu-242	--	--	--
Ra-223	--	--	--
Ra-226	--	--	--
Sm-147	--	--	--
Te-134	--	--	--
Th-227	--	--	--
Th-228	--	--	--
Th-229	--	--	--
Th-230	--	--	--
Tm-171	--	--	--
U-232	xx	--	--
U-233	xx	--	--

Waste Package α-emitting Radionuclides as generated (maximum annual) (continued)

Isotope	TBq	A_2 Multiple	Watts
U-234	xx	--	--
U-235	xx	--	--
U-236	xx	--	--

Values shown as "xx" are those from activities < 0.2 Bq/box.

"--" data not available

Safety Assessment Input Data Sheet

Title	Primary Resins ILW Operational Waste
File reference	
Document reference	63000333-000-00-111-D-208 Rev.3

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	Not required, tasks as per ITT		
Submission available?	Yes		Provided
Nature & Quantity evaluation available?	Yes		To be provided
Verified and agreed datasheets available?	Yes		To be provided
Basic package data			
Package mass	4,640 kg		
Package type	3 m^3 drum		
Number of packages	11 per year expected 21 per year maximum[1]		
Average package Inventory	~ A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	shielded		
organic materials	Yes, spherical resin/bead compounds		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	3.11 A_2 (see datasheet for details)		
Enrichment	N/A		
Heat generation	~ W average 1.83 W maximum		
Dose rates (mSv/hr)	Calculated using Microshield		
at 3m from a bare waste package: [2]	0.00178 mSv/hr		
at 1m from SWTC-70 with four packages [2]	6.918 mSv/hr		
contact dose for SWTC-70 [2]	18.67 mSv/hr		
at 1m from SWTC-285 with four packages [2]	0.001069 mSv/hr		

contact dose for SWTC-285 [2]	0.001759 mSv/hr		
Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	Yes		To be provided
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	Yes		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values[2]	I – 1.0	II – 2.5E-1	III – 1.3E-02
	IV – 1.3E-02	V – 3.4E-04	VI – 3.4E-04
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values[2]	10m drop – 1.0E-05		
	25m drop – 1.0E-05		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	ILW Store to be located on site	
Compatibility with Concept (*eg* any special emplacement requirements)	No	-	
Previous Assessment Reports			
Pre-conceptual stage	Yes		
Conceptual stage	Current assessment is Conceptual stage		
Interim stage	-		
Final stage	-		

Comments
1 The maximum spent resin production rate has been assumed to occur every 5 years due to fuel defects leading to an increase in spent ion-exchange resin production. 2. Initial Dose Rate shielding calculations performed for "worst case" Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The does rate with 0.58m concrete shielding @ 3m = 0.00178 mSv/hr. Actual calculated values to follow.

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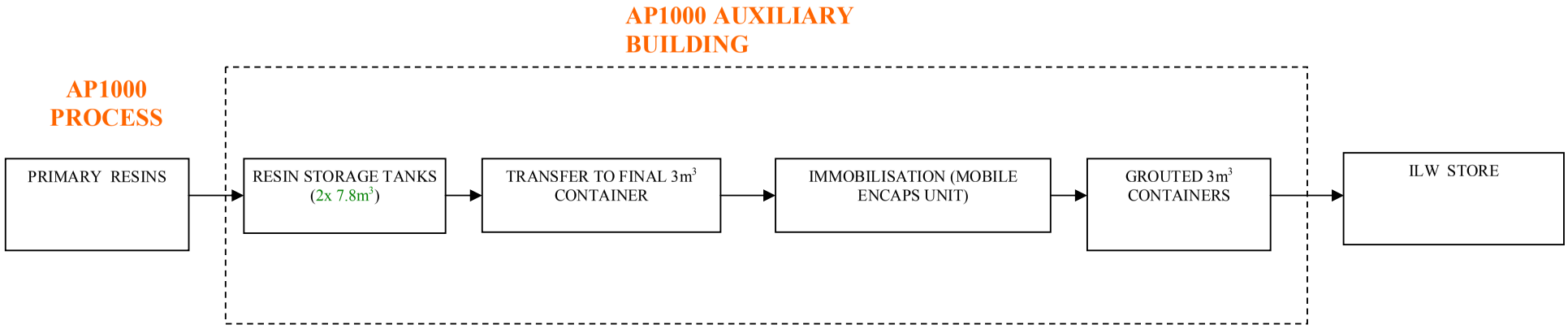
Waste Stream Assessment – High Level Process Block Flow Diagram



APPENDIX 3 - ILW FILTERS

Summary of Waste Package Physical / Chemical Parameters

Title: Filter Cartridges	Waste type: Intermediate Level Waste
Source of documentation:	Mass balance (Rev.3) and WEC Safety Security & Environment Report (SSER)
Waste stream identifiers:	
Nature of waste stream:	Primary Circuit Filters, including CVS RC, SFS, WLS inlet and outlet and WSS resin fines filters.
Raw waste volume:	0.011 m^3 (per filter), (25 filters per normal year, 42 filters maximum)[1]
Proposed matrix:	Cementitious Grout
Package type:	3 m^3 box (reference 1 - T/WPS/310)
Raw waste per package:	0.9 m^3 per box[3]
Waste form density:	326 kgm^{-3}
Waste package mass:	5,790 kg (5.79 te) comprising: 868 kg empty 3 m^3 box waste container 4136 kg matrix grout (assuming density 2350 kgm^{-3}) 291 kg waste (filters) 495 kg capping grout (assuming 0.3 m^3 with density 1650 kgm^{-3})
Number of packages:	2 boxes in 5 years
Physical/chemical composition:	The waste in an average package is expected to comprise: 291 kg metallic cylinder & polypropylene cartridge

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-111-C-0008)			
Reference date:	As generated.			
Total package activity:	0 TBq α 2.76 TBq βγ normal – 3.26 TBq βγ Maximum			
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 476.5 GBq t^{-1} βγ normal – 562.4 GBq t^{-1} βγ Maximum ILW			
Package A_2 multiples content[1]:	2.54 A_2			
Principal radionuclides contributing at least 1% to total A_2 content (%):	Cs-137 36% Cs-134 32% I-131 19% I-135 2% I-132 1% Co-60 2%			
Package heat output:	0.18 W			
Principal radionuclides contributing at least 1% to total heat output (%):	Cs-134 87 Cs-137 9		Co-60 3	
Soluble radiotoxic radionuclides:	Sr-90 6.57E-04 TBq Cs-134 5.77E-01 TBq Cs-137 5.51E-01 TBq			
Radiotoxicity from Sr-90 and Cs-137[2]:	Sv yr^{-1}			
Waste container lifetime requirement[‡]:	- years (from) (This is a Nirex compliant package)			
Package fissile/fuel waste inventory (g):	U-233 -- U-235 U-238		Pu-239 -- Pu-241	
Uranium enrichment (wt% U-235)	--			
Package Safeguards summary (g):	U-232 -- U-233 U-234 U-235 U-236 U-238 Total U		Pu-236 -- Pu-238 Pu-239 Pu-240 Pu-241 Pu-242 Total Pu	

	Th-227	--
	Th-228	
	Th-229	
	Th-230	
	Th-232	
	Th-234	
	Total Th	
External gamma dose rates:	(TBC) mSv hr^{-1} at 3m from unshielded package	
	(TBC) mSv hr^{-1} at 1m from package in SWTC-70	
	(TBC) mSv hr^{-1} at 1m from package in SWTC-285	

Notes:

1. Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standard Series No. TS R 1, 2005 Edition.

2. User Guide to DIQuest Derived Inventory Query and Scenario Toolkit, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

3. Based on a 3m3 box and filter geometry we have estimated that the maximum useable volume within a box will be 30% = 0.9m3. Until the loading mechanism is known, it has been assumed that a box will contain 25 filters. This also corresponds to the normal number of primary filters that will be produced per year.

