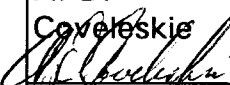

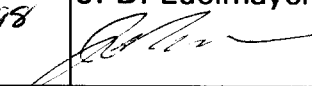


Project File Number TRA-ATR-1168-R2

Project/Task TRA Radiological Characterization

Subtask ATR Radiological Characterization

Title: Advanced Test Reactor (ATR) Radiological Characterization					
Summary: This summary briefly defines the problem or activity to be addressed in the EDF, gives a summary of the activities performed in addressing the problem and states the conclusions, recommendations, or results arrived at from this task.					
This EDF is a revision of the original EDF, File Number TRA-ATR-1168. This purpose of the revision is to incorporate additional data obtained from recent characterization surveys.					
In June 1996, swipe surveys were performed in the primary and secondary cubicles of the ATR and analyzed for Sr-90 and gamma emitting radionuclides. Several radionuclides were identified Their relative abundance, total and average activities are shown in Table 1. Sr-90 was then scaled to Cs-137 to determine a factor for calculating Sr-90 activity in waste streams without the need for additional analysis. Surveys were conducted in the cubicles, heat exchanger area, green room, nozzle trench and warm waste area because these areas are the most likely origins of LLW waste generation					
In July 1997, samples were again obtained from the ATR. They were analyzed for Fe-55, Ni-59, Ni-63, C-14, Tc-99, I-129, thorium, uranium and transuranic isotopes. Tc-99 and Pu-239 were not detected in all samples analyzed. Due to the difficulty, time, and cost for analyzing for all these radionuclides, scaling factors have been developed. The factors may be used to estimate the activities of these radionuclides in future waste streams by scaling to an easy to measure isotope such as Co-60 and Cs-137. The characterization data does not apply to spent resin and waste streams generated in the canal.					
Distribution (complete package): G. J. Andrews MS 8102, D. J. Bright MS 4201, A. D. Coveleskie MS 4138, D. M. Everett MS 7110, C. J. Greene MS 8108, J. A. Jones MS 4138, J. J. Lopez MS 7110, C. D. Morgan MS 7123, T. K. Mott MS 7110, O. R. Perry MS 4147, D. Picard MS 7116, T. A. Wheeler MS 7137					
Distribution (summary package only): E. M. Balsmeier MS 7110, G. C. Clarke 4138, J. D. Edelmayer MS 7110					
Author A. D. Coveleskie 	Dept. Radiological Controls	Reviewed J. J. Lopez 	Date 2-26-98	Approved J. D. Edelmayer 	Date 2-26-98
		LIMITCO Review N/A	Date	LIMITCO Approval N/A	Date

See Management Control Procedure (MCP) 6 for instructions on use of this form.

MAR 16 ENT'D

Sampling and Analysis In June of 1996 smear surveys were conducted in the ATR primary and secondary cubicles. The purpose of the survey was to obtain swipe samples for radiological characterization of Low Level Waste (LLW). Survey locations were based on areas where personnel typically enter and perform work during reactor outages. The number of swipes obtained varied with the size of the cubicle but generally averaged around twenty. These swipe papers were put into envelopes in groupings of five and taken to the Radiation Measurements Laboratory (RML) for analysis.

Using high resolution gamma-ray spectrometry techniques, the RML counted each envelope for one hour. In all samples Co-60 and Cs-137 were the dominant radionuclides. A copy of the laboratory results is shown in Attachment 1, Table 1 in pCi/sample.

Upon completion of gamma analysis, the swipes were removed from the envelope and analyzed, in groupings of five each, for Sr-90 by chemical separation techniques. A copy of the laboratory results is shown in Attachment 2, Table 1 in pCi/sample.

In July of 1997 samples were obtained from the same and additional areas of the ATR. These samples consisted of swipes and floor debris such as dirt, paint scrapings, and floor wax and weighed approximately one gram each. Twenty debris samples were obtained and analyzed for C-14, Fe-55, Ni-59, Ni-63, and I-129. A total of ninety swipe samples was also obtained. The swipe papers were put into envelopes in groupings of two and analyzed for uranium, thorium, and transuranic (TRU) radionuclides. Sample summary results for all analysis are shown in Tables 1, 2, and 3.

