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Engineering Design File

Radiological Characterization of the ETR Complex External Surfaces

Idaho Cleanup Project

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ENGINEERING DESIGN FILE

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1. Title: Radiological Characterization of the ETR Complex External Surfaces

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5. **Summary:**
The purpose of this EDF is to complete a radiological characterization of the ETR complex external surfaces (the surface not inside piping, equipment, tanks, or the reactor). This characterization was then used to calculate a source term for these surfaces. Future EDFs may use this information to calculate the source term for waste generated at the ETR complex, establish controls for radiological work, and to establish surface and airborne contamination monitoring requirements.

Summary of Revision 1:
The results determined in the original version of this EDF remain unchanged.
Removed discussion in the "Introduction" section of previous characterization EDFs that were found to contain errors.
Reworded the "Methodology and Assumption" section for clarification.
Added Appendix C showing contaminated surface area values

Summary of Revision 2:
Updated EDF to address DEQ comments. Updated source term to include previously un-surveyed areas (Emergency Loop Cubicles, PCS Pipe Tunnel, Crud Generator Cubicle, GEEL Pipe tunnel, Warm Waste Pit). Added additional clarification to methodology used. Removed UCL95 analysis

6. Review (R) and Approval (A) and Acceptance (Ac) Signatures:
(See instructions for definitions of terms and significance of signatures.)

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TABLES

1. INTRODUCTION

The purpose of this EDF is to complete a radiological characterization of the Engineering Test Reactor (ETR) complex external surfaces (the surface not inside piping, equipment, tanks, or the reactor). This characterization was then used to calculate a source term for these surfaces. Future EDFs may use this information to calculate the source term for waste generated at the ETR complex, establish controls for radiological work, to establish surface and airborne contamination monitoring requirements, etc.

2. SURVEY METHODOLOGY

In July of 2005 swipe samples (100 cm^2 swipe area) were performed throughout the accessible areas of ETR complex (Buildings TRA-642, 643, & 644). This survey effort consisted of 247 swipes performed in the Cubicles, Sub-pile Room, and Rod Access Room of TRA-642 (the most highly contaminated areas of the facility) and over 100 swipes performed throughout the remainder of the facility, performed as part of the routine surveys of the facility (Reference 1). The swipe surveys were performed mainly on the floor surfaces of the various rooms and areas in these buildings. During this survey effort, several locations were not accessible for survey including the following:

- Emergency Loop Cubicles (hot and cold pits located on the west side of TRA-642)
- Primary Coolant System (PCS) Pipe Tunnel
- Crud Generator Cubicle
- GEEL Pipe Tunnel
- Warm Waste Pit.

Since the 2005 survey effort, the above locations have been entered and characterization surveys completed. The Emergency Loop Cubicles were found to be free of contamination and released from radiological controls. Of the remaining areas, 10 swipes plus additional large area wipes were performed in the PCS Pipe Tunnel, 14 swipes plus large area wipes were performed in the Crud Generator Cubicle, multiple swipes, performed at various times, were performed in the GEEL Tunnel and 34 swipes were taken in the Warm Waste Pit (References 2-6).

3. LABORATORY DATA

As part of the 2005 survey effort, 30 random swipes were performed in the Cubicles. The purpose of these swipes was not to determine an activity level but to identify the radionuclides in the contamination. Of these 30 swipes, only a third had measurable activity (i.e. detectable by hand held survey instrumentation) and these high activity swipe samples were sent to Reactor Technology Complex (RTC) Radioanalytical Laboratory for analysis. The highest activity samples were selected so that radionuclides in lower concentrations would be identified in the analysis. The analysis performed consisted of gamma spec., alpha isotropics, Sr-90, and low energy beta emitters.

Table 1 summarizes the Gamma-Ray analysis results and Table 2 presents the Beta and Alpha results. Only those isotopes that were statistically positive and greater than the MDA of the analytical method were included in this analysis.

Table 1. Gamma Spec Results.

Gamma	Co-60 (pCi/100cm^2)	Cs-137 (Ba-137m) (pCi/100cm^2)	Ag_m 108 (pCi/100cm^2)
F-H10 Cubicle #16	3.46E+02	9.61E+04	
F-H10 Cubicle #3	7.15E+03	1.31E+03	
L-12/M-7 Cubicle #19	3.20E+02	3.45E+03	
L-12/M-7 Cubicle #6	6.00E+01	4.96E+03	
M-3/P-7 Sec. Cub. #6	1.55E+02	3.16E+02	8.10E+01
J,L-10 Cubicle #11		2.72E+02	
J,L-10 Cubicle #4		1.23E+03	
L-12/M-7 Cubicle #4		9.00E+02	
AVERAGE =	1606	13567	81

Table 2. Beta and Alpha Analysis Results.

Beta/alpha	Ni-63 (pCi/100cm^2)	U233,U234,Np237 (pCi/100cm^2)	Pu-239 (pCi/100cm^2)	Pu-238 (pCi/100cm^2)	Sr-90 (pCi/100cm^2)
F-H10 Cubicle #16	2.17E+02				7.82E+01
F-H10 Cubicle #3	5.93E+03		2.52E-01	2.44E+00	1.90E+02
L-12/M-7 Cubicle #19	5.41E+02		3.30E-01	7.48E-01	2.67E+00
L-12/M-7 Cubicle #6	1.30E+03		2.28E+00	1.01E+00	6.78E+01
M-3/P-7 Sec. Cub. #6	1.36E+02	1.65E-01	1.24E+01	6.03E+00	1.30E+02
J,L-10 Cubicle #11			1.98E-01		9.97E-01
J,L-10 Cubicle #4	3.36E+01		2.40E-01	1.10E-01	
L-12/M-7 Cubicle #4	4.40E+02				2.97E+01
SMR5	6.82E+01				
SMR19	1.71E+02				
AVERAGE =	981.87	0.17	2.62	2.07	71

4. SOURCE TERM DETERMINATION ASSUMPTIONS

The following assumptions were in the determination of the external surface source term:

- The scaling factors (relative activity values) between the radionuclides in the contamination throughout the facility are the same as that determined using the average values from the laboratory results above.

  As will be shown in the Uncertainty Analysis section, this assumption results in a negligible difference in the calculated source term. Additionally, the cubicle areas contain the highest quantities of loose surface contamination that is readily accessible to the workers, it is assumed that contamination outside of the cubicles is a result of cross-contamination from contact with the cubicle surfaces.

- Co-60 and Cs-137 are to only radionuclides detected during the βγ contamination survey and are detected with approximately equal efficiency.

  Of the identified radionuclides in Tables 1 & 2 above, two (Co-60 and Cs-137) were identified in the highest concentration and emit readily measurable radiations during a standard βγ contamination survey. These two radionuclides account for ~99% of the measurable βγ surface activity. Additionally, literature for the instrument used (Reference 8) to count the swipes (Ludlum 3030) gives an efficiency for Cs-137 of 29% and, while the literature did not give a Co-60 efficiency, in areas contaminated with Co-60, an efficiency of 30% is used.

- The scaling factors for C-14, Tc-99, and I-129 developed in TRA-EDF-007 (Reference 9) are used and assumed to be conservative for the source term determination.

  The current lab analysis identified above did not analyze for the radioisotopes C-14, Tc-99, and I-129 listed in TRA-EDF-007. TRA-EDF-007 calculations were based on swipe samples performed in March of 1996 and 24 samples consisting of dust, dirt, paint chips, etc., taken in February of 1997. The swipe samples were analyzed for Co-60, Cs-137, & Sr-90 while the samples were analyzed for low energy beta emitters Ni-63, C-14, Tc-99, I-129 and gross alpha. No method was listed on how the scaling factors between the various gamma and the beta/alpha emitters were established but a quick calculation of the average results listed in that EDF demonstrates how the ratios were determined. The Ni-63/Co-60 ratio for example was determined by dividing the average Ni-63 result (pCi/g) by the average Co-60 result (pCi/sample and, since the sample was swipes, the results can be interpreted to be pCi/100 cm^2) to obtain a Co-60 to Ni-63 ratio of 1:4.24. In performing the above calculation the assumption was made that the paint chips, dust, and dirt represented the same surface area as the swipes (i.e. pCi/sample or pCi/100 cm^2 = pCi/g). Additionally, since the sample and swipes were performed at different locations and had different analysis performed on them, it would be difficult to establish a correlation between the results. For example, a sample that showed a high concentration of Ni-63 may also have a high concentration of Co-60 but the Co-60 analysis was not performed. The scaling factor for Ni-63 to Co-60 listed in TRA-EDF-007 was 4.24:1 which over estimates the Ni-63 activity when compared to the 0.61:1 calculated from the average results in Tables 1 & 2 above. Since the scaling factor for Ni-63 in EDF-TRA-007 were shown to overestimate the Ni-63 concentration, it is assumed that the scaling factors for C-14, I-129, and Tc-99 determined in that EDF will also conservatively overestimate the activities of these radionuclides.

- The average contamination value determined from the surveys in an area is used to determine the source term for that area.

  Characterization surveys were mainly performed on the floor areas of each location. Contamination levels on the floor are higher than the contamination levels on either the wall or ceiling surfaces. The use of an average contamination level determined from the floor surveys results in a conservatively high source term being determined for the area.

- A total contamination is assumed to be 10 times the measured value of the loose contamination.

  Most locations in the ETR facility were the background levels are low enough to allow direct measurements exhibit loose contamination levels that are greater than 10% of the total contamination thus, the 10% values is considered conservative. For example, if the loose contamination is 1000 dpm/100 cm^2 and the total contamination is 5000 dpm/100 cm^2 then the loose contamination is greater than 10% of the total (it is 20%). With the use of the 10% value, the conservative 10,000 dpm/100 cm^2 instead of 5000 dpm/100 cm^2 is used to calculate the source term.

- If the contamination level measurements are less than the Minimum Detectable Activity (MDA) of the instrument used, the MDA of the instrument is used for the source term determination.

  For example, if the MDA of the instrument is 1000 dpm/100 cm^2 and the results of the contamination survey are documented as being less than 1000 dpm/100 cm^2, then 1000 dpm/100 cm^2 is used as the level of loose surface contamination.