4: Primary resin is the bounding case, the results of which indicate the packages are within the design limits.

Waste Package βγ-emitting Radionuclides as generated (max. annual).

Isotope	TBq	A_2 Multiple	Watts
I-129	2.07E-07	Unlimited	2.62E-09
Fe-55	6.87E-03	1.72E-04	6.31E-06
Fe-59	3.52E-04	3.91E-04	8.36E-06
Sr-90	6.57E-04	2.19E-03	2.06E-05
Mn-54	7.11E-03	7.11E-03	9.58E-04
Co-60	1.48E-02	3.69E-02	6.15E-03
Cs-137	5.51E-01	9.18E-01	1.65E-02
Cs-134	5.77E-01	8.24E-01	1.59E-01
Ag-108m	--	--	--
Ag-110	--	--	--
Ag-110m	--	--	--
Am-242m	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
Ba-133	--	--	--
Ba-136m	--	--	--
Ba-137m	5.22E-01	--	--
Ba-140	7.17E-04	2.39E-03	--
Be-10	--	--	--
Bi-208	--	--	--
Br-83	4.24E-04	--	--
Br-84	2.06E-05	--	--
Br-85	2.25E-07	--	--
C-14	--	--	--
Ca-41	--	--	--
Cd-109	--	--	--
Cd-113m	--	--	--
Ce-141	--	--	--
Ce-143	--	--	--
Ce-144	--	--	--
Cl-36	--	--	--
Co-58	1.83E-02	1.83E-02	--
Cr-51	2.38E-03	7.93E-05	--
Cs-135	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A_2 Multiple	Watts
Cs-136	--	--	--
Cs-138	6.39E-04	--	--
Eu-152	--	--	--
Eu-154	--	--	--
Eu-155	--	--	--
Gd-153	--	--	--
H-3	--	--	--
Hf-178m	--	--	--
Hf-182	--	--	--
Ho-163	--	--	--
Ho-166m	--	--	--
I-130	5.42E-04	--	--
I-131	3.28E-01	4.69E-01	--
I-132	1.19E-02	2.97E-02	--
I-133	1.00E-01	1.67E-01	--
I-134	4.40E-04	1.47E-03	--
I-135	2.30E-02	3.83E-02	--
K-40	--	--	--
Kr-81	--	--	--
Kr-83m		--	--
Kr-85	--	--	--
Kr-85m		--	--
La-137	--	--	--
La-138	--	--	--
La-140	6.45E-04	1.61E-03	--
Lu-176	--	--	--
Mn-56	2.86E-03	9.54E-03	--
Mo-93	--	--	--
Mo-99	xx	--	--
Na-24	--	--	--
Nb-91	--	--	--
Nb-92	--	--	--
Nb-93m	--	--	--
Nb-94	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) –(continued)

Isotope	TBq	A_2 Multiple	Watts
Nb-95	xx	--	--
Nb-95m	--	--	--
Ni-59	--	--	--
Ni-63	--	--	--
Pa-233	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Pd-107	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Pr-143	--	--	--
Pr-144	--	--	--
Pt-193	--	--	--
Pu-241	--	--	--
Ra-225	--	--	--
Ra-228	--	--	--
Rb-86	1.79E-03	3.58E-03	--
Rb-87	--	--	--
Rb-88	1.52E-03	--	--
Rb-89	5.92E-05	--	--
Rh-106	xx	--	--
Ru-103	xx	--	--
Ru-106	xx	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Se-79	--	--	--
Sm-151	--	--	--
Sn-119m	--	--	--
Sn-121m	--	--	--
Sn-123	--	--	--
Sn-126	--	--	--
Sr-89	2.75E-03	4.58E-03	--
Sr-91	6.99E-05	2.33E-04	--
Sr-92	6.00E-06	2.00E-05	--
Tc-97	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A_2 Multiple	Watts
Tc-99	--	--	--
Tc-99m	xx	--	--
Te-125m	xx	--	--
Te-127	xx	--	--
Te-127m	xx	--	--
Te-129	xx	--	--
Te-129m	xx	--	--
Te-131	--	--	--
Te-131m	xx	--	--
Te-132	xx	--	--
Th-234	--	--	--
Tl-204	--	--	--
Tm-170	--	--	--
Tm-171	--	--	--
Xe-131m	--	--	--
Xe-133	--	--	--
Xe-135	--		--
Y-90	6.45E-04	2.15E-03	--
Y-91	3.30E-05	5.50E-05	--
Y-91m	2.10E-05	1.05E-05	--
Y-92	2.52E-06	1.26E-05	--
Y-93	5.46E-09	1.82E-08	--
Zn-65	xx	--	--
Zr-93	--	--	--
Zr-95	xx	--	--

Values shown as "xx" are those from activities < 5.1 Bq/box.

"--" data not available

Waste Package α-emitting Radionuclides as generated

Isotope	TBq	A_2 Multiple	Watts
Ac-227	--	--	--
Am-241	--	--	--
Am-243	--	--	--
Bi-210m	--	--	--
Cf-249	--	--	--
Cf-250	--	--	--
Cf-251	--	--	--
Cf-252	--	--	--
Cm-242	--	--	--
Cm-243	--	--	--
Cm-244	--	--	--
Cm-245	--	--	--
Cm-246	--	--	--
Cm-248	--	--	--
Np-237	--	--	--
Pa-231	--	--	--
Po-210	--	--	--
Pu-236	--	--	--
Pu-238	--	--	--
Pu-239	--	--	--
Pu-240	--	--	--
Pu-242	--	--	--
Ra-223	--	--	--
Ra-226	--	--	--
Sm-147	--	--	--
Te-134	--	--	--
Th-227	--	--	--
Th-228	--	--	--
Th-229	--	--	--
Th-230	--	--	--
Th-232	--	--	--
U-232 (1)	--	--	--
U-233 (1)	--	--	--
U-234 (1)	--	--	--

Waste Package α-emitting Radionuclides as generated (continued)

Isotope	TBq	A_2 Multiple	Watts
U-235 (1)	--	--	--
U-236 (1)	--	--	--
U-238 (1)	--	--	--

"--" data not available

Safety Assessment Input Data Sheet

Title	Filter Cartridges ILW Operational Waste
File reference	
Document reference	63000333-000-00-111-D-205 Rev.3

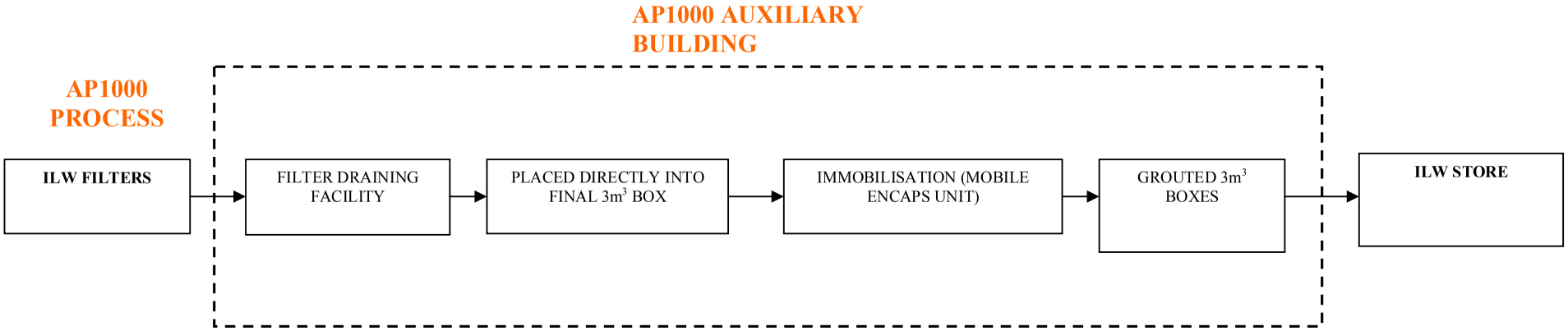
Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	N/A		
Submission available?	Yes		
Nature & Quantity evaluation available?	Yes		
Verified and agreed datasheets available?	Yes		
Basic package data			
Package mass	5,790 kg		
Package type	$3m^3$ box		
Number of packages	2 boxer in 5 years[1]		
Average package Inventory	~ A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	shielded		
organic materials	not significant		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	2.54 A_2 (see datasheet for details)		
Enrichment	N/A		
Heat generation	~ W average 0.18 W maximum		
Dose rates (mSv/hr)	Calculated using Microshield		
at 3m from a bare waste package[2]			
at 1m from SWTC-70 with four packages[2]			
contact dose for SWTC-70[2]			
at 1m from SWTC-285 with four packages[2]			
contact dose for SWTC-285[2]			

Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	Yes		
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	Yes		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values[1]	I – 1.0	II – 2.5E-1	III – 1.3E-02
	IV – 1.3E-02	V – 3.4E-04	VI – 3.4E-04
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values[1]	10m drop – 1.0E-05		
	25m drop – 1.0E-05		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	ILW Store located on site	
Compatibility with Concept (*eg* any special emplacement requirements)	No	-	
Previous Assessment Reports			
Pre-conceptual stage	Yes		
Conceptual stage	Current assessment is Conceptual stage		
Interim stage	-		
Final stage	-		

Comments
1. Based on a 3m3 box and filter geometry we have estimated that the maximum useable volume within a box will be 30% = 0.9m3. Until the loading mechanism is known, it has been assumed that a box will contain 25 filters. This also corresponds to the normal number of primary filters that will be produced per year. 2 Initial Dose Rate shielding calculations performed for "worst case" Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The worst case dose rate with 0.58m of concrete shielding @ 1m = 0.00051mSv/hr. Actual calculated values for Filter Cartridge packages to follow. 3. The information given is for a $3m^3$ drum, it has been assumed that a $3m^3$ box has the same values.

•

Waste Stream Assessment – High Level Process Block Flow Diagram



APPENDIX 4 - DECOMMISSIONING ILW

Summary of Waste Package Physical / Chemical Parameters

Title: Decommissioning Waste –ILW steel waste	Waste type: Intermediate Level Waste
Source of documentation:	Decommissioning Mass balance (Rev.3), Westinghouse Electric Company Design Control Document and ORIGEN-ARP (WEC Software) and FISPIN (Rolls-Royce software) runs.
Waste stream identifiers:	
Nature of waste stream:	Radial shield Baffle, barrel, neutron pads and formers; Upper and Lower Axial Shield, Loop pipes, Radial shield insulation and liner
Raw waste volume:	153.31 te (19.7 m^3)
Proposed matrix:	Concrete (grouted waste)
Package type:	(grouted) 3m^3 boxes disposed as ILW
Raw waste per package:	0.90 m^3 in 3m^3 box
Wasteform density:	7800 te/m^3
Waste package mass:	11.89 te (11,885 kg) of one 3m^3 box comprising: • 868 kg empty 3 m^3 box and lid • 495 kg capping grout • 10,522 kg grouted waste (assuming 2.39 m^3 with density 1490 kgm^{-3}).
Number of packages:	22 3m^3 box
Physical/chemical composition:	Stainless Steel

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-111-C-0008)
Reference date:	As generated
Total package maximum activity:	0 TBq α 3,800. TBq βγ in $3m^3$ box
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 3.2 E+05 GBq/te βγ in $3m^3$ boxes after 10 years decay ILW
Package A_2 multiples content[4]:	1,359 A_2
Principal radionuclides contributing at least 1% to total A_2 content (%):	Co-60 93% Ni-63 4% Fe-55 3%
Package heat output:	217 W
Principal radionuclides contributing at least 1% to total heat output (%):	Co-60 97% Ni-63 2%
Soluble radiotoxic radionuclides:	Sr-90 0 Cs-134 0 Cs-137 0
Radiotoxicity from Sr-90 and Cs-137[5]:	Sv yr^{-1}
Waste container lifetime requirement[‡]:	years
Package fissile/fuel waste inventory (g):	
Uranium enrichment (wt% U-235)	
Package Safeguards summary (g):	
External gamma dose rates:	mSv hr^{-1} at 3m from unshielded package mSv hr^{-1} at 1m from package in SWTC-70 mSv hr^{-1} at 1m from package in SWTC-285

4 *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standard Series No. TS-R-1, 2005 Edition.

5 *User Guide to DIQuest Derived Inventory Query and Scenario Toolkit*, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled.

Activities, calculated A_2 and Heat values from Origen data apart from C-14 data obtained from FISPIN.

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
C-14	**1.04E-01**	**3.47E-02**	**8.25E-04**
Ca-41	0.00E+00	Unlimited	0.00E+00
Eu-152	0.00E+00	0.00E+00	0.00E+00
H-3	0.00E+00	0.00E+00	0.00E+00
Ho-166m	0.00E+00	0.00E+00	0.00E+00
Sm-151	0.00E+00	0.00E+00	0.00E+00
Ni-59	1.10E+01	Unlimited	1.30E-02
Nb-93m	5.04E+01	1.68E+00	2.34E-01
Fe-55	1.52E+03	3.81E+01	1.40E+00
Ni-63	1.76E+03	5.86E+01	4.83E+00
Co-60	5.04E+02	1.26E+03	2.10E+02
Ag-108m	--	--	--
Ag-110	--	--	--
Ag-110m	--	--	--
Am-242m	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
Ba-133	--	--	--
Ba-136m	--	--	--
Ba-137m	--	--	--
Ba-140	--	--	--
Be-10	--	--	--
Bi-208	--	--	--
Br-83	--	--	--
Br-84	--	--	--
Br-85	--	--	--
Cd-109	--	--	--
Cd-113m	--	--	--
Ce-141	--	--	--
Ce-143	--	--	--
Ce-144	--	--	--
Cl-36	--	--	--
Co-58	--	--	--
Cr-51	--	--	--
Cs-134	--	--	--
Cs-135	--	--	--
Cs-136	--	--	--
Cs-137	--	--	--
Cs-138	--	--	--
Eu-154	--	--	--
Eu-155	--	--	--
Fe-59	--	--	--

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled (continued).

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Gd-153	--	--	--
Hf-178m	--	--	--
Hf-182	--	--	--
Ho-163	--	--	--
I-129	--	--	--
I-130	--	--	--
I-131	--	--	--
I-132	--	--	--
I-133	--	--	--
I-134	--	--	--
I-135	--	--	--
K-40	--	--	--
Kr-81	--	--	--
Kr-83m	--	--	--
Kr-85	--	--	--
Kr-85m	--	--	--
La-137	--	--	--
La-138	--	--	--
La-140	--	--	--
Lu-176	--	--	--
Mn-54	--	--	--
Mn-56	--	--	--
Mo-93	--	--	--
Mo-99	--	--	--
Na-24	--	--	--
Nb-91	--	--	--
Nb-92	--	--	--
Nb-94	--	--	--
Nb-95	--	--	--
Nb-95m	--	--	--
Pa-233	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Pd-107	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Pr-143	--	--	--
Pr-144	--	--	--
Pt-193	--	--	--
Pu-241	--	--	--
Ra-225	--	--	--
Ra-228	--	--	--
Rb-86	--	--	--
Rb-87	--	--	--

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled (continued).

