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Ambient Air Radionuclide Concentrations
at and near TA-50 from 2003 through
the First Quarter of 2004

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by

Keith W. Jacobson and Craig F. Eberhart

ABSTRACT

The Meteorology and Air Quality (MAQ) group at Los Alamos National Laboratory maintains and operates a large network of environmental air samplers called AIRNET. Some of these samplers are located near Material Disposal Area C at TA-50, a low-level radioactive waste burial site in the semiarid environment of the Pajarito Plateau, near Los Alamos. AIRNET sampling media consist of a filter and silica gel. They are exchanged once every 2 weeks. Presented are 5 months of air sampling results for 5 stations operating in the vicinity of Material Disposal Area C.

Introduction

The radiological air-sampling network, referred to as AIRNET, at Los Alamos National Laboratory (LANL or the Laboratory) is operated by the Air Quality Monitoring Team in the Meteorology and Air Quality Group (MAQ). AIRNET is designed to measure environmental levels of airborne radionuclides that may be released from Laboratory operations. These emissions include plutonium, americium, uranium, tritium, and activation products. The Laboratory currently operates about 50 environmental air samplers to sample radionuclides by collecting water vapor and particulate matter. This data analysis is a review of particulate matter AIRNET data collected near TA-50 from the beginning of 2003 through the second quarter of 2004 to evaluate radionuclide air concentrations in the vicinity of Materials Disposal Area C. The following sites listed in Table 1 were included in this review and are shown in Figure 1.

Table 1. AIRNET Samplers near TA-50	
Site Number	Site Name
53	TA-50, MDA-C sampler
12	Royal Crest sampler
23	TA-5 sampler
77	TA-36, IJ Site sampler
26	TA-49 sampler

Figure 1. Location of Sampler #53 and adjacent samplers.

Generally, each AIRNET sampler continuously collects particulate matter for approximately two weeks per sample. Particulate matter is collected on 47-mm polypropylene filters at airflow rates of about 0.11 m³ per minute (4 cfm). Individual particulate matter filters are analyzed for gross alpha and gross beta activities. We also combine half-filters from the six or seven sampling periods at each site during the quarter to prepare a quarterly composite for isotopic analyses for each AIRNET station. These composites are dissolved, separated chemically, and then analyzed for isotopes of americium, plutonium, and uranium using alpha spectroscopy. All analytical procedures meet the requirements of 40 Code of Federal Regulations (CFR) 61, Appendix B, Method 114. The AIRNET project plan provides a summary of the target minimum detectable activity (MDA) for the biweekly and quarterly samples.

All AIRNET concentrations and doses are total measurements without any type of regional background subtractions. The AIRNET air concentrations are blank corrected to include corrections for the radioactivity from the filter material and the analytical process.

The Meteorology and Air Quality Group (MAQ) compares ambient air concentrations, as calculated from the AIRNET sample measurements, with environmental compliance standards or workplace exposure standards, depending on the location of the sampler. For this analysis, annual concentrations are compared with the 10-mrem equivalent concentration established by the Environmental Protection Agency (EPA 1989) and published in 40 CFR, Part 61, Appendix E, Table 2, "Concentration Levels for Environmental Compliance." All radiation doses were calculated by using this 10 mrem concentration as the conversion factor.

Ambient Air Concentrations – alpha and beta

Figures 2 and 3 present the long-lived gross alpha and beta air concentrations in air at the selected set of samplers. No unusual readings were recorded, except for the first sampling period when the concentrations were somewhat higher. These data were qualified due to some data problems and do not indicate any unexpectedly high concentrations.

Figure 2

Figure 3

Ambient Air Concentrations – tritium

Figure 4 provides airborne tritium results from the TA-50, MDA-C sampler (#53) and other nearby stations. A series of measurements beginning with the May 26, 2003 sampling period through the Oct. 13, 2003 sample period show tritium results that are above background. A potential source for the elevated readings is tritium vapor escaping from waste buried at Area C. The vapor is driven out of the ground at a greater rate due to increased solar radiation and temperature during the late spring, summer, and early fall. This evapotranspiration-like phenomenon has been observed at our air samplers at MDA-G (Jacobson et al., 2004).