Since the debris samples were reported in pCi/g, with higher activity values than would normally be detected on a smear paper, the results were corrected for an activity typically found a smear. This correction factor was determined by weighing 100 unused swipe papers. The swipes were then used in a mock smear survey and weighed again. The average swipe had collected 1.71 mg/sample. The debris sample results were multiplied by the correction factor to obtain the activity per swipe (sample).

The activities for Ba-137m and Y-90, daughter products of Cs-137 and Sr-90 respectively, were calculated using their branching ratios because they are in secular equilibrium with the parent. Since there is no approved analytical protocol for Pu-241, its activity must be calculated from Am-241, the progeny of Pu-241. The following expression is used to determine the activity.

$$A_1 = \frac{(\lambda_2 - \lambda_1) \times (A_2) / (e^{-\lambda_1 t} - e^{-\lambda_2 t})}{\lambda_2}$$

Where: A_1 = Pu-241 activity
 A_2 = Am-241 activity
 λ_1 = $0.693/T_{1/2} (\text{Pu-241})$
 λ_2 = $0.693/T_{1/2} (\text{Am-241})$
 $T_{1/2}$ = half-life
t = decay time

If a decay time is assumed to be five years, then the Pu-241 activity is 141 times that of Am-241. Shorter periods will yield higher Pu-241 activities.

In terms of activity the most prominent radionuclides are Cs-137 and Co-60 for gamma emitters, Sr-90 for beta emitters, and Am-241 for the transuranics. Both Tc-99 and Pu-239 were not detected in any of the samples.

Scaling Factors From the analytical results, scaling were developed and listed in Table 4. All activities were first averaged. For those sample results reported as "ND", a value of zero was used. Samples, which were not analyzed, were not included in the average.

As recommended by the Electric Power Research institute (EPRI), Co-60 and Cs-137 were used as the primary radionuclides from which the scaling factors were developed. EPRI also recommends that TRU be scaled to other actinide or lanthanide series due to their rates of formation and release, and similar chemical and physical behavior. This same method was used for the uranium and TRU isotopes. However, they were one exception. Pu-238 was scaled to Cs-137 to eliminate the need of performing an alpha spectrometry analysis for every waste stream. This practice is not uncommon in the nuclear industry.

Conclusion The data obtained from the surveys and scaling factors can be used to characterize LLW generated from the ATR cubicles and other miscellaneous contamination areas. It is not recommended for ATR canal trash or resins.

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Table 1

Radionuclide	Total (pCi)	Average (pCi/sample)	Abundance (%)
Sc-46	8.20 E +1	2.83 E 0	1.65 E -2
Cr-51	9.00 E +2	3.10 E +1	1.81 E -1
Mn-54	3.73 E +3	1.28 E +2	7.48 E -1
Co-60	3.78 E +5	1.30 E +4	7.61 E +1
Zn-65	1.04 E +4	3.59 E +2	2.10 E 0
Sr-90/Y-90	1.91 E +3	6.59 E +1	3.85 E -1
Zr/Nb-95	8.70 E +1	3.00 E 0	1.75 E -2
Sb-124	3.20 E +2	1.10 E +1	6.43 E -2
Sb-125	5.92 E +2	2.04 E +1	1.19 E -1
Cs-134	1.81 E +3	6.26 E +1	3.66 E -1
Cs-137Ba-137m	9.53 E +4/9.05 E +4	3.29 E +3/3.13 E +3	1.92 E +1
Eu-152	2.00 E +3	6.90 E +1	4.03 E -1
Eu-154	9.95 E +2	3.43 E +1	2.00 E -1
Hf-181	1.82 E +2	6.28 E 0	3.67 E -2