5. SOURCE TERM DETERMINATION METHODOLOGY

The following methodology was used to determine the external surface source term:

1. Determine the relative ratio between Co-60 and Cs-137.

   The relative ratio between Co-60 and Cs-137 is determined by dividing the average activity value for Cs-137 by the average activity value for Co-60 from Table 1 above. This calculation is shown below:

$$\text{Re}\,lative\_Ratio = \frac{Cs137\_Activity}{Co60\_Activity} = \frac{13567\,pCi/100cm^2}{1606\,pCi/100cm^2} = 8.45$$

2. Determine the scaling factors between the remaining radionuclides.

   The radionuclides associated with fission/fuel (Sr-90, Tc-99, I-129, U-233, Pu-238, and Pu-239) were scaled to Cs-137 and the radionuclides associated with activation (C-14, Ag-108m and Ni63) were scaled to Co-60 (the ratios established in TRA-EDF-007 were used for C-14, Tc-99 and I-129). The scaling factors for those radionuclides identified in Tables 1 and 2 were determined by dividing the radionuclides average activity value by the average activity value of either Co-60 or Cs-137. The results of this calculation are shown in Table 3 below.

Table 3. Scaling Factors.

Ratio	Scaling Factor
Sr90/Cs137	5.26E-03
Tc99/Cs137	9.03E-04
I129/Cs137	5.87E-04
U233/Cs137	1.22E-05
Pu238/Cs137	1.52E-04
Pu239/Cs137	1.93E-04
C14/Co60	6.40E-02
Ni63/Co60	6.11E-01
Ag108m/Co-60	5.04E-02

3. Determine the average contamination levels for each area within the ETR complex

   The average measurable loose βγ contamination levels area determined from the data contained in References 1 – 6. If the recorded value is <1000 dpm/100 cm^2, 1000 dpm/100 cm^2 was used in the average determination. Total measurable βγ contamination is 10 times the measurable loose βγ contamination. The average contamination values for each area are shown in Table 4 below.

Table 4. Area Contamination Levels.

Building	Zone	Loose βγ Survey Results Average (dpm/100cm^2)	Total βγ Contamination (dpm/100cm^2)
Reactor Building (TRA-642)	Reactor Vessel	1000	10,000
	Nozzle Trench	1000	10,000
	Biological Shield (over cap)	1000	10,000
	Canal	1000	10,000
	Main Room	1000	10,000
	Console Floor	1000	10,000
	Balcony	1000	10,000
	P-7 Primary Cubicle	1030	10,295
	J-10/L-10 Primary Cubicle	2187	21,871
	C-7/M-13/N-14 Primary Cubicle	62135	621,346
	C-7/M-13/N-14 Secondary Cubicle	6458	64,580
	F-10/H-10 Primary Cubicle	87293	872,933
	F-10/H-10 Auxiliary Cubicle	14484	144,843
	F-10/H-10 Secondary Cubicle	31537	315,368
	Helium System Cubicle	1192	11,919
	L-12/M-7 Primary Cubicle	2045	20,450
	L-12/M-7 Secondary Cubicle	12848	128,483
	C-13/G-16 Primary Cubicle	1314	13,139
	C-13/G-16 Secondary Cubicle	1268	12,675
	Crud Generator Cubicle	1000	10,000
	Subpile Room Entryway	1000	10,000

Table 4. (continued).

Building	Zone	Loose βγ Survey Results Average (dpm/100cm^2)	Total βγ Contamination (dpm/100cm^2)
	AGS Cubicle	1000	10,000
	GEEL Pipe Tunnel	1000	10,000
	M-3 Primary Cubicle	1922	19,224
	M-3/P-7 Secondary Cubicle	2142	21,418
	Warm Waste Pit	1000	10,000
	Sub-Pile Room	1316	13,163
	Rod Access Room	1000	10,000
	Other Basement Areas	1000	10,000
Compressor Building (TRA-643)	Storage Area	1000	10,000
Heat Exchanger Building (TRA-644)	PCS Pipe Tunnel	1000	10,000
	Bypass valve room	1000	10,000
	Tank room	1000	10,000
	Main room	1000	10,000
	Basement	1000	10,000
	Degassing tank	1000	10,000
	Primary pump pits	1000	10,000
	Emergency shutdown pump pits	1000	10,000
	Degassifier pump pits	1000	10,000

4. Determine the surface area for each location.

   The surface area of each location was determined by graphical means. The surface area value for each location is presented in Appendix 3.

5. Determine area measurable βγ activity in each location.

   The area measurable activity is determined by multiplying the total measurable contamination value for each location shown in Table 4 above by the total surface area of that location. For example, if the Table 4 level of contamination is 10,000 dpm/100 cm^2 and the surface area for the location is 272.4 m^2, then the calculation is performed as follows:

$$Area\_Activity = \frac{10{,}000 dpm}{100 cm^2} * 272.4 m^2 * \frac{10{,}000 cm^2}{m^2} * \frac{Ci}{2.22 * 10^{12} dpm} = 1.23 * 10^{-4} Ci$$

6. Determine Co-60 and Cs-137 activity values.

   With the assumption that only Cs-137 and Co-60 contribute to the measurable βγ contamination, the assumption that they are detected with the same efficiency, and the ratio between the Co-60 activity and the Cs-137 activity, the total Co-60 activity value for each location (with the exception of the Hot Waste Pit) is determined as follows:

$$Cs137\_activity + Co60\_activity = area\_activity;$$

thus

$$8.45 * Co60\_activity + Co60\_activity = area\_activity$$

therefore

$$Co60\_activity * (8.45 + 1) = area\_activity$$

Which_results_in

$$Co60\_activity = \frac{area\_activity}{9.45}$$

Thus for the example above, the Co-60 activity is determined as follows:

$$Co60\_Activity = \frac{1.23 * 10^{-4}\, Ci}{9.45} = 1.30 * 10^{-5}\, Ci$$

The Cs-137 activity is then determined by multiplying the Co-60 activity by the ratio between the Co-60 activity and the Cs-137 activity (8.45).

Laboratory data exists for the contamination in the Hot Waste Pit. Co-60, Cs-137, & Sr-90 activity values for the hot waste pit are determined from this laboratory data. This data is shown in Table 5 below.

Table 5. Hot Waste Pit Data.

Radionuclide	Activity (Ci/cm^2)
Co-60	3.73E-09
Cs-137	1.56E-08
Sr-90	1.96E-09

7. Determine the activity values for the remaining radionuclides.

   Once the activity values for Co-60 and Cs-137 have been determined, the activity values for the remaining radionuclide may be determined using the radionuclide scaling factors presented in Table 3. From the example above, the Co-60 activity is 1.30E-05 Ci, the Ni-63 activity is determined as follows:

$$Ni63\_activity = 1.30 * 10^{-5} * 6.11 * 10^{-1} = 7.93 * 10^{-6}\, Ci$$

8. Total source term value

   The total source term value is the sum of the individual radionuclide values.

Results

Table 6. Radioisotope inventory for External Surfaces.