Figure 4

However, there are other nearby sources of tritium emissions that could also be the cause of the above background readings, such as stack emissions from two tritium facilities located at TA-21. We performed a simple air-dispersion analysis of the TA-21 tritium emissions for the periods of the elevated readings and found that there was a probable contribution to the elevated readings at stations #23 and #53 (please see Appendix B for this analysis).

Elevated tritium measurements frequently occur at MDA-G. A previous study showed that there is a ground-flux of tritium from certain locations inside MDA-G (Ekland, 1995). We analyzed the possibility these diffuse emissions could have added to the higher readings at samplers #23 and #53 and concluded there would not have been an impact.

We also used air-dispersion modeling to determine that the single high reading at Station #26 in early December 2003 was due to a small tritium release from TA-16.

Ambient Air Concentrations – selected radioisotopes

Based on past operating experience with AIRNET, the other radionuclides that could potentially be above background at LANL include Am-241, Pu-238, Pu-239 and depleted uranium. Air concentrations from individual samples are shown in Tables 2 and 3 for these radionuclides and for the three uranium isotopes (U-234, U-235, and U-238). Radionuclide concentrations are graphically compared between sites in Figures 4, 5, 6, 7, 8, and 9. Many of these measurements are less than their 2-sigma uncertainties, as shown in the table, but the measurements are estimated concentrations instead of “less than” values. Annual isotopic concentrations were calculated for these results (Table 2).

Figure 5

Figure 6

Figure 7

Figure 8

Figure 9

Table 2. Net Isotopic Readings from Sampler #53						
Sample Period	Pu-239 (aCi/m³)		Pu-238 (aCi/m³)		Am-241 (aCi/m³)	
	Result	2s	Result	2s	Result	2s
03Q1	-0.74	4.27	0.36	3.22	3.66	10.70
03Q2	6.88	3.08	-0.17	1.31	-0.39	2.57
03Q3	1.52	1.79	0.42	1.26	-0.29	1.79
03Q4	8.80	4.10	0.68	2.07	-0.21	2.35
04Q1	0.97	1.68	1.29	1.65	1.13	2.04

Table 3. Net Isotopic Readings from Sampler #53						
	U-238 (aCi/m³)		U-235 (aCi/m³)		U-234 (aCi/m³)	
	Result	2s	Result	2s	Result	2s
03Q1	4.2	9.8	7.2	11.4	11.4	12.5
03Q2	21.7	5.9	2.1	3.1	18.0	6.3
03Q3	37.3	6.1	1.8	1.9	15.6	4.4
03Q4	17.8	6.1	-0.1	2.7	8.3	4.9
04Q1	11.2	4.1	0.0	2.0	10.2	4.6

Two of the Pu-239 readings recorded at sampler #53 appear to be statistically different than background levels. However, there were no unusual readings of Pu-238, Am-241, or U-235 (Figures 6, 7, 8) that were recorded at any of the sampling stations during this time period.

Uranium concentrations were primarily due to natural uranium from suspended soils, with a few samples showing small amounts of depleted uranium from time to time at LANL. Measurable concentrations of depleted uranium have increased Laboratory-wide since the Cerro Grande fire, but concentrations are still similar to natural levels. For example, as shown in Figure 9, it appears some depleted uranium in air was detected by sampler #53 during the 3rd quarter of 2003, probably from resuspension of surface contamination at other LANL locations.

Doses and Conclusion

Figure 10 shows a close-up of the sampler #53 site in relation to TA-50 and MDA-C. Radiation doses from H-3, Pu-238, Pu-239, Am-241, U-234, U-235, and U-238 were calculated from the annual air concentrations and summed by site as shown in Table 4. Usually about half of these doses are from uranium concentrations that, based on their isotopic signatures, appear to be natural.