Table 2

Location and Sample #	I-129 (pCi/spl)	C-14 (pCi/spl)	Fe-55 (pCi/spl)	Ni-59 (pCi/spl)	Ni-63 (pCi/spl)
Nozzle Tr. 1	2.22 E -2	ND	1.88 E 0	3.95 E -1	1.30 E +2
2	1.20 E -2	ND	3.25 E 0	2.05 E 0	5.64 E +2
3	1.71 E -2	6.50 E -2	1.03 E +1	1.23 E 0	3.47 E +2
4	8.90 E -1	2.51 E 0	4.45 E 0	3.57 E 0	4.57 E +2
ATR 1-C 1	2.05 E -2	ND	3.25 E 0	4.51 E -1	2.50 E +2
2	5.13 E -3	ND	1.20 E 0	1.44 E -1	3.54 E +2
3	1.54 E -2	1.13 E -1	2.91 E 0	6.43 E -1	4.27 E +2
4	8.55 E -3	6.84 E -2	2.74 E 0	1.49 E -1	2.60 E +2
ATR HX 1	5.13 E -2	ND	1.54 E +1	1.44 E -1	1.61 E +1
2	1.03 E -2	ND	2.39 E +1	6.86 E -1	1.73 E +2
3	5.13 E -2	ND	8.55 E 0	3.37 E 0	2.53 E +2
4	5.10 E -1	ND	-	1.66 E 0	8.72 E +2
ATR 1-A 1	4.27 E -2	ND	3.08 E -1	1.39 E -2	3.25 E +2
2	2.39 E -2	ND	7.18 E 0	1.47 E -1	1.56 E +2
3	1.20 E -2	ND	1.71 E +1	5.13 E -2	1.50 E +2
4	4.27 E -2	ND	2.56 E 0	4.79 E -2	4.46 E +2
ATR 2-B 1	-	3.93 E -1	-	-	-
2	ND	5.30 E -1	6.84 E -1	-	4.45 E -1
3	ND	1.88 E -1	1.71 E -1	-	2.56 E -1
4	ND	2.22 E -2	3.08 E -1	-	1.06 E 0
Total	1.73 E 0	3.89 E 0	1.06 E +2	1.47 E +1	5.18 E +3
Average	9.13 E -2	1.94 E -1	5.90 E 0	9.22 E -1	2.73 E +2

1. A blank space indicates that an analysis was not performed.
2. ND indicates that the analysis was performed but no analyte was detected.
3. NA indicates that the analysis was performed but the results were not reported due to cross contamination or analytical failure.