Building	Zone	Total (m^2)	Survey Results Average dpm/ $100cm^2$	Co-60 (Ci)	Ag-108m (Ci)	Ni-63 (Ci)	C-14 (Ci)	Sr-90 (Ci)	U-233 U-234 Np237 (Ci)	Pu-238 (Ci)	Pu-239 (Ci)	Tc-99 (Ci)	I-129 (Ci)	Cs-137	Total
Reactor Building (TRA-642)	Reactor Vessel	272.4	10000	1.30E-05	6.55E-07	7.94E-06	8.31E-07	5.77E-07	1.33E-09	1.67E-08	2.12E-08	9.91E-08	6.44E-08	1.10E-04	1.33E-04
	Nozzle Trench	63.5	10000	3.03E-06	1.53E-07	1.85E-06	1.94E-07	1.35E-07	3.11E-10	3.90E-09	4.93E-09	2.31E-08	1.50E-08	2.56E-05	3.10E-05
	Biological Shield (over cap)	45.6	10000	2.17E-06	1.10E-07	1.33E-06	1.39E-07	9.66E-08	2.23E-10	2.80E-09	3.54E-09	1.66E-08	1.08E-08	1.84E-05	2.22E-05
	Canal	521.7	10000	2.49E-05	1.25E-06	1.52E-05	1.59E-06	1.11E-06	2.56E-09	3.20E-08	4.05E-08	1.90E-07	1.23E-07	2.10E-04	2.55E-04
	Main Room	6423.4	10000	3.06E-04	1.54E-05	1.87E-04	1.96E-05	1.36E-05	3.15E-08	3.94E-07	4.99E-07	2.34E-06	1.52E-06	2.59E-03	3.13E-03
	Console Floor	3643.0	10000	1.74E-04	8.75E-06	1.06E-04	1.11E-05	7.72E-06	1.78E-08	2.24E-07	2.83E-07	1.32E-06	8.61E-07	1.47E-03	1.78E-03
	Balcony	607.5	10000	2.90E-05	1.46E-06	1.77E-05	1.85E-06	1.29E-06	2.98E-09	3.73E-08	4.72E-08	2.21E-07	1.44E-07	2.45E-04	2.96E-04
	PCS Pipe Tunnel	192.5	10000	9.18E-06	4.63E-07	5.61E-06	5.87E-07	4.08E-07	9.43E-10	1.18E-08	1.50E-08	7.00E-08	4.55E-08	7.75E-05	9.39E-05
	Hot Waste Pit	144.1	Lab Data	5.38E-03	2.71E-04	3.29E-03	3.44E-04	2.82E-03	2.73E-07	3.43E-06	4.34E-06	2.03E-05	1.32E-05	2.25E-02	3.46E-02
	P-7 Primary Cubicle	45.5	10295	2.23E-06	1.13E-07	1.36E-06	1.43E-07	9.92E-08	2.29E-10	2.87E-09	3.64E-09	1.70E-08	1.11E-08	1.89E-05	2.28E-05
	J-10/L-10 Primary Cubicle	39.9	21871	4.16E-06	2.09E-07	2.54E-06	2.66E-07	1.85E-07	4.27E-10	5.35E-09	6.77E-09	3.17E-08	2.06E-08	3.51E-05	4.25E-05
	C-7/M-13/N-14 Primary Cubicle	46.1	621346	1.37E-04	6.89E-06	8.36E-05	8.75E-06	6.07E-06	1.40E-08	1.76E-07	2.23E-07	1.04E-06	6.78E-07	1.15E-03	1.40E-03
	C-7/M-13/N-14 Secondary Cubicle	98.7	64580	3.04E-05	1.53E-06	1.86E-05	1.95E-06	1.35E-06	3.12E-09	3.91E-08	4.95E-08	2.32E-07	1.51E-07	2.57E-04	3.11E-04
	F-10/H-10 Primary Cubicle	50.3	872933	2.09E-04	1.05E-05	1.28E-04	1.34E-05	9.29E-06	2.15E-08	2.69E-07	3.41E-07	1.60E-06	1.04E-06	1.77E-03	2.14E-03
	F-10/H-10 Auxiliary Cubicle	25.8	144843	1.78E-05	8.98E-07	1.09E-05	1.14E-06	7.92E-07	1.83E-09	2.29E-08	2.90E-08	1.36E-07	8.83E-08	1.50E-04	1.82E-04
	F-10/H-10 Secondary Cubicle	39.4	315368	5.93E-05	2.99E-06	3.62E-05	3.79E-06	2.63E-06	6.09E-09	7.63E-08	9.66E-08	4.52E-07	2.94E-07	5.01E-04	6.07E-04
	Helium System Cubicle	82.6	11919	4.70E-06	2.37E-07	2.87E-06	3.01E-07	2.09E-07	4.82E-10	6.05E-09	7.65E-09	3.58E-08	2.33E-08	3.97E-05	4.81E-05
	L-12/M-7 Primary Cubicle	96.4	20449.5	9.40E-06	4.74E-07	5.74E-06	6.01E-07	4.17E-07	9.65E-10	1.21E-08	1.53E-08	7.17E-08	4.66E-08	7.94E-05	9.61E-05
	L-12/M-7 Secondary Cubicle	37.5	128483	2.30E-05	1.16E-06	1.41E-05	1.47E-06	1.02E-06	2.36E-09	2.96E-08	3.75E-08	1.75E-07	1.14E-07	1.94E-04	2.35E-04
	C-13/G-16 Primary Cubicle	44.0	13139	2.76E-06	1.39E-07	1.69E-06	1.77E-07	1.23E-07	2.83E-10	3.55E-09	4.50E-09	2.10E-08	1.37E-08	2.33E-05	2.82E-05
	C-13/G-16 Secondary Cubicle	41.7	12675	2.52E-06	1.27E-07	1.54E-06	1.61E-07	1.12E-07	2.59E-10	3.24E-09	4.10E-09	1.92E-08	1.25E-08	2.13E-05	2.58E-05
	Crud Generator Cubicle	9.4	10000	4.50E-07	2.27E-08	2.75E-07	2.88E-08	2.00E-08	4.62E-11	5.79E-10	7.33E-10	3.43E-09	2.23E-09	3.80E-06	4.61E-06
	Subpile Room Entryway	21.0	10000	1.00E-06	5.04E-08	6.11E-07	6.40E-08	4.44E-08	1.03E-10	1.29E-09	1.63E-09	7.63E-09	4.96E-09	8.45E-06	1.02E-05
	AGS Cubicle	42.3	10000	2.02E-06	1.02E-07	1.23E-06	1.29E-07	8.96E-08	2.07E-10	2.60E-09	3.29E-09	1.54E-08	1.00E-08	1.70E-05	2.06E-05
	GEEL Pipe Tunnel	512.8	10000	2.45E-05	1.23E-06	1.49E-05	1.56E-06	1.09E-06	2.51E-09	3.15E-08	3.98E-08	1.86E-07	1.21E-07	2.07E-04	2.50E-04
	M-3 Primary Cubicle	29.9	19224	2.74E-06	1.38E-07	1.67E-06	1.75E-07	1.22E-07	2.81E-10	3.52E-09	4.46E-09	2.09E-08	1.36E-08	2.31E-05	2.80E-05
	M-3/P-7 Secondary Cubicle	13.7	21418	1.40E-06	7.04E-08	8.54E-07	8.94E-08	6.20E-08	1.43E-10	1.80E-09	2.28E-09	1.07E-08	6.92E-09	1.18E-05	1.43E-05
	Warm Waste Pit	164.0	10000	7.82E-06	3.94E-07	4.78E-06	5.00E-07	3.47E-07	8.03E-10	1.01E-08	1.27E-08	5.96E-08	3.88E-08	6.60E-05	8.00E-05
	Sub-Pile Room	55.0	13163	3.46E-06	1.74E-07	2.11E-06	2.21E-07	1.54E-07	3.55E-10	4.45E-09	5.63E-09	2.64E-08	1.71E-08	2.92E-05	3.54E-05
	Rod Access Room	25.5	10000	1.21E-06	6.12E-08	7.42E-07	7.77E-08	5.39E-08	1.25E-10	1.56E-09	1.98E-09	9.26E-09	6.02E-09	1.03E-05	1.24E-05
	Other Basement Areas	1280.2	10000	6.10E-05	3.08E-06	3.73E-05	3.91E-06	2.71E-06	6.27E-09	7.86E-08	9.94E-08	4.66E-07	3.03E-07	5.16E-04	6.25E-04
	TRA-642 Total Ci			**6.54E-03**	**3.30E-04**	**4.00E-03**	**4.19E-04**	**2.88E-03**	**3.93E-07**	**4.93E-06**	**6.24E-06**	**2.92E-05**	**1.90E-05**	**3.24E-02**	**4.66E-02**

Table 6. (continued).

Building	Zone	Total (m^2)	Survey Results Average dpm/ $100cm^2$	Co-60 (Ci)	Ag-108m (Ci)	Ni-63 (Ci)	C-14 (Ci)	Sr-90 (Ci)	U-233 U-234 Np237 (Ci)	Pu-238 (Ci)	Pu-239 (Ci)	Tc-99 (Ci)	I-129 (Ci)	Cs-137 (Ci)	Total (Ci)
Compressor Building (TRA-643)	Storage Area	177.6	10000	8.47E-06	4.27E-07	5.18E-06	5.42E-07	3.76E-07	8.70E-10	1.09E-08	1.38E-08	6.46E-08	4.20E-08	7.15E-05	8.67E-05
	TRA-643 Total Ci			**8.47E-06**	**4.27E-07**	**5.18E-06**	**5.42E-07**	**3.76E-07**	**8.70E-10**	**1.09E-08**	**1.38E-08**	**6.46E-08**	**4.20E-08**	**7.15E-05**	**8.67E-05**

Building	Zone	Total (m^2)	Survey Results Average dpm/ $100cm^2$	Co-60 (Ci)	Ag-108m (Ci)	Ni-63 (Ci)	C-14 (Ci)	Sr-90 (Ci)	U-233 U-234 Np237 (Ci)	Pu-238 (Ci)	Pu-239 (Ci)	Tc-99 (Ci)	I-129 (Ci)	Cs-137	Total
Heat Exchanger Building (TRA-644)	Bypass valve room	47.9	10000	2.29E-06	1.15E-07	1.40E-06	1.46E-07	1.02E-07	2.35E-10	2.94E-09	3.72E-09	1.74E-08	1.13E-08	1.93E-05	2.34E-05
	Tank room	39.4	10000	1.88E-06	9.47E-08	1.15E-06	1.20E-07	8.34E-08	1.93E-10	2.42E-09	3.06E-09	1.43E-08	9.31E-09	1.59E-05	1.92E-05
	Main room	313.6	10000	1.50E-05	7.54E-07	9.14E-06	9.57E-07	6.64E-07	1.54E-09	1.92E-08	2.44E-08	1.14E-07	7.41E-08	1.26E-04	1.53E-04
	Basement	604.6	10000	2.88E-05	1.45E-06	1.76E-05	1.84E-06	1.28E-06	2.96E-09	3.71E-08	4.70E-08	2.20E-07	1.43E-07	2.43E-04	2.95E-04
	Degassing tank	27.6	10000	1.32E-06	6.63E-08	8.04E-07	8.42E-08	5.84E-08	1.35E-10	1.69E-09	2.14E-09	1.00E-08	6.52E-09	1.11E-05	1.35E-05
	Primary pump pits	167.2	10000	7.97E-06	4.02E-07	4.87E-06	5.10E-07	3.54E-07	8.19E-10	1.03E-08	1.30E-08	6.08E-08	3.95E-08	6.73E-05	8.16E-05
	Emergency shutdown pump pits	27.1	10000	1.29E-06	6.52E-08	7.91E-07	8.28E-08	5.75E-08	1.33E-10	1.66E-09	2.11E-09	9.87E-09	6.41E-09	1.09E-05	1.32E-05
	Degassifier pump pits	26.3	10000	1.25E-06	6.32E-08	7.66E-07	8.02E-08	5.57E-08	1.29E-10	1.61E-09	2.04E-09	9.56E-09	6.22E-09	1.06E-05	1.28E-05
	PCS Pipe Tunnel	754.3	10000	3.60E-05	1.81E-06	2.20E-05	2.30E-06	1.60E-06	3.69E-09	4.63E-08	5.86E-08	2.74E-07	1.78E-07	3.04E-04	3.68E-04
	TRA-644 Total Ci			**9.57E-05**	**4.83E-06**	**5.85E-05**	**6.13E-06**	**4.25E-06**	9.84E-09	1.23E-07	1.56E-07	7.30E-07	**4.75E-07**	**8.09E-04**	**9.80E-04**
	Total External Surface Source Term (Ci)			**6.65E-03**	**3.35E-04**	**4.06E-03**	**4.25E-04**	**2.88E-03**	4.04E-07	5.06E-06	6.41E-06	3.00E-05	**1.95E-05**	**3.32E-02**	**4.77E-02**

A ratio of the specific activity of the beta/gamma emitters to the alpha emitters was also calculated. This ratio may be used in later EDFs as necessary to justify the types of surveys performed, the analysis of air samples, etc. The calculate ratio = $\beta\gamma/\alpha$ = 3363:1 was calculated by dividing the average specific activity of the beta and gamma emitters by the average specific activity of the alpha emitters.