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Rb-88	--	--	--
Rb-89	--	--	--
Rh-106	--	--	--
Ru-103	--	--	--
Ru-106	--	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Se-79	--	--	--
Sn-119m	--	--	--
Sn-121m	--	--	--
Sn-123	--	--	--
Sn-126	--	--	--
Sr-89	--	--	--
Sr-90	--	--	--
Sr-91	--	--	--
Sr-92	--	--	--
Tc-97	--	--	--
Tc-99	--	--	--
Tc-99m	--	--	--
Te-125m	--	--	--
Te-127	--	--	--
Te-127m	--	--	--
Te-129	--	--	--
Te-129m	--	--	--
Te-131	--	--	--
Te-131m	--	--	--
Te-132	--	--	--
Th-234	--	--	--
Tl-204	--	--	--
Tm-170	--	--	--
Tm-171	--	--	--
Xe-131m	--	--	--
Xe-133	--	--	--
Xe-135	--	--	--
Y-90	--	--	--
Y-91	--	--	--
Y-91m	--	--	--
Y-92	--	--	--
Y-93	--	--	--
Zn-65	--	--	--
Zr-93	--	--	--
Zr-95	--	--	--

TOTAL	***3.85E+03***	***1.36E+03***	***2.17E+02***

"--" data not available

The Waste does not contain α- emitting radionuclides

Safety Assessment Input Data Sheet

Title	ILW Decommissioning Waste
File reference	
Document reference	63000333-000-00-111-D-223 Rev2

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	N/A		
Submission available?	Yes		
Nature & Quantity evaluation available?	Yes		
Verified and agreed datasheets available?	Yes		
Basic package data			
Package mass	11,885 kg		
Package type	$3m^3$ box		
Number of packages	20 box		
Average package Inventory	1,359 A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	shielded		
organic materials	not significant		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	A_2 (see datasheet for details)		
Enrichment	N/A		
Heat generation	217 W average		
Dose rates (mSv/hr)	not calculated		
at 3m from a bare waste package: [1]			
at 1m from SWTC-70 with four packages [1]			
contact dose for SWTC-70 [1]			
at 1m from SWTC-285 with four packages [1]			
contact dose for SWTC-285 [1]			

Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	No		
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	No		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values $<1x10^{-5}$ (Pending further evaluation of waste packages)	I –	II –	III –
	IV –	V –	VI –
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values	10m drop –		
	25m drop –		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	ILW Store located on site	
Compatibility with Concept (*eg* any special emplacement requirements)	No	-	
Previous Assessment Reports			
Pre-conceptual stage	Yes		
Conceptual stage	Current assessment is Conceptual stage		
Interim stage	-		
Final stage	-		

Comments

-

[1] Initial Dose Rate shielding calculations performed for “worst case” Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The worst case dose rate with 0.58m of concrete shielding @ 1m = 0.00051mSv/hr. Actual calculated values for Filter Cartridge packages to follow.

APPENDIX 5 - MIXED RESIN

Summary of Waste Package Physical / Chemical Parameters

Title: Mixed Resins	Waste type: Intermediate Level Waste
Source of documentation:	Mass balance (Rev.3) and WEC Safety Security & Environment Report (SSER).
Waste stream identifiers:	
Nature of waste stream:	Organic Resins including CVS Mixed Bed Resin, CVCS Cation Bed, SFS demineralizer, WLS units 2, 3, 4, Condensate Polisher Spent Resin, Steam Generator Blow down material. Inorganic Resin from WLS unit 1.
Raw waste volume:	13.62 m^3 per year (expected) 27.24 m^3 per year (maximum)[3]
Proposed matrix:	Cementitious Grout
Package type:	3 m^3 drum (reference 1 - T/WPS/320)
Raw waste per package:	0.75 m^3
Wasteform density:	1148 kgm^{-3} (assumed)
Waste package mass:	4,640kg (4.64 te) comprising: 583 kg empty 3m^3 drum and lid 3561 kg grouted waste (assuming 2.39 m^3 with density 1490 kgm^{-3}) 495 kg capping grout (assuming 0.3 m^3 with density 1650 kgm^{-3}).
Number of packages:	19 drums per year (expected) 38 drums per year (maximum)[3]
Physical/chemical composition:	The waste in an average package is expected to comprise: Spherical bead/resin compound

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-111-C-0008)			
Reference date:	As generated.			
Total package activity:	0 TBq α 14.3 TBq βγ normal – 20.3 TBq βγ Maximum arisings			
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 3,090 GBq t^{-1} βγ normal – 4,370 GBq t^{-1} βγ maximum ILW			
Package A_2 multiples content[1]:	23.4 A_2			
Principal radionuclides contributing at least 1% to total A_2 content (%):	Cs-134 Cs-137 Cs-136 Co-60	30% 32% 14% 1%	Co-60 I-131 I-133 I-135	1% 14% 5% 1%
Package heat output:	1.55 W			
Principal radionuclides contributing at least 1% to total heat output (%):	Cs-134 Cs-137 Co-60	88% 7% 3%		
Soluble radiotoxic radionuclides:	Sr-90 Cs-134 Cs-137	0.0042 TBq 4.96 TBq 4.43 TBq		
Radiotoxicity from Sr-90 and Cs-137[1]:	Sv yr^{-1}			
Waste container lifetime requirement[2]:	- years (This is a Nirex compliant package)			
Package fissile/fuel waste inventory (g):	U-233 U-235 U-238	--	Pu-239 Pu-241	--
Uranium enrichment (wt% U-235)	--			
Package Safeguards summary (g):	U-232 U-233 U-234 U-235 U-236 U-238 Total U	--	Pu-236 Pu-238 Pu-239 Pu-240 Pu-241 Pu-242 Total Pu	--

	Th-227	--
	Th-228	
	Th-229	
	Th-230	
	Th-232	
	Th-234	
	Total Th	
External gamma dose rates[4]:	(TBC) mSv hr^{-1} at 3m from unshielded package	
	(TBC) mSv hr^{-1} at 1m from package in SWTC-70	
	(TBC) mSv hr^{-1} at 1m from package in SWTC-285	

Notes:

1. Regulations for the Safe Transport of Radioactive Material, IAEA Safety Standard Series No. TS R 1, 2005 Edition.
2. User Guide to DIQuest Derived Inventory Query and Scenario Toolkit, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.
3. The maximum spent resin production rate has been assumed to occur every 5 years due to fuel defects leading to an increase in spent ion-exchnage resin production.
4. Primary resin is the bounding case, the results of which indicate the packages are within the design limits.

Waste Package βγ-emitting Radionuclides as generated (maximum annual).