Table 3

Location and Sample #	Pu-238 (pCi/spl)	Th-230 (pCi/spl)	Th-232 (pCi/spl)	Am-241 (pCi/spl)	U-234 (pCi/spl)	U-235 (pCi/spl)	U-238 (pCi/spl)
1-C (1-2)	ND	ND	ND	ND	ND	ND	1.34 E -1
1-C (3-4)	ND	1.90 E 0	ND	ND	ND	ND	1.51 E -1
1-C (5-6)	ND	1.67 E 0	ND	ND	ND	ND	ND
1-C (7-8)	ND	ND	1.57 E -1	ND	1.00 E -1	ND	1.14 E -1
1-C (9-10)	ND	5.57 E 1	ND	ND	1.36 E -1	ND	1.33 E -1
1-D (1-2)	2.19 E 0	8.50 E -1	ND	ND	1.05 E -1	ND	1.29 E -1
1-D (3-4)	ND	1.51 E 0	ND	ND	1.55 E -1	ND	1.50 E -1
1-D (5-6)	6.37 E -1	1.45 E 0	ND	ND	1.27 E -1	ND	9.57 E -2
1-D (7-8)	2.24 E -1	8.20 E -1	ND	ND	1.38 E -1	ND	1.87 E -1
1-D (9-10)	ND	3.07 E -1	ND	5.48 E -1	1.27 E -1	ND	1.43 E -1
HX (1-2)	NA	ND	ND	NA	ND	ND	ND
HX (3-4)	NA	NA	NA	NA	NA	NA	NA
HX (5-6)	1.95 E -1	1.16 E 0	ND	2.37 E 0	NA	NA	NA
HX (7-8)	ND	1.36 E 0	ND	1.16 E 0	ND	ND	ND
HX (9-10)	ND	NA	NA	ND	ND	ND	ND
HX (11-12)	ND	4.46 E 0	5.27 E -1	7.79 E -1	NA	NA	NA
HX (13-14)	ND	2.66 E 0	9.90 E -2	1.92 E 0	ND	ND	ND
HX (15-16)	ND	3.24 E 0	ND	ND	NA	NA	NA
HX (17-18)	ND	ND	2.26 E -1	1.18 E 0	NA	NA	NA
HX (19-20)	ND	ND	ND	ND	ND	ND	ND
GR (1-2)	ND	1.63 E -1	ND	ND	9.20 E -2	ND	1.10 E -1
GR (3-4)	ND	8.70 E -1	5.29 E -2	ND	1.42 E -1	ND	1.45 E -1
GR (5-6)	ND	ND	ND	ND	ND	ND	ND
GR (7-8)	ND	ND	ND	1.30 E -1	2.76 E -1	ND	1.88 E -1
GR (9-10)	ND	ND	ND	ND	5.22 E -1	ND	ND
2-B (1-2)	ND	5.59 E -1	ND	ND	7.96 E -2	ND	9.67 E -2
2-B (3-4)	ND	1.31 E 0	2.34 E -1	ND	1.37 E -1	ND	1.60 E -1
2-B (5-6)	ND	7.80 E -1	8.80 E -2	9.83 E -2	2.48 E -1	ND	ND
2-B (7-8)	ND	1.17 E 0	9.50 E -2	1.10 E -1	2.28 E -2	ND	7.90 E -2
2-B (9-10)	ND	3.16 E 0	8.90 E -2	1.03 E -1	7.51 E -2	ND	1.22 E -1
2-D (1-2)	ND	ND	ND	ND	ND	ND	ND
2-D (3-4)	ND	1.42 E 0	ND	ND	1.15 E -1	ND	1.25 E -1
2-D (5-6)	ND	6.27 E -1	ND	ND	2.08 E -1	ND	ND
2-D (7-8)	ND	1.02 E 0	9.15 E -2	ND	2.00 E -1	ND	1.83 E -1
2-D (9-10)	ND	1.60 E 0	9.80 E -2	ND	1.21 E -1	ND	1.25 E -1
2-E (1-2)	ND	1.72 E 0	ND	ND	7.16 E 0	ND	1.68 E -1
2-E (3-4)	ND	ND	ND	ND	NA	NA	NA
2-E (5-6)	ND	1.32 E 0	ND	ND	1.80 E -1	ND	1.76 E -1
2-E (7-8)	ND	1.86 E 0	ND	ND	5.31 E 0	8.90 E -2	2.30 E -1
2-E (9-10)	ND	1.65 E 0	ND	ND	ND	1.53 E -1	ND
WW (1-2)	ND	1.63 E 0	ND	ND	1.85 E -1	ND	1.64 E -1
WW (3-4)	ND	5.91 E -1	ND	ND	4.94 E -1	ND	3.90 E -1
WW (5-6)	ND	8.00 E -1	1.66 E -1	ND	1.62 E -1	ND	1.26 E -1
WW (7-8)	ND	4.22 E -1	ND	1.39 E -1	1.42 E -1	ND	1.56 E -1
WW (9-10)	4.57 E -2	2.15 E -1	ND	ND	1.68 E -1	ND	1.73 E -1
Total	3.29 E 0	99.97	1.92 E 0	8.57 E 0	16.93	2.42 E -1	4.15 E 0
Average	7.65 E -2	2.27 E 0	4.47 E -2	1.95 E -1	4.34 E -1	6.20 E -3	1.06 E -1