6. SOURCES OF ERROR/UNCERTAINTY ANALYSIS

Sources of uncertainty in the characterization of the ETR complex external surfaces consist of the following:

- Uncertainty in the lab analysis performed in the swipe samples used to identify the radionuclides in the surface contamination;
- Uncertainty in the establishment of the ratios (or scaling factors) between the various identified radionuclides;
- Measurement uncertainties in the activity determinations on the swipe samples;
- Uncertainty associated with the assignment of an average surface contamination level to each of the areas in the ETR;
- Uncertainty associated with the collection efficiency of the swipe sample process and the ratios associated with the loose to total contamination;
- Uncertainty associated with the actual contaminated surface area in the ETR.

1. Lab Analysis

Uncertainties associated with the laboratory analysis were determined by the analyzing laboratory. Per the lab report, “The uncertainty associated with any reported activity in this report 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 at one standard deviation.” The Lab results, associated uncertainties, and the % error (determined by the equation 100 X error/reported value) are shown in the Table 7 below.

Table 7. Sampling Error.

Location	Radionuclide	Activity (pCi/Sample)	Uncertainty (pCi/Sample) (+/-)	% Error (+/-)
F10/H10	Co-60	3.50E+02	3.00E+01	8.57%
F10/H10	Co-60	7.30E+03	5.00E+02	6.85%
L12/M7	Co-60	3.20E+02	3.00E+01	9.38%
L12/M7	Co-60	6.00E+01	8.00E+00	13.33%
M3/P7	Co-60	1.55E+02	1.50E+01	9.68%
M3/P7	Ag-108m	8.10E+01	7.00E+00	8.64%
F10/H10	Cs-137	9.60E+04	7.00E+03	7.29%
F10/H10	Cs-137	1.31E+03	1.00E+02	7.63%
J10/L10	Cs-137	2.70E+02	3.00E+01	11.11%
J10/L10	Cs-137	1.23E+03	9.00E+01	7.32%
L12/M7	Cs-137	3.50E+03	3.00E+02	8.57%
L12/M7	Cs-137	9.00E+02	7.00E+01	7.78%
L12/M7	Cs-137	2.80E+03	2.00E+02	7.14%
L12/M7	Cs-137	5.00E+03	4.00E+02	8.00%
M3/P7	Cs-137	3.20E+02	3.00E+01	9.38%
J10/L10	Pu-239/240	2.40E-01	4.31E-02	17.96%

Table 7. (continued).

Location	Radionuclide	Activity (pCi/Sample)	Uncertainty (pCi/Sample) (+/-)	% Error (+/-)
J10/L10	Pu-238/Am-241	1.10E-01	3.15E-02	28.64%
L12/M7	Pu239/240	4.37E-01	6.02E-02	13.78%
L12/M7	Sr-90	8.06E+01	5.78E+00	7.17%
L12/M7	Ni-63	6.11E+02	3.35E+01	5.48%
L12/M7	Pu-238/Am-241	8.73E-01	9.38E-02	10.74%
L12/M7	Sr-90	2.97E+01	6.22E+00	20.94%
L12/M7	Ni-63	4.40E+02	3.06E+01	6.95%
L12/M7	Pu-239/240	2.28E+00	2.14E-01	9.39%
L12/M7	Sr-90	6.78E+01	5.77E+00	8.51%
L12/M7	Ni-63	1.30E+03	6.44E+01	4.95%
L12/M7	Pu-238/Am-241	1.01E+00	1.58E-01	15.64%
L12/M7	Pu-239/240	3.30E-01	6.46E-02	19.58%
L12/M7	Ni-63	5.41E+02	3.26E+01	6.03%
L12/M7	Pu-238/Am-241	7.48E-01	1.07E-01	14.30%
F10/H10	Pu-239/240	3.30E-01	6.46E-02	19.58%
F10/H10	Ni-63	5.41E+02	3.26E+01	6.03%
F10/H10	Pu-238/Am-241	7.48E-01	1.07E-01	14.30%
F10/H10	Pu-239/240	2.52E-01	5.04E-02	20.00%
F10/H10	Sr-90	1.90E+02	8.28E+00	4.36%
F10/H10	Ni-63	5.93E+03	2.70E+02	4.55%
F10/H10	Pu-238/Am-241	2.44E+00	1.91E-01	7.83%
F10/H10	Sr-90	7.82E+01	4.67E+00	5.97%
F10/H10	Ni-63	2.17E+02	1.83E+01	8.43%
M3/P7	U233/234/Np237	1.65E-01	5.53E-02	33.52%
M3/P7	Pu-239/240	1.24E+01	6.77E-01	5.46%
M3/P7	Sr-90	1.30E+02	5.46E+00	4.20%
M3/P7	Ni-63	1.36E+02	1.58E+01	11.62%
M3/P7	Pu-238/Am-241	6.03E+00	4.11E-01	6.82%
J10/L10	Pu-239/240	1.98E-01	5.72E-02	28.89%
SMR5	Ni-63	6.82E+01	1.64E+01	24.05%
SMR19	Ni-63	1.71E+02	1.59E+01	9.30%

Based on the total average activity value of the above results, Cs-137 contributes the majority (70%) of the activity for the external surface source term and has a percentage error in the laboratory analysis of ~+/-8%.

2. Scaling Factors

The scaling factors between the radionuclides were determined using the average of the above sample results for each radionuclide. To determine the error introduced utilizing this methodology, the following analysis was performed:

- Since Cs-137 and Co-60 contribute the most activity to the facility external surface source term and emit radiations which are readily measurable, only the ratios between these radionuclides were varied.
- Those radionuclides associated with activation were scaled to Co-60 and those associated with fission were scaled to Cs-137.
- The relative ratios analyzed between Cs-137 and Co-60 were the ratios resulting for the lab analysis above and those determined form the laboratory results documented in TRA-EDF-007.

- 1000 dpm/100 cm^2 was used in this analysis as the measured activity value (the actual activity value used does not effect this analysis since only the relative difference in activity is important).
- For this analysis, it is assumed that only Co-60 and Cs-137 are detected by the bench counter and are detected with approximately equal efficiency.
- The activity is determined as discussed in the Source Term Determination Methodology section above.

The area specific activity (Ci/cm^2) determined in the above analysis for the Cs to Co ratio based on the average activity values in the lab analysis is 4.88E-12 Ci/cm^2. Table 8 below presents the total activity concentration values resulting in varying the Co to Cs ratio and the resulting percentage difference in activity. From the table, neglecting outlier values, the percent uncertainty in using the average activity ratios is estimated to be ~ +/-5%

3. Measurement Uncertainties

Per the MARSSIM (Reference 10), "Measurement uncertainties are often broken into two sub-classes of uncertainty termed systematic uncertainty and random uncertainty. Systematic uncertainties derive from a lack of knowledge about the true distribution of values associated with a numerical parameter and result in data that is consistently higher (or lower) than the true value. Random uncertainties refer to fluctuations associated with a known distribution of values."

The systematic uncertainty associated with each instrument used to develop the facility external surface source term was not determined. The MARSSIM states that "If no other information on systematic uncertainty is available, Currie (NRC 1984) recommends using 16% as an estimate for systemic uncertainties (1% for blanks, 5% for baseline, and 10% for calibration factors)."

To determine the total (random) uncertainty associated with the counting process, the MARSSIM provides the following equation to calculate the standard deviation of the net count rate or the statistical counting uncertainty:

$$\sigma_n = \sqrt{\frac{C_{s+b}}{T_{s+b}^2} + \frac{C_b}{T_b^2}}$$

Where

σ_n = standard deviation of the net count rate result

C_{s+b} = number of gross counts (sample)

T_{s+b} = gross count time

C_b = number of background counts

T_b = background count time

From the above equation, it can be determined that the error increases only as the square root of the counts, thus the percent error and relative error will get smaller as the number of counts becomes larger. The majority of the survey results documented to characterize the external surfaces where <1000 dpm/100 cm^2 and thus 1000 dpm/100 cm^2 (300 cpm with an assume 30% counting efficiency) was used. Using the following data:

C_{s+b} = 400 counts for a 1 minute count (300 cpm + 100 cpm background)

T_{s+b} = 1 minute sample count time

C_b = 1000 counts in a 10 minute count (100 cpm)

T_b = 10 minute background count time

The calculated statistical counting uncertainty is determined as follows:

$$\sigma_n = \sqrt{\frac{400 counts}{1^2 \min^2} + \frac{1000 counts}{10^2 \min^2}} = 20.2 cpm$$

Thus the error associated with the 300 cpm measured value is:

$$\frac{20.2}{300} * 100\% = +/- 6.7\%$$

4. Average Surface Contamination Values

The error resulting from the use of the average activity value for each location to determine the source term of that location was not determined. The reason for not determining this value is two fold. First, the survey locations chosen where those known or suspected to contain the highest amount of loose surface contamination to bias the survey result high to add conservatism to the calculation and second, the minimum documented activity level is 1000 dpm/100 cm^2. It cannot be determined from the survey maps how far below 1000 dpm/100 cm^2 the value actual is. When the contamination level was documented as being less than 1000 dpm/100 cm^2, 1000 dpm/100 cm^2 was used to add additional conservatism to the calculation.

5. Swipe Collection Efficiency

During the characterization, no attempt was made to quantify the efficiency of the swipe to remove radioactive contamination from the various surfaces. Swipe efficiency will vary from location to location, and is function of the type of contamination, the surface composition and texture, humidity, and other factors. The multiplication of the swipe results by 10 is thought to produce a conservative estimation of the total surface contamination.

6. Contaminated Surface Area

As stated previously, during the characterization of the external surfaces, swipe surveys were performed in locations known or suspected of containing the highest quantities of loose surface contamination. These highly contaminated surfaces are the floor areas in the various locations. Wall and ceiling surfaces contain substantially less contamination than the floor surfaces. No attempt was made during the source term determination to establish an average contamination level on these floor and ceiling surfaces and, to add to the conservatism of the calculation, the source term values for the walls and ceilings were determined based on the average contamination level on the floors.