Isotope	TBq	A2 Multiple	Heat (Watts)
I-129	1.30E-06	Unlimited	1.65E-08
Fe-55	4.37E-02	1.09E-03	4.02E-05
Fe-59	2.33E-03	2.58E-03	5.53E-05
Sr-90	4.22E-03	1.41E-02	1.33E-04
Mn-54	4.54E-02	4.54E-02	6.11E-03
Co-60	9.30E-02	2.33E-01	3.88E-02
Cs-137	4.43E+00	7.38E+00	1.33E-01
Cs-134	4.96E+00	7.08E+00	1.37E+00
Ag-108m	--	--	--
Ag-110m	4.33E-04	1.08E-03	--
Am-242m	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
Ba-133	--	--	--
Ba-137m	4.27E+00	--	--
Ba-140	5.05E-03	1.68E-02	--
Be-10	--	--	--
Bi-208	--	--	--
Br-83	2.73E-03	--	--
Br-84	1.32E-04	--	--
Br-85	1.42E-06	--	--
C-14	--	--	--
Ca-41	--	--	--
Cd-109	--	--	--
Cd-113m	--	--	--
Ce-144	1.22E-04	--	--
Cl-36	--	--	--
Co-58	1.17E-01	1.17E-01	--
Cr-51	1.60E-02	5.32E-04	--
Cs-135	1.19E-10	1.19E-10	--
Cs-138	4.08E-03	--	--
Eu-152	--	--	--
Eu-154	--	--	--
Eu-155	--	--	--
Gd-153	--	--	--
H-3	--	--	--
Hf-178m	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A2 Multiple	Heat (Watts)
Hf-182	--	--	--
Ho-163	--	--	--
Ho-166m	--	--	--
I-130	3.64E-03	--	--
I-131	2.33E+00	3.33E+00	--
I-132	8.77E-02	2.19E-01	--
I-133	6.77E-01	1.13E+00	--
I-134	2.86E-03	9.55E-03	--
I-135	1.52E-01	2.53E-01	--
K-40	--	--	--
Kr-81	--	--	--
Kr-85	xx	--	--
La-137	--	--	--
La-138	--	--	--
La-140	4.69E-03	1.17E-02	--
Lu-176	--	--	--
Mn-56	1.84E-02	6.14E-02	--
Mo-93	--	--	--
Mo-99	2.94E-02	4.89E-02	--
Nb-91	--	--	--
Nb-92	--	--	--
Nb-93m	--	--	--
Nb-94	--	--	--
Nb-95	1.59E-04	1.59E-04	--
Ni-59	--	--	--
Ni-63	--	--	--
Pa-233	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Pd-107	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Pr-143	8.94E-05	--	--
Pr-144	1.22E-04	--	--
Pt-193	--	--	--
Pu-241	--	--	--
Ra-225	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A2 Multiple	Heat (Watts)
Ra-228	--	--	--
Rb-86	1.12E-02	2.25E-02	--
Rb-87	--	--	--
Rb-88	9.63E-03	--	--
Rb-89	3.75E-04	--	--
Rh-106	1.15E-04	--	--
Ru-103	1.21E-04	6.07E-05	--
Ru-106	xx	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Se-79	--	--	--
Sm-151	--	--	--
Sn-119m	--	--	--
Sn-121m	--	--	--
Sn-123	--	--	--
Sn-126	--	--	--
Sr-89	1.90E-02	3.17E-02	--
Sr-91	4.80E-04	1.60E-03	--
Sr-92	3.91E-05	1.30E-04	--
Tc-97	--	--	--
Tc-99	--	--	--
Te-125m	xx	--	--
Te-127	xx	--	--
Te-127m	xx	--	--
Te-129	2.30E-03	3.83E-03	--
Te-129m	2.13E-03	5.31E-03	--
Te-131m	3.88E-04	7.77E-04	--
Te-132	1.30E-02	3.26E-02	--
Th-232	--	--	--
Th-234	--	--	--
Tl-204	--	--	--
Tm-170	--	--	--

Waste Package βγ-emitting Radionuclides as generated (max. annual) (continued)

Isotope	TBq	A2 Multiple	Heat (Watts)
U-238 (1)	--	--	--
Xe-131m	xx	--	--
Xe-133	xx	--	--
Xe-135	xx	--	--
Y-90	4.14E-03	1.38E-02	--
Y-91	2.91E-04	4.86E-04	--
Y-91m	1.73E-04	8.63E-05	--
Y-92	2.10E-05	1.05E-04	--
Y-93	2.04E-06	6.81E-06	--
Zn-65	1.50E-04	7.48E-05	--
Zr-93	--	--	--
Zr-95	xx	--	--
Ag-110	2.59E-05	--	--
Ba-136m	1.23E+00	--	--
Ce-141	1.24E-04	2.07E-04	--
Ce-143	9.54E-06	1.59E-05	--
Cs-136	1.65E+00	3.29E+00	--
Kr-83m	xx	--	--
Kr-85m	xx	--	--
Na-24	8.93E-07	4.46E-06	--
Nb-95m	1.07E-04	1.07E-04	--
Tc-99m	3.25E-02	8.11E-03	--
Te-131	4.54E-03	--	--

Values shown as "xx" are those from activities < 0.2 Bq/box.

"--" data not available

Waste Package α-emitting Radionuclides as generated (maximum annual)

Isotope	TBq	A2 Multiple	Heat (Watts)
Ac-227	--	--	--
Am-241	--	--	--
Am-243	--	--	--
Bi-210m	--	--	--
Cf-249	--	--	--
Cf-250	--	--	--
Cf-251	--	--	--
Cf-252	--	--	--
Cm-242	--	--	--
Cm-243	--	--	--
Cm-244	--	--	--
Cm-245	--	--	--
Cm-246	--	--	--
Cm-248	--	--	--
Np-237	--	--	--
Pa-231	--	--	--
Po-210	--	--	--
Pu-236	--	--	--
Pu-238	--	--	--
Pu-239	--	--	--
Pu-240	--	--	--
Pu-242	--	--	--
Ra-223	--	--	--
Ra-226	--	--	--
Sm-147	--	--	--
Te-134	2.88E-06	--	--
Th-227	--	--	--
Th-228	--	--	--
Th-229	--	--	--
Th-230	--	--	--
Tm-171	--	--	--
U-232 (1)	--	--	--
U-233 (1)	--	--	--
U-234 (1)	--	--	--
U-235 (1)	--	--	--
U-236 (1)	--	Unlimited	--

"--" data not available

Safety Assessment Input Data Sheet

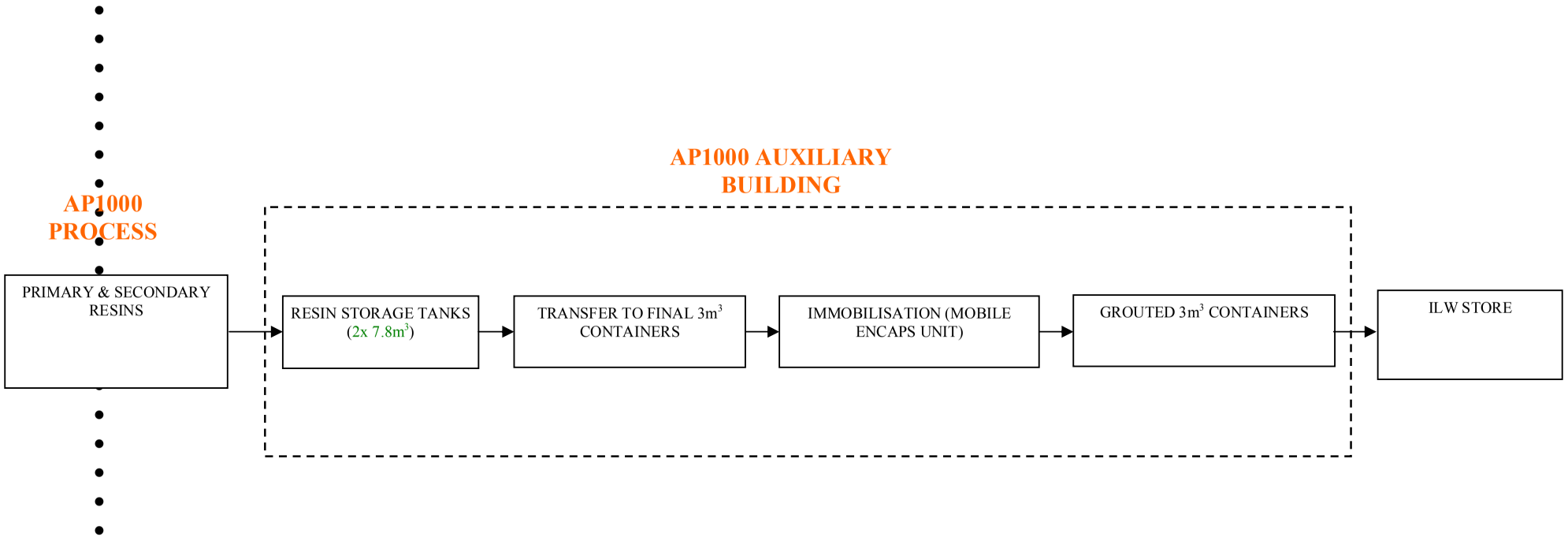
Title	Mixed Resins ILW Operational Waste
File reference	
Document reference	63000333-000-00-111-D-211 Rev. 3