Table 4

Radionuclide	Scale	Scaling Factor
C-14	C-14/Co-60	1.49 E -5
Fe-55	Fe-55/Co-60	4.54 E -4
Ni-63	Ni-63/Co-60	2.10 E -2
Ni-59	Ni-59/Ni63	3.38 E -3
Sr-90	Sr90/Cs-137	2.00 E -2
Y-90	Sr-90	1 x (Sr-90)
I-129	I-129/Cs-137	2.77 E -5
Ba-137m	Cs-137	0.95 x (Cs-137)
Pm-147	Cs-137	2 x (Cs-137)
U-234	U-234/Pu-238	5.67 E 0
U-235	U-235/U-238	5.85 E -2
U-238	U-238/Pu-238	1.39 E 0
Pu-238	Pu-238/Cs-137	2.32 E -5
Pu-241	Am-241	141.10 x (Am241)

TABLE 1
 RADIATION MEASUREMENTS LABORATORY
 GAMMA-RAY ANALYSIS RESULTS
 TRA CHARACTERIZATION SMEARS (ATR)

Sample ID	RML ID	Manmade Radionuclides	Activity	Estimated Bias (%)
ATRIC(1-5)	A3060696023	MN-54	(4.9 +/- 1.2)E+01 pCi/SMPL	0.0
		CO-60	(3.5 +/- 0.3)E+02 pCi/SMPL	0.0
		ZN-65	(1.7 +/- 0.3)E+02 pCi/SMPL	0.0
		CS-137	(4.3 +/- 1.5)E+01 pCi/SMPL	0.0
ATRIC(11-15)	A1060696021	MN-54	(8.6 +/- 1.0)E+01 pCi/SMPL	0.0
		CO-60	(7.9 +/- 0.6)E+02 pCi/SMPL	0.0
		SB-125	(6.7 +/- 1.0)E+01 pCi/SMPL	0.0
		CS-137	(4.9 +/- 0.7)E+01 pCi/SMPL	0.0
ATRIC(16-20)	A6060696024	MN-54	(2.2 +/- 0.4)E+01 pCi/SMPL	0.0
		CO-60	(5.8 +/- 0.5)E+02 pCi/SMPL	0.0
		CS-134	(1.6 +/- 0.3)E+01 pCi/SMPL	0.0
		CS-137	(5.6 +/- 0.6)E+01 pCi/SMPL	0.0
ATRIC(6-10)	A2060696022	MN-54	(2.6 +/- 0.2)E+02 pCi/SMPL	0.0
		CO-60	(7.2 +/- 0.6)E+02 pCi/SMPL	0.0
		ZN-65	(3.8 +/- 0.4)E+02 pCi/SMPL	0.0
		SB-125	(5.3 +/- 1.1)E+01 pCi/SMPL	0.0
		CS-134	(5.0 +/- 0.6)E+01 pCi/SMPL	0.0
		CS-137	(1.22 +/- 0.13)E+02 pCi/SMPL	0.0
ATR1D(1-5)	B3060596040	MN-54	(3.3 +/- 0.4)E+01 pCi/SMPL	0.0
		CO-60	(2.8 +/- 0.2)E+02 pCi/SMPL	0.0
		CS-134	(1.9 +/- 0.3)E+01 pCi/SMPL	0.0
		CS-137	(4.7 +/- 0.3)E+03 pCi/SMPL	0.0
		EU-152	(1.05 +/- 0.10)E+02 pCi/SMPL	0.0
		EU-154	(5.7 +/- 0.8)E+01 pCi/SMPL	0.0
ATR1D(11-15)	A1060696018	MN-54	(6.9 +/- 0.9)E+01 pCi/SMPL	0.0
		CO-60	(3.7 +/- 0.3)E+02 pCi/SMPL	0.0
		CS-134	(2.8 +/- 0.4)E+01 pCi/SMPL	0.0
		CS-137	(6.4 +/- 0.5)E+03 pCi/SMPL	0.0
		EU-152	(2.5 +/- 0.2)E+02 pCi/SMPL	0.0
		EU-154	(9.6 +/- 1.1)E+01 pCi/SMPL	0.0
ATR1D(16-20)	A3060696020	MN-54	(4.6 +/- 1.3)E+01 pCi/SMPL	0.0