Table 8. Scaling Factor Error.

	Scale fac	-	0.0504	0.611	0.064	0.0053	1.22E-05	1.52E-04	1.93E-04	9.03E-04	5.87E-04	-		
	Rel to	-	Co-60	Co-60	Co-60	Cs-137	Cs-137	Cs-137	Cs-137	Cs-137	Cs-137	-		
Cs	: Co	Co-60 (Ci)	Ag-108m (Ci)	Ni-63 (Ci)	C-14 (Ci)	Sr-90 (Ci)	U-233 U-234 Np237 (Ci)	Pu-238 (Ci)	Pu-239 (Ci)	Tc-99 (Ci)	I-129 (Ci)	Cs-137 (Ci)	Total (Ci)	% Difference
1:	4.17E-02	1.80E-13	9.09E-15	1.10E-13	1.15E-14	2.27E-14	5.26E-17	6.59E-16	8.34E-16	3.90E-15	2.54E-15	4.32E-12	4.67E-12	4.37%
1:	4.76E-02	2.05E-13	1.03E-14	1.25E-13	1.31E-14	2.26E-14	5.23E-17	6.55E-16	8.29E-16	3.88E-15	2.52E-15	4.30E-12	4.68E-12	4.01%
1:	1.82E-01	6.93E-13	3.49E-14	4.24E-13	4.44E-14	2.00E-14	4.64E-17	5.81E-16	7.35E-16	3.44E-15	2.24E-15	3.81E-12	5.03E-12	-3.18%
1:	6.54E-03	2.93E-14	1.48E-15	1.79E-14	1.87E-15	2.35E-14	5.44E-17	6.82E-16	8.63E-16	4.04E-15	2.63E-15	4.48E-12	4.56E-12	6.59%
1:	5.00E-02	2.15E-13	1.08E-14	1.31E-13	1.37E-14	2.26E-14	5.22E-17	6.54E-16	8.27E-16	3.87E-15	2.52E-15	4.29E-12	4.69E-12	3.86%
1:	2.08E-01	7.77E-13	3.92E-14	4.75E-13	4.97E-14	1.96E-14	4.53E-17	5.68E-16	7.19E-16	3.37E-15	2.19E-15	3.73E-12	5.09E-12	-4.42%
1:	7.69E-01	1.96E-12	9.88E-14	1.20E-12	1.25E-13	1.34E-14	3.10E-17	3.88E-16	4.91E-16	2.30E-15	1.49E-15	2.55E-12	5.94E-12	-21.82%
1:	1.69E-01	6.53E-13	3.29E-14	3.99E-13	4.18E-14	2.03E-14	4.68E-17	5.87E-16	7.43E-16	3.48E-15	2.26E-15	3.85E-12	5.01E-12	-2.59%
1:	3.70E-01	1.22E-12	6.14E-14	7.44E-13	7.79E-14	1.73E-14	4.00E-17	5.01E-16	6.34E-16	2.97E-15	1.93E-15	3.29E-12	5.41E-12	-10.91%
1:	2.38E-02	1.05E-13	5.28E-15	6.40E-14	6.70E-15	2.31E-14	5.35E-17	6.71E-16	8.49E-16	3.97E-15	2.58E-15	4.40E-12	4.61E-12	5.48%
1:	3.33E-02	1.45E-13	7.33E-15	8.88E-14	9.30E-15	2.29E-14	5.30E-17	6.64E-16	8.41E-16	3.94E-15	2.56E-15	4.36E-12	4.64E-12	4.88%
1:	2.08E-01	7.77E-13	3.92E-14	4.75E-13	4.97E-14	1.96E-14	4.53E-17	5.68E-16	7.19E-16	3.37E-15	2.19E-15	3.73E-12	5.09E-12	-4.42%
1:	2.33E-01	8.50E-13	4.29E-14	5.20E-13	5.44E-14	1.92E-14	4.44E-17	5.57E-16	7.05E-16	3.30E-15	2.15E-15	3.65E-12	5.15E-12	-5.49%
1:	1.28E-01	5.12E-13	2.58E-14	3.13E-13	3.28E-14	2.10E-14	4.86E-17	6.08E-16	7.70E-16	3.61E-15	2.34E-15	3.99E-12	4.90E-12	-0.52%
1:	1.08E-02	4.79E-14	2.42E-15	2.93E-14	3.07E-15	2.34E-14	5.42E-17	6.79E-16	8.60E-16	4.02E-15	2.62E-15	4.46E-12	4.57E-12	6.32%
1:	1.08E-02	4.79E-14	2.42E-15	2.93E-14	3.07E-15	2.34E-14	5.42E-17	6.79E-16	8.60E-16	4.02E-15	2.62E-15	4.46E-12	4.57E-12	6.32%
1:	1.69E-01	6.53E-13	3.29E-14	3.99E-13	4.18E-14	2.03E-14	4.68E-17	5.87E-16	7.43E-16	3.48E-15	2.26E-15	3.85E-12	5.01E-12	-2.59%
1:	2.17E-01	8.04E-13	4.06E-14	4.92E-13	5.15E-14	1.95E-14	4.50E-17	5.64E-16	7.14E-16	3.34E-15	2.17E-15	3.70E-12	5.11E-12	-4.82%
1:	2.44E-02	1.07E-13	5.41E-15	6.56E-14	6.86E-15	2.31E-14	5.35E-17	6.70E-16	8.48E-16	3.97E-15	2.58E-15	4.40E-12	4.61E-12	5.44%
1:	3.70E-02	1.61E-13	8.11E-15	9.83E-14	1.03E-14	2.28E-14	5.28E-17	6.62E-16	8.38E-16	3.92E-15	2.55E-15	4.34E-12	4.65E-12	4.65%
1:	2.33E-01	8.50E-13	4.29E-14	5.20E-13	5.44E-14	1.92E-14	4.44E-17	5.57E-16	7.05E-16	3.30E-15	2.15E-15	3.65E-12	5.15E-12	-5.49%
1:	9.09E-02	3.75E-13	1.89E-14	2.29E-13	2.40E-14	2.17E-14	5.02E-17	6.29E-16	7.96E-16	3.73E-15	2.42E-15	4.13E-12	4.81E-12	1.49%
1:	6.67E-01	1.80E-12	9.09E-14	1.10E-12	1.15E-13	1.42E-14	3.29E-17	4.12E-16	5.21E-16	2.44E-15	1.59E-15	2.70E-12	5.83E-12	-19.51%
1:	3.60E-03	1.61E-14	8.14E-16	9.87E-15	1.03E-15	2.36E-14	5.46E-17	6.84E-16	8.66E-16	4.05E-15	2.63E-15	4.49E-12	4.55E-12	6.79%
1:	5.00E+00	3.75E-12	1.89E-13	2.29E-12	2.40E-13	3.95E-15	9.13E-18	1.14E-16	1.45E-16	6.78E-16	4.41E-16	7.51E-13	7.23E-12	-48.26%
1:	9.09E-02	3.75E-13	1.89E-14	2.29E-13	2.40E-14	2.17E-14	5.02E-17	6.29E-16	7.96E-16	3.73E-15	2.42E-15	4.13E-12	4.81E-12	1.49%
1:	1.20E-02	5.36E-14	2.70E-15	3.28E-14	3.43E-15	2.34E-14	5.41E-17	6.78E-16	8.58E-16	4.02E-15	2.61E-15	4.45E-12	4.58E-12	6.23%
1:	5.00E-01	1.50E-12	7.57E-14	9.18E-13	9.61E-14	1.58E-14	3.65E-17	4.58E-16	5.79E-16	2.71E-15	1.76E-15	3.00E-12	5.62E-12	-15.09%

Propagated Error for the External Surfaces, (calculated in quadrature)

Source of Error	Percent Uncertainty
Sampling	8%
Scaling Factors	5%
Measurements- Systematic	16%
Measurements- Random	6.70%
Average of Contamination Level	-
Swipe Efficiency	-
Contaminated Surface Area	-
Total Propagated Error =	+/-20%

7. CONCLUSION

Based on the analysis stated above, the total source term for external surfaces is 0.0477 Ci (+/-20%). Nearly all of this activity is in the reactor building (TRA-642). The dominate nuclides are Cs-137 at ~70% and Co-60 at ~14%.

8. REFERENCES

1. ETR RadCon Log for TRA-642/643/644 Dated June 2005 thru July 2005.

2. ETR RadCon Log for Cold Pit, Entry #231 Dated March 1, 2006

3. ETR RadCon Log for Hot Pit, Entry #267 Dated March 7, 2006

4. ETR RadCon Log for PCS Pipe Tunnel, Entry #5 Dated November 17, 2005

5. ETR RadCon Log for the Crud Generator Cubicle, Entry #1039 Dated June 13, 2006

6. ETR RadCon Log for the GEEL Tunnel, Entry #16 Dated February 2, 2006

7. ETR RadCon Log for the Warm Waste Pit, Entry #4 Dated June 21, 2005

8. www.Ludlums.com, Ludlum Measurements Inc.

9. A. D. Coveleskie, September 3, 1997, Engineering Test Reactor (*ETR) Radiological Characterization*, TRA-EDF-007 (TRA-ATR-1145-R1), Idaho National Engineering Laboratory, Idaho Falls, Idaho.

10. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM),* NUREG-1575, Rev 1, August 2000.

9. APPENDIXES

Appendix A, Gamma Analytical Results

Appendix B, Alpha & Beta Analytical Results

Appendix C, Surface Area Data

Appendix A

Gamma Analytical Results

Appendix A

Gamma Results

July 14, 2005 CCN 201846

W. R. Spruill
CWI
P.O. Box 1625
Idaho Falls, ID 83415-8101

SUBJECT: RADIATION MEASUREMENTS LABORATORY GAMMA-RAY ANALYSIS OF NINE ETR DECONTAMINATION AND DECOMMISSIONING FILTER SAMPLES, JULY 7, 2005

Dear Wiley:

Nine ETR DECONTAMINATION AND DECOMMISSIONING FILTER SAMPLES submitted to the RTC (Reactor Technology Complex) Radioanalytical Laboratory July 7, 2005 by Kevin Montgomery and Bryan King were counted for one hour each and screened for manmade radioactivity using standardized high-resolution gamma-ray spectrometry techniques by the Radiation Measurements Laboratory (RML). Analyses results can be found in the attached gamma analyses report.