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	Not required, tasks as per ITT		
Submission available?	Yes		Provided
Nature & Quantity evaluation available?	Yes		To be provided
Verified and agreed datasheets available?	Yes		To be provided
Basic package data			
Package mass	4,640 kg		
Package type	$3m^3$ drum		
Number of packages	19 drums per year (expected) 38 drums per year (maximum)[1]		
Average package Inventory	~ A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	shielded		
organic materials	not significant		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	23.4 A_2 (see datasheet for details)		
Enrichment	N/A		
Heat generation	~ W average 1.55 W maximum		
Dose rates (mSv/hr)	Calculated using Microshield		
at 3m from a bare waste package: [2]			
at 1m from SWTC-70 with four packages [2]			
contact dose for SWTC-70 [2]			
at 1m from SWTC-285 with four packages [2]			
contact dose for SWTC-285 [2]			

Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	Yes		To be provided
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	Yes		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values	I – 1.0	II – 2.5E-1	III – 1.3E-02
	IV – 1.3E-02	V – 3.4E-04	VI – 3.4E-04
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values	10m drop – 1.0E-05		
	25m drop – 1.0E-05		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	ILW Store to be located on site	
Compatibility with Concept (*eg* any special emplacement requirements)	No	-	
Previous Assessment Reports			
Pre-conceptual stage	Yes		
Conceptual stage	Current assessment is Conceptual stage		
Interim stage	-		
Final stage	-		

Comments
1 The maximum spent resin production rate has been assumed to occur every 5 years due to fuel defects leading to an increase in spent ion-exchnage resin production. 2. Initial Dose Rate shielding calculations performed for "worst case" Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The does rate with 0.58m concrete shielding @ 3m = 0.00178 mSv/hr. Actual calculated values to follow.

Waste Stream Assessment – High Level Process Block Flow Diagram



APPENDIX 6 – DECOMISSIONG REACTOR VESSEL

Summary of Waste Package Physical / Chemical Parameters

Title: Decommissioning Waste – Pressure Vessel	Waste type: Intermediate
Source of documentation:	Decommissioning Mass balance (Rev.3), Westinghouse Electric Company Design Control Document and ORIGEN-ARP (WEC Software) and FISPIN (Rolls-Royce software) runs.
Waste stream identifiers:	
Nature of waste stream:	Pressure Vessel & cladding
Raw waste volume:	302.1 te (38.73 m^3)
Proposed matrix:	Concrete
Package type:	(grouted) 3m^3 boxes
Raw waste per package:	0.90 m^3 in 3m^3 box
Wasteform density:	~7800 te/m^3
Waste package mass:	11.88 te (11,880 kg) of one 3m^3 box comprising: • 868 kg empty 3 m^3 box and lid • 495 kg capping grout • 10,522 kg grouted waste (assuming 2.39 m^3 with density 1490 kgm^{-3}).
Number of packages:	43 3m^3 box after 10 years decay
Physical/chemical composition:	Mild / Stainless Steel

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-000-000-111-C-0008)
Reference date:	As generated
Total package activity:	0 TBq α 1.0 TBq βγ in $3m^3$ box after 10 years decay
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 88 GBq/te βγ in $3m^3$ boxes after 10 years decay ILW
Package A_2 multiples content[6]:	0.442 A_2
Principal radionuclides contributing at least 1% to total A_2 content (%):	Co-60 **95**% Fe-55 **4**% Ni-63 **2**% (after 10 years, in $3m^3$ boxes)
Package heat output:	7.09E-02 W
Principal radionuclides contributing at least 1% to total heat output (%):	Co-60 98% (after 10 years, in $3m^3$ boxes)
Soluble radiotoxic radionuclides:	0
Radiotoxicity from Sr-90 and Cs-137[7]:	Sv yr^{-1}
Waste container lifetime requirement[‡]:	years
Package fissile/fuel waste inventory (g):	
Uranium enrichment (wt% U-235)	
Package Safeguards summary (g):	
External gamma dose rates:	mSv hr^{-1} at 3m from unshielded package mSv hr^{-1} at 1m from package in SWTC-70 mSv hr^{-1} at 1m from package in SWTC-285

6 *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standard Series No. TS-R-1, 2005 Edition.

7 *User Guide to DIQuest Derived Inventory Query and Scenario Toolkit*, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled.

Activities, calculated A2 and Heat values from Origen data apart from C-14 data obtained from FISPIN.

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Ni-59	2.16E-03	Unlimited	2.55E-06
Ni-63	2.09E-01	6.97E-03	5.74E-04
Fe-55	6.27E-01	1.57E-02	5.76E-04
Co-60	1.67E-01	4.18E-01	6.97E-02
H-3	4.18E-02	1.05E-03	3.81E-05
C-14	6.22E-06	2.07E-06	4.93E-08
Ca-41	0.00E+00	Unlimited	--
Eu-152	0.00E+00	0.00E+00	--
Ho-166m	0.00E+00	0.00E+00	0.00E+00
Nb-93m	0.00E+00	0.00E+00	0.00E+00
Sm-151	0.00E+00	0.00E+00	0.00E+00
Ag-108m	--	--	--
Ag-110	--	--	--
Ag-110m	--	--	--
Am-242m	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
Ba-133	--	--	--
Ba-136m	--	--	--
Ba-137m	--	--	--
Ba-140	--	--	--
Be-10	--	--	--
Bi-208	--	--	--
Br-83	--	--	--
Br-84	--	--	--
Br-85	--	--	--
Cd-109	--	--	--
Cd-113m	--	--	--
Ce-141	--	--	--
Ce-143	--	--	--
Ce-144	--	--	--
Cl-36	--	--	--
Co-58	--	--	--
Cr-51	--	--	--
Cs-134	--	--	--
Cs-135	--	--	--
Cs-136	--	--	--
Cs-137	--	--	--
Cs-138	--	--	--

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled (continued).

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Eu-154	--	--	--
Eu-155	--	--	--
Fe-59	--	--	--
Gd-153	--	--	--
Hf-178m	--	--	--
Hf-182	--	--	--
Ho-163	--	--	--
I-129	--	--	--
I-130	--	--	--
I-131	--	--	--
I-132	--	--	--
I-133	--	--	--
I-134	--	--	--
I-135	--	--	--
K-40	--	--	--
Kr-81	--	--	--
Kr-83m	--	--	--
Kr-85	--	--	--
Kr-85m	--	--	--
La-137	--	--	--
La-138	--	--	--
La-140	--	--	--
Lu-176	--	--	--
Mn-54	--	--	--
Mn-56	--	--	--
Mo-93	--	--	--
Mo-99	--	--	--
Na-24	--	--	--
Nb-91	--	--	--
Nb-92	--	--	--
Nb-94	--	--	--
Nb-95	--	--	--
Nb-95m	--	--	--
Pa-233	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Pd-107	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Pr-143	--	--	--
Pr-144	--	--	--
Pt-193	--	--	--
Pu-241	--	--	--
Ra-225	--	--	--

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled (continued).