Attachment 1

TABLE 1 CONTINUED

Sample ID	RML ID	Manmade Radionuclides	Activity	Estimated Bias (%)
ATR1D(16-20)	A3060696020	CO-60	(5.5 +/-	0.0
		CS-134	(3.9 +/-	0.0
		CS-137	(1.19 +/-	0.0
		EU-152	(7.0 +/-	0.0
		EU-154	(2.8 +/-	0.0
ATR1D(6-10)	A2060696019	MN-54	(2.7 +/-	0.0
		CO-60	(3.4 +/-	0.0
		CS-134	(2.8 +/-	0.0
		CS-137	(5.7 +/-	0.0
		EU-152	(3.0 +/-	0.0
ATR2B(1-5)	A1060596026	MN-54	(6.2 +/-	0.0
		CO-60	(4.1 +/-	0.0
		CS-134	(1.29 +/-	0.0
		CS-137	(2.42 +/-	0.0
		EU-154	(1.42 +/-	0.0
ATR2B(11-15)	A3060596028	CO-60	(2.9 +/-	0.0
		CS-134	(4.1 +/-	0.0
		CS-137	(6.3 +/-	0.0
ATR2B(16-20)	A6060596029	MN-54	(5.2 +/-	0.0
		CO-60	(1.82 +/-	0.0
		CS-134	(1.0 +/-	0.0
		CS-137	(1.31 +/-	0.0
ATR2B(6-10)	A2060596027	CO-60	(1.40 +/-	0.0
		CS-134	(9.2 +/-	0.0
		CS-137	(3.2 +/-	0.0
ATR2D(1-5)	A1060596031	CO-60	(1.08 +/-	0.0
		CS-137	(5.4 +/-	0.0
ATR2D(11-15)	A3060596033	CO-60	(1.45 +/-	0.0
		CS-137	(3.1 +/-	0.0
ATR2D(16-20)	A6060596034	MN-54	(2.10 +/-	0.0
		CO-60	(1.44 +/-	0.0
		ZN-65	(9.8 +/-	0.0
		SB-125	(3.8 +/-	0.0
		CS-137	(1.20 +/-	0.0
		EU-152	(4.5 +/-	0.0