The RML performed quality assurance and quality control checks applicable to the gamma-ray measurements for the detector systems utilized for these measurements. The RML gamma-ray counting systems were “in control” for all relevant parameters.

Please call if you have any questions or need additional information concerning data from this report (T. C. Sorensen, 3-4410 or A. L. Freeman, 3-4158).

Sincerely,

A. L. Freeman
Data Analyst

Attachments:

BLIS REF.: 02SR

cc: C. C. Jensen, BEA, MS 7113
T. C. Sorensen, BEA, MS 7111

bcc: BEACC, MS 3105
A. L. Freeman File, ALF-078-05

Uniform File Code: 6404
Disposition Authority: ENV5-c-1
Retention Schedule: Destroy in 75 years

NOTE: Original disposition authority, retention schedule, and Uniform Filing Code applied by the sender may not be appropriate for all recipients. Make adjustments as needed.

GAMMA-RAY ANALYSIS RESULTS
Computed by PCGAP(c) for Windows

ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

PREPARED BY THE
RADIATION MEASUREMENT LABORATORY
14-JUL-05

IDAHO NATIONAL ENGINEERING AND ENVIRONMENTAL LABORATORY
IDAHO FALLS, IDAHO

The uncertainty associated with any reported activity in this report 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 at one standard deviation.

Analyzed by _____

Approved by _____

SAMPLE INFORMATION
ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

CUSTOMER SAMPLE IDS	COLLECTION DATE	BLIS BARCODE ID(S)	RML SPECTRUM ID(S)	SAMPLE VOLUME	LAB BACKGROUND ID(S)
F-H10 CUBICLE #16	070705	02SR-01-A	A1071105018	1.000	A1070505031 A1060205022 A1050205033 A1040405012
F-H10 CUBICLE #3	070705	02SR-02-A	B3071105017	1.000	B3070705018 B3060805028 B3050405021 B3040705017
J, L-10 CUBICLE #11	070705	02SR-03-A	B3071105020	1.000	B3070705018 B3060805028 B3050405021 B3040705017
J, L-10 CUBICLE #4	070705	02SR-04-A	A1071105012	1.000	A1070505031 A1060205022 A1050205033 A1040405012
L-12/M-7 CUBICLE #19	070705	02SR-05-A	A2071105016	1.000	A2070605020 A2060205023 A2050305031 A2040405013
L-12/M-7 CUBICLE #4	070705	02SR-06-A	B3071105014	1.000	B3070705018 B3060805028 B3050405021 B3040705017
L-12/M-7 CUBICLE #6	070705	02SR-07-A	A2071105013	1.000	A2070605020 A2060205023 A2050305031 A2040405013
L-12/M-7 CUBICLE #6	070705	02SR-08-A	A1071105015	1.000	A1070505031 A1060205022 A1050205033 A1040405012
M-3/P-7 SEC. CUB. #6	070705	02SR-09-A	A2071105019	1.000	A2070605020 A2060205023 A2050305031 A2040405013

ANALYST'S RESULTS OF MANMADE GAMMA-EMITTING RADIONUCLIDES
ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

CUSTOMER SAMPLE ID(S)	RML SPECTRUM ID(S)	RADIONUCLIDE(S) (GAMMA)	ACTIVITY (pCi/sample)	MDL	PERCENT UNCERTAINTIES GEOM.	EFF.	OTHER	ACTIVITY(T) (pCi/smpl)
Requested gamma-emitting radionuclides determined to be true-positive								
F-H10 CUBICLE #16	A1071105018	CO 60	(3.46 +/- 0.12)E+02	7.07E+01	5.0	5.0	0.0	(3.5 +/- 0.3)E+02
F-H10 CUBICLE #3	B3071105017	CO 60	(7.15 +/- 0.08)E+03	3.65E+02	5.0	5.0	0.0	(7.2 +/- 0.5)E+03
L-12/M-7 CUBICLE #19	A2071105016	CO 60	(3.20 +/- 0.13)E+02	7.55E+01	5.0	5.0	0.0	(3.2 +/- 0.3)E+02
L-12/M-7 CUBICLE #6	A1071105015	CO 60	(6.0 +/- 0.6)E+01	3.58E+01	5.0	5.0	0.0	(6.0 +/- 0.8)E+01
M-3/P-7 SEC. CUB. #6	A2071105019	CO 60	(1.55 +/- 0.10)E+02	6.03E+01	5.0	5.0	0.0	(1.55 +/- 0.15)E+02
M-3/P-7 SEC. CUB. #6	A2071105019	AGM 108	(8.1 +/- 0.4)E+01	3.01E+01	5.0	5.0	0.0	(8.1 +/- 0.7)E+01
F-H10 CUBICLE #16	A1071105018	CS 137	(9.61 +/- 0.15)E+04	5.83E+03	5.0	5.0	0.0	(9.6 +/- 0.7)E+04
F-H10 CUBICLE #3	B3071105017	CS 137	(1.31 +/- 0.03)E+03	1.28E+02	5.0	5.0	0.0	(1.31 +/- 0.10)E+03
J, L-10 CUBICLE #11	B3071105020	CS 137	(2.72 +/- 0.17)E+02	7.09E+01	5.0	5.0	0.0	(2.7 +/- 0.3)E+02
J, L-10 CUBICLE #4	A1071105012	CS 137	(1.23 +/- 0.02)E+03	9.16E+01	5.0	5.0	0.0	(1.23 +/- 0.09)E+03
L-12/M-7 CUBICLE #19	A2071105016	CS 137	(3.45 +/- 0.04)E+03	1.68E+02	5.0	5.0	0.0	(3.5 +/- 0.3)E+03
L-12/M-7 CUBICLE #4	B3071105014	CS 137	(9.0 +/- 0.3)E+02	1.03E+02	5.0	5.0	0.0	(9.0 +/- 0.7)E+02
L-12/M-7 CUBICLE #6	A2071105013	CS 137	(2.76 +/- 0.04)E+03	1.53E+02	5.0	5.0	0.0	(2.8 +/- 0.2)E+03
L-12/M-7 CUBICLE #6	A1071105015	CS 137	(4.96 +/- 0.05)E+03	2.04E+02	5.0	5.0	0.0	(5.0 +/- 0.4)E+03
M-3/P-7 SEC. CUB. #6	A2071105019	CS 137	(3.16 +/- 0.16)E+02	6.59E+01	5.0	5.0	0.0	(3.2 +/- 0.3)E+02

Other gamma-emitting radionuclides determined to be true-positive

None

ANALYST'S RESULTS OF REJECTED GAMMA-EMITTING RADIONUCLIDES
ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

CUSTOMER SAMPLE IDS	RML SPECTRUM IDS	RADIONUCLIDE (GAMMA)	ANALYSIS REJECTION CODE(S) (See the next page for code definitions.)
Requested gamma-emitting radionuclides determined to be false-positive.			
J, L-10 CUBICLE #4	A1071105012	CO 60	4,6
L-12/M-7 CUBICLE #4	B3071105014	CO 60	4,6
L-12/M-7 CUBICLE #6	A2071105013	CO 60	1,4,6
L-12/M-7 CUBICLE #6	A2071105013	AGM 110	1,2,4,5,6
L-12/M-7 CUBICLE #6	A1071105015	EU 154	1,2,4,6
Other gamma-emitting radionuclides determined to be false-positive.			
L-12/M-7 CUBICLE #6	A1071105015	NA 22	1,4,6

NUMBER REJECTION CODE DEFINITIONS

1	Uncertainty too high to be accepted by analyst.
2	Radionuclide had no supporting photo peaks energies.
3	Peak width unacceptable by the analyst.
4	Radionuclide results below decision critical level.
5	Other radionuclide gamma-ray interferences were present.
6	Graphical display of analyzed photo peaks showed unacceptable fitting results.
7	No parent activity, therefore the state of equilibrium is unknown and the radionuclide cannot be quantified.
8	Naturally occurring radionuclide with expected activity.
9	Other_____

ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

SAMPLE ACTIVITIES AND MDLS (pCi/smpl)

CUSTOMER ID	MN 54	MDL	CO 58	MDL	CO 60	MDL
F-H10 CUBICLE #16	(+1.09 +/- 3.2)E+00	1.48E+01	(+1.06 +/- 3.3)E+00	1.49E+01	+(+3.46 +/- .27)E+02	7.07E+01
F-H10 CUBICLE #3	(+1.92 +/- 1.1)E+01	4.84E+01	(-8.85 +/- 18.)E+00	7.53E+01	+(+7.15 +/- .51)E+03	3.65E+02
J, L-10 CUBICLE #11	(-3.40 +/- 25.)E-01	1.29E+01	(-1.28 +/- 3.0)E+00	1.50E+01	(+4.77 +/- 4.1)E+00	2.08E+01
J, L-10 CUBICLE #4	(-7.81 +/- 16.)E-01	8.13E+00	(+9.12 +/- 18.)E-01	9.07E+00	+(+1.12 +/- .29)E+01	1.84E+01
L-12/M-7 CUBICLE #19	(-1.45 +/- 3.0)E+00	1.40E+01	(-3.28 +/- 3.0)E+00	1.41E+01	+(+3.20 +/- .26)E+02	7.55E+01
L-12/M-7 CUBICLE #4	(+1.90 +/- 2.8)E+00	1.41E+01	(-5.15 +/- 36.)E-01	1.73E+01	+(+1.54 +/- .47)E+01	2.79E+01
L-12/M-7 CUBICLE #6	(+2.18 +/- 1.8)E+00	9.40E+00	(-2.52 +/- 1.9)E+00	9.50E+00	+(+1.24 +/- .42)E+01	2.20E+01
L-12/M-7 CUBICLE #6	(+1.32 +/- 2.9)E+00	1.35E+01	(+4.10 +/- 20.)E-01	9.90E+00	+(+6.01 +/- .75)E+01	3.58E+01
M-3/P-7 SEC. CUB. #6	(+1.34 +/- 2.4)E+00	1.17E+01	(-1.57 +/- 2.3)E+00	1.14E+01	+(+1.55 +/- .15)E+02	6.03E+01