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Ra-228	--	--	--
Rb-86	--	--	--
Rb-87	--	--	--
Rb-88	--	--	--
Rb-89	--	--	--
Rh-106	--	--	--
Ru-103	--	--	--
Ru-106	--	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Se-79	--	--	--
Sn-119m	--	--	--
Sn-121m	--	--	--
Sn-123	--	--	--
Sn-126	--	--	--
Sr-89	--	--	--
Sr-90	--	--	--
Sr-91	--	--	--
Sr-92	--	--	--
Tc-97	--	--	--
Tc-99	--	--	--
Tc-99m	--	--	--
Te-125m	--	--	--
Te-127	--	--	--
Te-127m	--	--	--
Te-129	--	--	--
Te-129m	--	--	--
Te-131	--	--	--
Te-131m	--	--	--
Te-132	--	--	--
Th-234	--	--	--
Tl-204	--	--	--
Tm-170	--	--	--
Tm-171	--	--	--
Xe-131m	--	--	--
Xe-133	--	--	--
Xe-135	--	--	--
Y-90	--	--	--
Y-91	--	--	--
Y-91m	--	--	--
Y-92	--	--	--
Y-93	--	--	--
Zn-65	--	--	--

Waste Package ($3m^3$) βγ-emitting Radionuclides at 10 year cooled (continued).

Isotope	Activity (TBq)	A_2 multiple	Heat (W)
Zr-93	--	--	--
Zr-95	--	--	--
TOTALβγ	***1.05E+00***	***4.42E-01***	***7.09E-02***

"--" data not available

No α-emitting radionuclides.

Safety Assessment Input Data Sheet

Title	Reactor Vessel (ILW) Decommissioning Waste
File reference	
Document reference	63000333-000-00-111-D-220 Rev2

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	N/A		
Submission available?	Yes		
Nature & Quantity evaluation available?	Yes		
Verified and agreed datasheets available?	Yes		
Basic package data			
Package mass	11,885 kg		
Package type	3 m^3 boxes		
Number of packages	5 HHISOs or 43 3m^3 boxes		
Average package Inventory	0.442 A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	unshielded		
organic materials	not significant		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	(see datasheet for details)		
Enrichment	N/A		
Heat generation	7.09E-02 W		
Dose rates (mSv/hr)	not calculated		
at 3m from a bare waste package: [1]			
at 1m from SWTC-70 with four packages [1]			
contact dose for SWTC-70 [1]			
at 1m from SWTC-285 with four packages [1]			
contact dose for SWTC-285 [1]			

Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	No		
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	No		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values $<1x10^{-5}$ (Pending further evaluation of waste packages)	I –	II –	III –
	IV –	V –	VI –
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values	10m drop –		
	25m drop –		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	Temporary storage located in Auxiliary building	
Compatibility with Concept (*eg* any special emplacement requirements)	No	-	
Previous Assessment Reports			
Pre-conceptual stage	Yes		
Conceptual stage	Current assessment is Conceptual stage		
Interim stage	-		
Final stage	-		

Comments

[1] Initial Dose Rate shielding calculations performed for “worst case” Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The worst case dose rate with 0.58m of concrete shielding @ 1m = 0.00051mSv/hr. Actual calculated values for Filter Cartridge packages to follow.

APPENDIX 7 - LOW LEVEL WASTE

Summary of Waste Package Physical / Chemical Parameters

Title: Misc. Reactor Components	Waste type: Low Level Waste
Source of documentation:	
Waste stream identifiers:	
Nature of waste stream:	
Raw waste volume:	
Proposed matrix:	
Package type:	500 litre drum
Raw waste per package:	m^3
Wasteform density:	
Waste package mass:	t comprising: •
Number of packages:	
Physical/chemical composition:	The waste in an average package is expected to comprise: •

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	FISPIN calculations	
Reference date:		
Total package activity:	TBq α TBq βγ	
Waste classification: (based on mass of wasteform)	GBq t^{-1} α GBq t^{-1} βγ LLW	
Package A_2 multiples content[8]:	A_2	
Principal radionuclides contributing at least 1% to total A_2 content (%):	Pu-239 Am-241 Pu-240 Pu-238	Sr-90 Cs-137 Pu-241
Package heat output:	W	
Principal radionuclides contributing at least 1% to total heat output (%):	Sr-90 Cs-137 Co-60 Pu-239	Am-241 Nb-94 Pu-240 Pu-238
Soluble radiotoxic radionuclides:	Sr-90 TBq Cs-134 TBq Cs-137 TBq	
Radiotoxicity from Sr-90 and Cs-137[9]:	Sv yr^{-1}	
Waste container lifetime requirement[‡]:	years (from)	
Package fissile/fuel waste inventory (g):	U-233 U-235 U-238	Pu-239 Pu-241
Uranium enrichment (wt% U-235)		

8 *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standard Series No. TS-R-1, 2005 Edition.

9 *User Guide to DIQuest Derived Inventory Query and Scenario Toolkit*, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

Package Safeguards summary (g):	U-232	Pu-236
	U-233	Pu-238
	U-234	Pu-239
	U-235	Pu-240
	U-236	Pu-241
	U-238	Pu-242
	Total U	Total Pu
	Th-227	
	Th-228	
	Th-229	
	Th-230	
	Th-232	
	Th-234	
	Total Th	

External gamma dose rates:

mSv hr^{-1} at 3m from unshielded package

mSv hr^{-1} at 1m from package in SWTC-70

mSv hr^{-1} at 1m from package in SWTC-285

Waste Package βγ-emitting Radionuclides at 2040

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
H-3	--	--	--
Be-10	--	--	--
C-14	--	--	--
Cl-36	--	--	--
Ar-39	--	--	--
Ar-42	--	--	--
K-40	--	--	--
Ca-41	--	--	--
Mn-53	--	--	--
Mn-54	--	--	--
Fe-55	--	--	--
Co-60	--	--	--
Ni-59	--	--	--
Ni-63	--	--	--
Zn-65	--	--	--
Se-79	--	--	--
Kr-81	--	--	--
Kr-85	--	--	--
Rb-87	--	--	--
Sr-90	--	--	--
Zr-93			--
Nb-91			--
Nb-92			--
Nb-93m			--
Nb-94			--
Mo-93			--
Tc-97			--
Tc-99			--
Ru-106			--
Pd-107			--
Ag-108m			--
Ag-110m			--
Cd-109			--
Cd-113m			--
Sn-119m			--
Sn-121m			--

Waste Package βγ-emitting Radionuclides at 2040 (continued)

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
Sn-123	--	--	--
Sn-126	--	--	--
Sb-125	--	--	--
Sb-126	--	--	--
Te-125m	--	--	--
Te-127m	--	--	--
I-129	--	--	--
Cs-134	--	--	--
Cs-135	--	--	--
Cs-137	--	--	--
Ba-133	--	--	--
La-137	--	--	--
La-138	--	--	--
Ce-144	--	--	--
Pm-145	--	--	--
Pm-147	--	--	--
Sm-151	--	--	--
Eu-152	--	--	--
Eu-154	--	--	--
Eu-155	--	--	--
Gd-153	--	--	--
Ho-163	--	--	--
Ho-166m	--	--	--
Tm-170	--	--	--
Tm-171	--	--	--
Lu-174	--	--	--
Lu-176	--	--	--
Hf-178n	--	--	--
Hf-182	--	--	--
Pt-193	--	--	--
Tl-204	--	--	--
Pb-205	--	--	--
Pb-210	--	--	--
Bi-208	--	--	--
Ra-225	--	--	--
Ra-228	--	--	--

Waste Package βγ-emitting Radionuclides at 2040 (continued)

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
Th-234	--	--	--
Pa-233	--	--	--
Pu-241	--	--	--
Am-242m	--	--	--
Total βγ	--	--	--

"--" data not available

Waste Package α-emitting Radionuclides at 2040

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
Sm-147	--	--	--
Bi-210m	--	--	--
Po-210	--	--	--
Ra-223	--	--	--
Ra-226	--	--	--
Ac-227	--	--	--
Th-227	--	--	--
Th-228	--	--	--
Th-229	--	--	--
Th-230	--	--	--
Th-232	--	--	--
Pa-231	--	--	--
U-232	--	--	--
U-233	--	--	--
U-234	--	--	--
U-235	--	--	--
U-236	--	--	--
U-238	--	--	--
Np-237	--	--	--
Pu-236	--	--	--
Pu-238	--	--	--
Pu-239	--	--	--
Pu-240	--	--	--
Pu-242	--	--	--
Am-241			--
Am-243	--	--	--
Cm-242	--	--	--
Cm-243	--	--	--
Cm-244	--	--	--
Cm-245	--	--	--
Cm-246	--	--	--
Cm-248	--	--	--
Cf-249	--	--	--
Cf-250	--	--	--
Cf-251	--	--	--
Cf-252	--	--	--