Attachment 1

TABLE 1 CONTINUED

Sample ID	RML ID	Manmade Radionuclides	Activity	Estimated Bias (%)
ATR2D(16-20)	A6060596034	EU-154	(4.2 +/- 0.5)E+02 pCi/SMPL	0.0
ATR2D(6-10)	A2060596032	CO-60 CS-137	(1.16 +/- 0.09)E+03 pCi/SMPL (7.9 +/- 1.1)E+01 pCi/SMPL	0.0 0.0
ATR2E(1-5)	B3060596035	MN-54 CO-60 CS-134 CS-137	(5.4 +/- 0.9)E+01 pCi/SMPL (2.00 +/- 0.14)E+03 pCi/SMPL (1.6 +/- 0.5)E+01 pCi/SMPL (1.99 +/- 0.14)E+03 pCi/SMPL	0.0 0.0 0.0 0.0
ATR2E(11-15)	A3060596038	CO-60 CS-134 CS-137	(2.19 +/- 0.16)E+03 pCi/SMPL (2.9 +/- 0.8)E+01 pCi/SMPL (2.7 +/- 0.2)E+03 pCi/SMPL	0.0 0.0 0.0
ATR2E(16-20)	A6060596039	MN-54 CO-60 CS-137	(2.2 +/- 0.5)E+01 pCi/SMPL (1.02 +/- 0.08)E+03 pCi/SMPL (9.3 +/- 0.7)E+02 pCi/SMPL	0.0 0.0 0.0
ATR2E(6-10)	A2060596037	MN-54 CO-60 CS-134 CS-137	(7.1 +/- 1.9)E+01 pCi/SMPL (3.0 +/- 0.2)E+03 pCi/SMPL (3.1 +/- 0.6)E+01 pCi/SMPL (5.7 +/- 0.4)E+03 pCi/SMPL	0.0 0.0 0.0 0.0
ATRGR(1-5)	B3060696027	MN-54 CO-60 SB-125	(8 +/- 3)E+00 pCi/SMPL (5.7 +/- 0.4)E+02 pCi/SMPL (2.4 +/- 0.5)E+01 pCi/SMPL	0.0 0.0 0.0
ATRGR(11-15)	B3061096015	MN-54 CO-60 ZN-65 CS-137	(4.1 +/- 0.8)E+01 pCi/SMPL (8.0 +/- 0.6)E+03 pCi/SMPL (5.8 +/- 1.9)E+01 pCi/SMPL (1.8 +/- 0.5)E+01 pCi/SMPL	0.0 0.0 0.0 0.0
ATRGR(16-20)	A1061096013	CO-60	(8.6 +/- 0.6)E+02 pCi/SMPL	0.0
ATRGR(6-10)	A6061096012	MN-54 CO-60	(1.6 +/- 0.6)E+01 pCi/SMPL (1.60 +/- 0.12)E+03 pCi/SMPL	0.0 0.0
ATRMB(16-20)	A6061096027	SC-46 CR-51 MN-54 CO-58 CO-60 ZRNB-95	(8.2 +/- 0.8)E+01 pCi/SMPL (9.0 +/- 1.0)E+02 pCi/SMPL (2.4 +/- 0.2)E+02 pCi/SMPL (4.9 +/- 0.7)E+01 pCi/SMPL (9.5 +/- 0.7)E+02 pCi/SMPL (8.7 +/- 0.9)E+01 pCi/SMPL	0.0 0.0 0.0 0.0 0.0 0.0

TABLE 1 CONTINUED

sample ID	RML ID	Manmade Radionuclides	Activity	Estimated Bias (%)
ATRM8(16-20)	A6061096027	SB-124 SB-125 EU-152 HP-181	(3.2 +/- 0.3)E+02 pCi/SMPL (6.8 +/- 0.8)E+01 pCi/SMPL (1.90 +/- 0.18)E+02 pCi/SMPL (1.82 +/- 0.15)E+02 pCi/SMPL	0.0 0.0 0.0 0.0
ATRRW(1-5)	A2061096014	CO-60	(5.2 +/- 0.7)E+01 pCi/SMPL	0.0
ATRRW(11-15)	A6061096017	CO-60 CS-137	(2.28 +/- 0.16)E+03 pCi/SMPL (2.8 +/- 0.5)E+01 pCi/SMPL	0.0 0.0
ATRRW(16-20)	B3061096026	CO-60 CS-137	(4.7 +/- 0.4)E+02 pCi/SMPL (1.0 +/- 0.2)E+01 pCi/SMPL	0.0 0.0
ATRRW(6-10)	B3061096016	CO-60	(5.0 +/- 0.5)E+01 pCi/SMPL	0.0

- Notes:
- (1) A "None Detected" under "Manmade Radionuclides" means that the analyst determined that no manmade true-positive radionuclides were present in the respective sample(s).
 - (2) The uncertainty associated with any reported activity includes the statistical uncertainty and estimated uncertainties in the detector efficiency and the sample geometry (both are typically 5%). Uncertainties are propagated in quadrature and expressed as one standard deviation.
 - (3) When a sample's matrix differs radically from that of the calibration standard used by the RML, the measured activity may not accurately represent the true radionuclide concentration in that sample. In such cases, a non-zero estimated bias is applied in place of the estimated sample geometry; this bias is not propagated into the total uncertainty and is listed separately.