Even though detectable concentrations of DU, Pu-239 and tritium were measured, the maximum estimated dose was about 0.1 mrem which is well below the EPA standard of

10 mrem for DOE facilities. We also calculated a hypothetical dose to a field worker based on the maximum two-week tritium in-air concentration of about 25 pCi/m³. Assuming an 8-hour work day over a 2-week work period (10 days) that dose came out to 2×10^{-4} mrem.

Figure 10. Close-up view of location of sampler #53 TA-50, MDA-C.

Table 4. Estimated Doses from Sampler #53 Averaged Readings			
Radioisotope	Dose Factor (yr m³ / mrem pCi)	Average Concentration (pCi/m³)	Estimated Dose (mrem/yr)
H-3	150	8.8	0.059
	(yr m ³ / mrem aCi)	(aCi/m ³)	(mrem/yr)
Am-241	190	0.8	0.004
Pu-238	210	0.5	0.002
Pu-239	200	3.5	0.017
U-234	770	12.7	0.016
U-235	710	2.2	0.003
U-238	830	18.4	0.022
Sum =			0.125

References

Keith W. Jacobson and Craig F. Eberhart, "Air-Sampling from Area G: A Radioactive-Waste Management Site," Los Alamos National Laboratory report LA-14090 (2004).

Bart Eklund, "Measurements of Emission Fluxes from Technical Area 53, Areas G and L," Radian Corporation report, Austin, Texas (1995).

Appendix A. Tritium Results for Station #53

Sample Period ID	Start Date	Ending Date	Net Tritium Air Concentration (pCi/m ³)	2-sigma Uncertainty (pCi/m ³)
030217	02/03/2003	02/17/2003	7.2	2.5
030303	02/17/2003	03/03/2003	5.0	1.9
030317	03/03/2003	03/17/2003	4.8	1.8
030331	03/17/2003	03/31/2003	4.0	1.9
030414	03/31/2003	04/14/2003	3.1	1.9
030428	04/14/2003	04/28/2003	0.4	2.4
030512	04/28/2003	05/12/2003	2.3	1.6
030526	05/12/2003	05/26/2003	7.3	2.7
030609	05/26/2003	06/09/2003	13.2	4.4
030623	06/09/2003	06/23/2003	14.6	3.7
030707	06/23/2003	07/07/2003	20.6	4.3
030721	07/07/2003	07/21/2003	20.5	4.5
030804	07/21/2003	08/04/2003	19.8	4.9
030818	08/04/2003	08/18/2003	24.0	6.3
030901	08/18/2003	09/01/2003	16.7	5.7
030915	09/01/2003	09/15/2003	12.0	3.7
030929	09/15/2003	09/29/2003	21.5	4.1
031013	09/29/2003	10/13/2003	13.3	3.2
031027	10/13/2003	10/27/2003	20.0	2.9
031110	10/27/2003	11/10/2003	6.6	2.1
031124	11/10/2003	11/24/2003	3.0	1.5
031208	11/24/2003	12/08/2003	5.4	1.5
031222	12/08/2003	12/22/2003	3.4	1.3
040105	12/22/2003	01/05/2004	2.5	1.1
040119	01/05/2004	01/19/2004	2.2	1.2
040202	01/19/2004	02/02/2004	2.7	1.3
040216	02/02/2004	02/16/2004	1.7	1.0
040301	02/16/2004	03/01/2004	0.5	1.2
040315	03/01/2004	03/15/2004	3.7	1.4
040329	03/15/2004	03/29/2004	2.2	1.4

Appendix B. Tritium Air-Dispersion Analysis

Bi-Weekly Tritium Emissions		
Ending Date	TA-21-155 (#Ci)	TA-21-209 (#Ci)
9-Jun-2003	9.2	28.7
23-Jun-2003	8.9	27.8
7-Jul-2003	9.6	43.3
21-Jul-2003	10.7	59.3
4-Aug-2003	12.8	31.9
18-Aug-2003	12.8	22.1
1-Sep-2003	14.0	7.9
15-Sep-2003	17.6	7.0
29-Sep-2003	20.8	10.3
13-Oct-2003	14.0	13.4
27-Oct-2003	14.7	11.3

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