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
Total α	--	--	--

"--" data not available

APPENDIX 8 - DECOMMISSIONING LLW

Summary of Waste Package Physical / Chemical Parameters

Title: Decommissioning Waste – LLW waste	Waste type: Low Level Waste
Source of documentation:	Mass balance (Rev.2) and WEC Design Control Document (DCD)
Waste stream identifiers:	
Nature of waste stream:	Reactor pressure vessel vertical supports Reactor Building, Auxiliary building, Fuel Building, Radwaste building Structures (steel&concrete)
Raw waste volume:	6,323 te (1,807 m^3) concrete and 1842 m^3 steel
Proposed matrix:	N/A
Package type:	HHISO containers. Waste dismantled/cut-up and filled in 210L drums that are put into the HHISOs, or large equipment/items wrapped and put directly into the HHISO).
Raw waste per package:	8.19 m^3 per HHISOs
Wasteform density:	7,800 te/m^3 (steel) or 3.5 te/m^3 (high-density concrete)
Waste package mass:	between 30.9 to 66.1 tonne of one HHISO container comprising: • 2.2 tonne empty HHISO container • 63.9 te steel waste or 28.7 te concrete waste
Number of packages:	243 HHISO containers
Physical/chemical composition:	Mild / Stainless Steel / concrete

Summary of Waste Package Radionuclide Related Parameters

Derivation of case:	AP1000 Fuel Assembly Isotopic Decay Heat and Activity for 18-Month Fuel Cycles (UKP-GW-GLC-001) and A2 and Heat Generation calculation (63000333-111-C-0008)
Reference date:	As generated
Total package activity:	0 GBq α 5.9 TBq βγ for steel waste-filled HHISOs 3.1E-04 TBq βγ for concrete waste-filled HHISOs
Waste classification: (based on mass of wasteform)	0 GBq t^{-1} α 8.94 GBq/te βγ for steel waste-filled HHISOs 0.01 GBq/te βγ for concrete waste-filled HHISOs LLW
Package A_2 multiples content[10]:	0.8 A_2 for steel waste-filled HHISOs 7.73e-06 A_2 for concrete waste-filled HHISOs
Principal radionuclides contributing at least 1% to total A_2 content (%):	Co-60 99 for steel waste-filled HHISOs H-3 100 for concrete waste-filled HHISOs Eu-152 66 H-3 26 Ho-116m 4 Ni-63 3 C-14 1 for concrete waste-filled HHISOs
Package heat output:	5.65E-04 W for steel waste-filled HHISOs 2.82E-07 W for concrete waste-filled
Principal radionuclides contributing at least 1% to total heat output (%):	Co-60 100 for steel waste-filled HHISOs H-3 100 for concrete waste-filled HHISOs
Soluble radiotoxic radionuclides:	
Radiotoxicity from Sr-90 and Cs-137[11]:	Sv yr^{-1}

10 *Regulations for the Safe Transport of Radioactive Material*, IAEA Safety Standard Series No. TS-R-1, 2005 Edition.

11 *User Guide to DIQuest Derived Inventory Query and Scenario Toolkit*, A report produced for UK Nirex Ltd, Report No. BM1524/1, Issue 3 draft 1 #484387.

Waste container lifetime requirement[‡]: years

Package fissile/fuel waste inventory (g):

Uranium enrichment (wt% U-235)

Package Safeguards summary (g):

External gamma dose rates: mSv hr^{-1} at 3m from unshielded package

mSv hr^{-1} at 1m from package in SWTC-70

mSv hr^{-1} at 1m from package in SWTC-285

Waste Package βγ-emitting Radionuclides for steel waste at 10 year cooled.

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
H-3			
Fe-55	1.13E-01	2.83E-03	1.04E-04
Co-60	3.16E-01	7.89E-01	3.32E-01
Ni-59	--	--	--
Ni-63	1.62E-01	5.40E-03	4.45E-04
Total βγ	4.7E-01	0.72	0.03385

"--" data not avaiable

Waste Package βγ-emitting Radionuclides for concrete waste at 10 years cooled

Isotope	Activity (TBq)	A_2 multiples	Heat (W)
H3	3.1E-04	7.7E-06	2.826E-07
Total βγ	3.1E+08	7.7E-06	2.826E-07

The Waste does not contain α- emitting radionuclides

Safety Assessment Input Data Sheet

Title	LLW Decommissioning Waste
File reference	
Document reference	63000333-000-00-111-D-231

Information	Yes/No	Nirex reference	Availability
Task sheets for Safety Assessments	N/A		
Submission available?	Yes		
Nature & Quantity evaluation available?	Yes		
Verified and agreed datasheets available?	Yes		
Basic package data			
Package mass	30,900 kg for concrete to 66,100 kg for steel		
Package type	HHISO container		
Number of packages	1092 HHISOs		
Average package Inventory	~ A_2 (see datasheet for details)		
waste stream type (shielded or unshielded)	unshielded		
organic materials	not significant		
chemotoxic inventory	not significant		
fissile content (see datasheet for details)	0 g average (U-235+Pu-239) 0 g maximum (U-235+Pu-239)		
other components potentially affecting solubility and sorption of radionuclides	not significant		
Maximum package inventory	0.72 A_2 (steel) to 7E-06 A_2 for concrete (see datasheet for details)		
Enrichment	N/A		
Heat generation	0.03385 W for steel 2.826E-07 W for concrete waste		
Dose rates (mSv/hr)	Calculated using Microshield		
at 3m from a bare waste package: [1]			
at 1m from SWTC-70 with four packages [1]			
contact dose for SWTC-70 [1]			

at 1m from SWTC-285 with four packages [1]			
contact dose for SWTC-285 [1]			
Do any evaluation reports identify issues that would undermine the operational safety assessment?	No		
Wasteform properties			
Waste-form evaluation available?	No		
Nature of the wasteform	Heterogeneous		
SMOGG evaluation available	No		To be provided
Source of gas generation rates	SMOGG calculation		
bulk gas generation rate (litres/yr)	litres/yr (average package) litres/yr (maximum package)		
tritiated gases (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
C-14 gases (*eg* $C^{14}H_4$) (TBq/yr)	TBq/yr (average package) TBq/yr (maximum package)		
radon (TBq/yr)	not estimated		
Fire accident performance			
Fire evaluation available?	No		To be provided
radionuclide volatility group fire RF values $<1x10^{-5}$ (Pending further evaluation of waste packages)	I –	II –	III –
	IV –	V –	VI –
non-radioactive, toxic releases	not significant		
Impact accident performance			
Impact evaluation available?	No		To be provided
impact RF values	10m drop –		
	25m drop –		
Other issues			
Is the inventory considered in the national inventory?	No	-	
Interim storage proposals	Yes	LLW Temporary Storage area located in Radwaste building	

Compatibility with Concept (*eg* any special emplacement requirements)	No	-
Previous Assessment Reports		
Pre-conceptual stage	Yes	
Conceptual stage	Current assessment is Conceptual stage	
Interim stage	-	
Final stage	-	
Comments		

[1] Initial Dose Rate shielding calculations performed for "worst case" Resin Activity Data indicate that the SWTC-70 and SWTC-285 packages will be more than adequate, to ensure the packages are within the designated limits. The worst case dose rate with 0.58m of concrete shielding @ 1m = 0.00051mSv/hr. Actual calculated values for Filter Cartridge packages to follow.