Attachment 2

TABLE 1 CONTINUED

Laboratory Sample Number	Customer Sample Number	Nuclide Identification	Nuclide Activity (one sigma uncertainties)
S2429 -1	ATR1D(16-20)	Sr-90	(4.97 +/- 0.11)E-04 uCi/SMPL
S2430 -1	ATR1C(1-5)	Sr-90	(5.5 +/- 0.4)E-06 uCi/SMPL
S2431 -1	ATR1C(6-10)	Sr-90	(3.47 +/- 0.11)E-05 uCi/SMPL
S2432 -1	ATR1C(11-15)	Sr-90	(8.8 +/- 0.5)E-06 uCi/SMPL
S2433 -1	ATR1C(16-20)	Sr-90	(3.7 +/- 0.3)E-06 uCi/SMPL
S2434 -1	ATRGR(1-5)	Sr-90	(3.9 +/- 0.4)E-06 uCi/SMPL
S2435 -1	ATRGR(6-10)	Sr-90	(1.33 +/- 0.06)E-05 uCi/SMPL
S2436 -1	ATRGR(11-15)	Sr-90	(3.11 +/- 0.10)E-05 uCi/SMPL
S2437 -1	ATRGR(16-20)	Sr-90	(2.1 +/- 0.3)E-06 uCi/SMPL
S2438 -1	ATRW(1-5)	Sr-90	(2.6 +/- 0.3)E-06 uCi/SMPL
S2439 -1	ATRW(6-10)	Sr-90	(2.4 +/- 0.3)E-06 uCi/SMPL
S2440 -1	ATRW(11-15)	Sr-90	(1.39 +/- 0.06)E-05 uCi/SMPL
S2441 -1	ATRW(16-20)	Sr-90	(5.2 +/- 0.4)E-06 uCi/SMPL
S2442 -1	ATRM8(16-20)	Sr-90	(7.9 +/- 0.2)E-05 uCi/SMPL

TABLE 1

ANALYTICAL RADIOCHEMISTRY LABORATORY

BETA ANALYSIS RESULTS

TRA CHARACTERIZATION SMEARS (ATR)

Sample Submitted By: Al Coveleski

Analyzed By: *Karen Scott*

Date Generated: 25-JUN-96

Laboratory Sample Number	Customer Sample Number	Nuclide Identification	Nuclide Activity (one sigma uncertainties)
S2394 -1	ATR2B(1-5)	Sr-90	(7.8 +/- 0.5)E-06 uCi/SMPL
S2395 -1	ATR2B(6-10)	Sr-90	(5.25 +/- 0.14)E-05 uCi/SMPL
S2396 -1	ATR2B(11-15)	Sr-90	(1.05 +/- 0.03)E-04 uCi/SMPL
S2397 -1	ATR2B(16-20)	Sr-90	(1.84 +/- 0.07)E-05 uCi/SMPL
S2398 -1	ATR2D(1-5)	Sr-90	(8.4 +/- 0.5)E-06 uCi/SMPL
S2399 -1	ATR2D(6-10)	Sr-90	(1.00 +/- 0.05)E-05 uCi/SMPL
S2420 -1	ATR2D(11-15)	Sr-90	(4.9 +/- 0.4)E-06 uCi/SMPL
S2421 -1	ATR2D(16-20)	Sr-90	(2.91 +/- 0.06)E-04 uCi/SMPL
S2422 -1	ATR2E(1-5)	Sr-90	(2.13 +/- 0.08)E-05 uCi/SMPL
S2423 -1	ATR2E(6-10)	Sr-90	(2.71 +/- 0.09)E-05 uCi/SMPL
S2424 -1	ATR2E(11-15)	Sr-90	(2.35 +/- 0.08)E-05 uCi/SMPL
S2425 -1	ATR2E(16-20)	Sr-90	(1.45 +/- 0.06)E-05 uCi/SMPL
S2426 -1	ATR1D(1-5)	Sr-90	(9.9 +/- 0.2)E-05 uCi/SMPL
S2427 -1	ATR1D(6-10)	Sr-90	(2.48 +/- 0.06)E-04 uCi/SMPL
S2428 -1	ATR1D(11-15)	Sr-90	(2.75 +/- 0.06)E-04 uCi/SMPL