CUSTOMER ID	ZN 65	MDL	NB 94	MDL	ZR 95	MDL
F-H10 CUBICLE #16	(+3.39 +/- 62.)E-01	2.98E+01	(+4.81 +/- 3.6)E+00	1.63E+01	(+8.11 +/- 5.1)E+00	2.33E+01
F-H10 CUBICLE #3	(+1.14 +/- 2.3)E+01	9.90E+01	(+2.58 +/- 1.3)E+01	5.54E+01	(+2.39 +/- 18.)E+00	7.59E+01
J, L-10 CUBICLE #11	(+9.11 +/- 5.4)E+00	2.86E+01	(+2.97 +/- 2.3)E+00	1.21E+01	(-2.47 +/- 5.5)E+00	2.71E+01
J, L-10 CUBICLE #4	(-2.73 +/- 34.)E-01	1.87E+01	(-1.34 +/- 1.5)E+00	7.92E+00	(-9.96 +/- 29.)E-01	1.45E+01
L-12/M-7 CUBICLE #19	(-8.88 +/- 6.1)E+00	3.02E+01	(+3.48 +/- 3.1)E+00	1.46E+01	(-7.01 +/- 4.5)E+00	2.16E+01
L-12/M-7 CUBICLE #4	(+1.32 +/- 5.9)E+00	3.10E+01	(+1.16 +/- 2.7)E+00	1.36E+01	(+4.18 +/- 5.1)E+00	2.52E+01
L-12/M-7 CUBICLE #6	(+3.74 +/- 4.3)E+00	2.31E+01	(-1.35 +/- 2.0)E+00	1.02E+01	-2.20 +/- 3.5)E+00	1.77E+01
L-12/M-7 CUBICLE #6	(-8.83 +/- 37.)E-01	2.00E+01	(-1.52 +/- 1.7)E+00	8.82E+00	(-2.23 +/- 3.4)E+00	1.65E+01
M-3/P-7 SEC. CUB. #6	(+3.33 +/- 43.)E-01	2.32E+01	(+4.66 +/- 2.9)E+00	1.39E+01	(+3.33 +/- 48.)E-01	2.28E+01

CUSTOMER ID	NB 95	MDL	RU 103	MDL	RURH 106	MDL
F-H10 CUBICLE #16	(+6.35 +/- 34.)E-01	1.55E+01	(-2.21 +/- 1.7)E+01	6.76E+01	(+5.49 +/- 7.9)E+01	3.28E+02
F-H10 CUBICLE #3	(-1.10 +/- 12.)E+00	5.16E+01	(+3.19 +/- 8.1)E+00	3.44E+01	(-9.57 +/- 9.1)E+01	3.84E+02
J, L-10 CUBICLE #11	(+2.84 +/- 28.)E-01	1.42E+01	(-4.79 +/- 2.1)E+00	1.06E+01	(+7.21 +/- 22.)E+00	1.12E+02
J, L-10 CUBICLE #4	(-4.16 +/- 18.)E-01	9.14E+00	(-3.54 +/- 2.7)E+00	1.20E+01	(-1.66 +/- 16.)E+00	7.85E+01
L-12/M-7 CUBICLE #19	(+4.66 +/- 39.)E-01	1.77E+01	(+4.14 +/- 4.6)E+00	1.99E+01	(+3.39 +/- 3.4)E+01	1.51E+02
L-12/M-7 CUBICLE #4	(+2.87 +/- 3.9)E+00	1.82E+01	(+3.93 +/- 4.3)E+00	1.92E+01	(+6.19 +/- 31.)E+00	1.45E+02
L-12/M-7 CUBICLE #6	(+3.63 +/- 2.3)E+00	1.11E+01	(+4.96 +/- 3.9)E+00	1.70E+01	(+7.89 +/- 25.)E+00	1.16E+02
L-12/M-7 CUBICLE #6	(+4.82 +/- 17.)E-01	8.49E+00	(-8.59 +/- 53.)E-01	2.24E+01	(-2.66 +/- 2.2)E+01	1.00E+02
M-3/P-7 SEC. CUB. #6	(+0.66 +/- 29.)E-01	1.36E+01	(-3.74 +/- 24.)E-01	1.12E+01	(-4.60 +/- 2.4)E+01	1.09E+02

CUSTOMER ID	AGM 108	MDL	AGM 110	MDL	SB 125	MDL
F-H10 CUBICLE #16	(-5.69 +/- 9.8)E+00	4.05E+01	(+1.70 +/- .91)E+02	3.64E+02	(+2.33 +/- 5.5)E+01	2.25E+02
F-H10 CUBICLE #3	(-9.90 +/- 11.)E+00	4.79E+01	(+1.34 +/- .70)E+01	3.01E+01	(-1.41 +/- 1.9)E+01	8.28E+01
J, L-10 CUBICLE #11	(+8.51 +/- 31.)E-01	1.49E+01	(+0.83 +/- 17.)E-01	9.07E+00	(-1.56 +/- 8.8)E+00	4.04E+01
J, L-10 CUBICLE #4	(+1.58 +/- 2.1)E+00	9.83E+00	(-2.25 +/- 1.1)E+00	5.77E+00	(-8.64 +/- 6.5)E+00	2.89E+01
L-12/M-7 CUBICLE #19	(-6.75 +/- 4.1)E+00	1.79E+01	(+3.81 +/- 3.8)E+00	1.67E+01	(+3.55 +/- 14.)E+00	5.79E+01
L-12/M-7 CUBICLE #4	(+3.97 +/- 3.9)E+00	1.79E+01	(+1.94 +/- 2.9)E+00	1.38E+01	(+3.84 +/- 11.)E+00	5.07E+01
L-12/M-7 CUBICLE #6	(+0.75 +/- 37.)E-01	1.65E+01	(+5.15 +/- 4.4)E+00	1.91E+01	(+8.98 +/- 12.)E+00	5.19E+01
L-12/M-7 CUBICLE #6	(+3.81 +/- 30.)E-01	1.34E+01	+(+8.72 +/- 3.0)E+00	1.33E+01	(-1.04 +/- 1.5)E+01	6.24E+01
M-3/P-7 SEC. CUB. #6	+(+8.12 +/- .69)E+01	3.01E+01	(-1.17 +/- 1.7)E+00	8.38E+00	(+1.56 +/- 1.0)E+01	4.41E+01

CUSTOMER ID	CS 134	MDL	CS 137	MDL	CE 144	MDL
F-H10 CUBICLE #16	(+6.25 +/- 3.5)E+00	1.60E+01	+(+9.61 +/- .70)E+04	5.83E+03	(+6.30 +/- 4.2)E+01	1.69E+02
F-H10 CUBICLE #3	(-4.87 +/- 13.)E+00	5.55E+01	+(+1.31 +/- .10)E+03	1.28E+02	(+3.08 +/- 3.4)E+01	1.43E+02
J, L-10 CUBICLE #11	(+2.18 +/- 3.8)E+00	1.84E+01	+(+2.72 +/- .26)E+02	7.09E+01	(-3.26 +/- 20.)E+00	8.59E+01
J, L-10 CUBICLE #4	(-2.51 +/- 1.9)E+00	9.47E+00	+(+1.23 +/- .09)E+03	9.16E+01	(+5.19 +/- 12.)E+00	5.12E+01
L-12/M-7 CUBICLE #19	(+3.16 +/- 4.0)E+00	1.83E+01	+(+3.45 +/- .25)E+03	1.68E+02	(+1.79 +/- 11.)E+00	4.79E+01
L-12/M-7 CUBICLE #4	(+1.51 +/- 3.3)E+00	1.62E+01	+(+9.02 +/- .68)E+02	1.03E+02	(-0.57 +/- 23.)E+00	9.80E+01
L-12/M-7 CUBICLE #6	(-1.34 +/- 2.1)E+00	1.08E+01	+(+2.76 +/- .20)E+03	1.53E+02	(-7.00 +/- 11.)E+00	4.52E+01
L-12/M-7 CUBICLE #6	(-3.48 +/- 1.9)E+00	9.68E+00	+(+4.96 +/- .35)E+03	2.04E+02	(-5.46 +/- 13.)E+00	5.46E+01
M-3/P-7 SEC. CUB. #6	(+4.07 +/- 3.1)E+00	1.48E+01	+(+3.16 +/- .27)E+02	6.59E+01	(-1.10 +/- .88)E+01	3.77E+01

CUSTOMER ID	EU 152	MDL	EU 154	MDL	EU 155	MDL
F-H10 CUBICLE #16	(-4.54 +/- 4.0)E+01	1.62E+02	(-2.98 +/- 70.)E-01	3.60E+01	(-4.02 +/- 1.7)E+01	7.00E+01
F-H10 CUBICLE #3	(-1.26 +/- 2.1)E+01	8.72E+01	(+1.58 +/- 1.8)E+01	8.32E+01	(-2.12 +/- 1.4)E+01	5.82E+01
J, L-10 CUBICLE #11	(+6.76 +/- 6.8)E+00	3.19E+01	(-6.27 +/- 11.)E+00	5.47E+01	(+8.42 +/- 68.)E-01	3.05E+01
J, L-10 CUBICLE #4	(-3.46 +/- 5.7)E+00	2.52E+01	(+2.41 +/- 6.8)E+00	3.53E+01	(-9.44 +/- 39.)E-01	1.70E+01
L-12/M-7 CUBICLE #19	(+2.58 +/- 11.)E+00	4.87E+01	(-1.48 +/- 9.0)E+00	4.56E+01	(+1.98 +/- 6.0)E+00	2.54E+01
L-12/M-7 CUBICLE #4	(-1.31 +/- .71)E+01	3.28E+01	(-0.75 +/- 11.)E-00	5.50E+01	(-9.97 +/- 11.)E+00	4.53E+01
L-12/M-7 CUBICLE #6	(+3.38 +/- 12.)E+00	4.97E+01	(-5.05 +/- 8.9)E+00	4.52E+01	(+2.93 +/- 6.2)E+00	2.59E+01
L-12/M-7 CUBICLE #6	(-4.51 +/- 9.7)E+00	4.12E+01	+(+1.88 +/- .90)E+01	4.36E+01	(-3.54 +/- 4.8)E+00	2.05E+01
M-3/P-7 SEC. CUB. #6	(+6.71 +/- 7.7)E+00	3.36E+01	(-3.29 +/- 8.9)E+00	4.52E+01	(-3.28 +/- 4.0)E+00	1.73E+01

CUSTOMER ID	RA 226	MDL	U 235	MDL	AM 241	MDL
F-H10 CUBICLE #16	(-9.19 +/- 31.)E+01	1.26E+03	(+3.37 +/- 3.9)E+01	1.57E+02	(-3.32 +/- 17.)E+00	6.91E+01
F-H10 CUBICLE #3	(-1.52 +/- 1.1)E+02	4.58E+02	(+6.36 +/- 3.6)E+01	1.49E+02	(+2.31 +/- 25.)E+00	1.09E+02
J, L-10 CUBICLE #11	(-1.63 +/- 5.8)E+01	2.55E+02	(+1.68 +/- 14.)E+00	6.06E+01	(-1.42 +/- .82)E+01	3.98E+01
J, L-10 CUBICLE #4	(-7.71 +/- 3.3)E+01	1.42E+02	(+9.26 +/- 7.6)E+00	3.30E+01	(+0.61 +/- 26.)E-01	1.19E+01
L-12/M-7 CUBICLE #19	(-2.64 +/- 4.7)E+01	2.00E+02	(-0.25 +/- 12.)E+00	5.07E+01	(-1.14 +/- .83)E+01	3.47E+01
L-12/M-7 CUBICLE #4	(+1.51 +/- 8.2)E+01	3.53E+02	(-3.52 +/- 23.)E+00	9.89E+01	(-2.77 +/- 1.4)E+01	6.43E+01
L-12/M-7 CUBICLE #6	(+8.19 +/- 5.2)E+01	2.19E+02	(+8.54 +/- 11.)E+00	4.67E+01	(+7.83 +/- 5.4)E+00	2.31E+01
L-12/M-7 CUBICLE #6	(+8.03 +/- 5.3)E+01	2.21E+02	(-4.56 +/- 15.)E+00	6.12E+01	(+1.83 +/- 4.7)E+00	2.01E+01
M-3/P-7 SEC. CUB. #6	(+1.99 +/- 3.3)E+01	1.43E+02	(-1.30 +/- .68)E+01	2.97E+01	(+3.53 +/- 4.7)E+00	2.04E+01

NOTE: A plus sign before a parenthesis "+(" indicates the activity is greater than two standard deviations, i.e., true positive.

ETR DECONTAMINATION AND DECOMMISSIONING
JULY 7, 2005

NON-TARGET NUCLIDE SAMPLE ACTIVITY AND MDL (pCi/smpl)

None

Appendix B

Alpha & Beta Results

Appendix B

Alpha & Beta Results

August 17, 2005 CCN: 202231

Wiley R Spruill
CWI
MS 7141

SUBJECT: ETR D&D VCO SMEARS

Attached you will find the results for the ETR D&D VCO smears. The samples were leached and filtered before entering the separations process. A method blank and a traceable control were run for qc purposes.

Sample ID: J, L-10 Cubicle #4 ***Lab Blis ID: 02SR-01-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	2.40E-01	4.31E-02	5.21E-02
^{90}Sr	-1.29E+01	3.47E+00	1.08E+01
^{63}Ni	-2.84E+01	1.10E+01	3.74E+01
^{241}Am/^{238}Pu*	1.10E-01	3.15E-02	6.76E-02

*Due to overlapping energies, isotopes are listed together

Sample ID: L-12/M-7 Cubicle #6 ***Lab Blis ID: 02SR-02-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	4.37E-01	6.02E-02	5.32E-02
^{90}Sr	8.06E+01	5.78E+00	1.08E+01
^{63}Ni	6.11E+02	3.35E+01	4.75E+01
^{241}Am/^{238}Pu*	8.73E-01	9.38E-02	1.09E-01

*Due to overlapping energies, isotopes are listed together

Sample ID: L-12/M-7 Cubicle #4 ***Lab Blis ID: 02SR-03-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{90}Sr	2.97E+01	6.22E+00	1.63E+01
^{63}Ni	4.40E+02	3.06E+01	6.56E+01

*Due to overlapping energies, isotopes are listed together

Sample ID: L-12/M-7 Cubicle #6 ***Lab Blis ID: 02SR-04-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	2.28E+00	2.14E-01	3.84E-01
^{90}Sr	6.78E+01	5.77E+00	1.17E+01
^{63}Ni	1.30E+03	6.44E+01	5.71E+01
^{241}Am/^{238}Pu*	1.01E+00	1.58E-01	3.84E-01

*Due to overlapping energies, isotopes are listed together

Sample ID: L-12/M-7 Cubicle #19 ***Lab Blis ID: 02SR-05-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	3.30E-01	6.46E-02	1.25E-01
^{90}Sr	2.67E+00	3.05E+00	9.01E+00
^{63}Ni	5.41E+02	3.26E+01	5.76E+01
^{241}Am/^{238}Pu*	7.48E-01	1.07E-01	2.03E-01

*Due to overlapping energies, isotopes are listed together

Sample ID: F-H10 Cubicle #3 ***Lab Blis ID: 02SR-06-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	2.52E-01	5.04E-02	8.05E-02
^{90}Sr	1.90E+02	8.28E+00	8.56E+00
^{63}Ni	5.93E+03	2.70E+02	4.08E+01
^{241}Am/^{238}Pu*	2.44E+00	1.91E-01	1.87E-01

*Due to overlapping energies, isotopes are listed together

Sample ID: F-H10 Cubicle #16 ***Lab Blis ID: 02SR-07-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{90}Sr	7.82E+01	4.67E+00	1.06E+01
^{63}Ni	2.17E+02	1.83E+01	4.54E+01

*Due to overlapping energies, isotopes are listed together

Sample ID: M-3/P-7 Sec. Cub. #6 ***Lab Blis ID: 02SR-08-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{234}U/^{233}U/^{237}Np*	1.65E-01	5.53E-02	1.35E-01
$^{239/240}$Pu*	1.24E+01	6.77E-01	1.99E-01
^{90}Sr	1.30E+02	5.46E+00	7.63E+00
^{63}Ni	1.36E+02	1.58E+01	4.45E+01
^{241}Am/^{238}Pu*	6.03E+00	4.11E-01	3.29E-01

*Due to overlapping energies, isotopes are listed together

Sample ID: J, L-10 Cubicle #11 ***Lab Blis ID: 02SR-09-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
$^{239/240}$Pu*	1.98E-01	5.72E-02	1.37E-01
^{90}Sr	9.97E-01	2.49E+00	9.02E+00
^{63}Ni	-2.33E+01	1.29E+01	4.37E+01

*Due to overlapping energies, isotopes are listed together

Sample ID: CTL1 ETR 07JUL05 ***Lab Blis ID: 02SQ-01-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{63}Ni	-3.99E+01	1.48E+01	5.04E+01

Sample ID: SMR4 ETR 07JUL05 ***Lab Blis ID: 02SQ-02-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{63}Ni	3.36E+01	1.62E+01	5.29E+01

Sample SMR5 ETR 07JUL05 ***Lab Blis ID: 02SQ-03-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{63}Ni	6.82E+01	1.64E+01	5.19E+01

Sample ID: SMR19 ETR 07JUL05 ***Lab Blis ID: 02SQ-04-A***

Isotope	Activity pCi/Sample	Uncertainty	MDA
^{63}Ni	1.71E+02	1.59E+01	4.16E+01

Reviewed by J. G. Eisenmenger

Please call me at 533-4293 if you have any questions.

Sincerely,

B. K. Harris
Analytical Chemistry and Instrumentation

BKH: sgh

cc: W. F. Bauer, INL, MS-2808

Appendix C

Surface Area Data

Appendix C

Surface Area Data

Building	Zone	Total (m^2)
Reactor Building (TRA-642)	Reactor Vessel	272.4
	Nozzle Trench	63.5
	Biological Shield (over cap)	45.6
	Canal	521.7
	Main Room	6423.4
	Console Floor	3643.0
	Balcony	607.5
	Emergency Cooling Loop Cubicles	598.9
	PCS Pipe Tunnel	192.5
	Hot Waste Pit	144.1
	P-7 Primary Cubicle	45.5
	J-10/L-10 Primary Cubicle	39.9
	C-7/M-13/N-14 Primary Cubicle	46.1
	C-7/M-13/N-14 Secondary Cubicle	98.7
	F-10/H-10 Primary Cubicle	50.3
	F-10/H-10 Auxiliary Cubicle	25.8
	F-10/H-10 Secondary Cubicle	39.4
	Helium System Cubicle	82.6
	L-12/M-7 Primary Cubicle	96.4
	L-12/M-7 Secondary Cubicle	37.5
	C-13/G-16 Primary Cubicle	44.0
	C-13/G-16 Secondary Cubicle	41.7
	Crud Generator Cubicle	9.4
	Subpile Room Entryway	21.0
	AGS Cubicle	42.3
	GEEL Pipe Tunnel	512.8
	M-3 Primary Cubicle	29.9
	M-3/P-7 Secondary Cubicle	13.7
	Warm Waste Pit	164.0
	Sub-Pile Room	55.0
	Rod Access Room	25.5
	Other Basement Areas	1280.2
Compressor Building (TRA-643)	Storage Area	177.6
Heat Exchanger Building (TRA-644)	Bypass valve room	47.9
	Tank room	39.4
	Main room	313.6
	Basement	604.6
	Degassing tank	27.6
	Primary pump pits	167.2
	Emergency shutdown pump pits	27.1
	Degassifier pump pits	26.3
	PCS Pipe Tunnel	754.3