4. Air Monitoring Programs

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Lawrence Livermore National Laboratory performs continuous air sampling to evaluate its compliance with local, state, and federal laws and regulations and to ensure that human health and the environment are protected. Federal environmental air quality laws and U.S. DOE regulations include 40 CFR 61, Subpart H—the NESHAPs section of the Clean Air Act; applicable portions of DOE Order 5400.5; and ANSI standards. The *Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance* (U.S. DOE 1991) provides the guidance for implementing DOE Order 5400.5.

The EPA Region IX has enforcement authority for LLNL compliance with radiological air emission regulations. Enforcement authority for the Clean Air Act regulations pertaining to nonradiological air emissions belongs to two local air districts: the BAAQMD and the SJVAPCD.

4.1 Air Effluent Monitoring

Air effluent monitoring of atmospheric discharge points is in place for compliance with 40 CFR 61, Subpart H and is used to determine the actual radionuclide releases from individual facilities during routine and nonroutine operations and to confirm the operation of facility emission control systems. Subpart H requires continuous monitoring of facility radiological air effluents if the potential off-site (fence-line) dose equivalent is greater than 1 μSv/y (0.1 mrem/y), as calculated using the EPA-mandated air dispersion dose model, CAP88-PC, without credit for emission control devices. The results of monitoring air discharge points provide the actual emission source information for modeling, which is used to ensure that the NESHAPs standard of 100 μSv/y (10 mrem/y) total site effective dose equivalent is not exceeded. See **Chapter 7** for further information on radiological dose assessment.

Currently, the air effluent sampling program measures only radiological emissions. For LLNL operations with nonradiological discharges, LLNL obtains permits from local air districts (i.e., BAAQMD and SJVAPCD) for stationary emission sources, and from the CARB for portable emission sources such as diesel air compressors and generators. Current permits do not require monitoring of air effluent but do require monitoring of equipment usage, material usage, and record keeping during operations. Based on air toxics emissions inventory and risk assessment required by the California Air Toxics “Hot Spots” Information and Assessment Act of 1987, BAAQMD and SJVAPCD have ranked LLNL as a low-risk facility for nonradiological air emissions.

4.1.1 Air Effluent Radiological Monitoring Results and Impact on the Environment

In 2007, LLNL measured releases of radioactivity from air exhausts at six facilities at the Livermore site and at one facility at Site 300. Air monitoring locations at the Livermore site and Site 300 are shown in **Figures 4-1** and **4-2**, respectively.

In 2007, a total of 0.57 TBq (15.4 Ci) of tritium was released from the Tritium Facility. Of this, approximately 0.42 TBq (11.4 Ci) of tritium was released as vapor (HTO/TTO). The remaining tritium released, 0.15 TBq (4.0 Ci), was gaseous tritium (HT/TT). The tritium emissions from the facility for 2007 are the lowest in decades and may be the lowest since the facility began activities.

In 2007, a total of 1.7×10^{-3} TBq (4.6×10^{-2} Ci) of measured tritium was released from the DWTF. Of this, approximately 1.6×10^{-3} TBq (4.4×10^{-2} Ci) of tritium was released as HTO/TTO, and 6.3×10^{-5} TBq (1.7×10^{-3} Ci) was released as HT/TT. The emissions from the DWTF for 2007 are similar to past years.

The Contained Firing Facility (CFF) at Site 300 had measured depleted uranium emissions in 2007. A total of 2.8×10^{-10} TBq (7.7×10^{-9} Ci) of uranium-234, 1.6×10^{-11} TBq (4.2×10^{-10} Ci) of uranium-235, and 1.8×10^{-9} TBq (4.9×10^{-8} Ci) of uranium-238 was released in particulate form. The emissions were a result of planned activities with depleted uranium.

None of the other facilities monitored for radionuclides had reportable emissions in 2007. The data tables in **Appendix A, Section A.1** provide summary results of all air effluent monitored facilities and include upwind locations (control stations) for gross alpha and gross beta background comparison to stack effluent gross alpha and gross beta results.

The dose to the hypothetical, site-wide maximally exposed member of the public caused by the measured air emissions from the Tritium Facility (modeling HT emissions as HTO as required by EPA) was 1.3×10^{-2} μSv/y (1.3×10^{-3} mrem/y); the dose from the DWTF (modeling HT emissions as HTO) was 4.3×10^{-5} μSv/y (4.3×10^{-6} mrem/y); and the dose from the CFF was 1.1×10^{-6} μSv/y (1.1×10^{-7} mrem/y).

All of the reported doses are less than one-tenth of one percent of the annual NESHAPs standard, which is 100 μSv/y (10 mrem/y) total site effective dose equivalent. As shown in **Chapter 7**, the estimated radiological dose caused by measured air emissions from LLNL operations was minimal. See also the *LLNL NESHAPs 2007 Annual Report* (Bertoldo et al. 2008) for a complete description of air effluent monitoring.

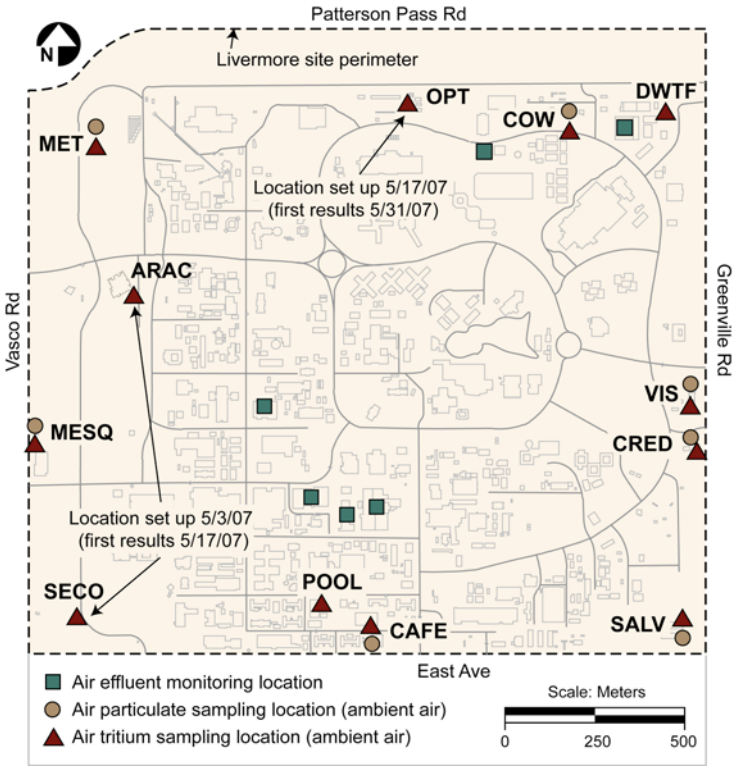

Figure 4-1. Air effluent and ambient air monitoring locations at the Livermore site, 2007.

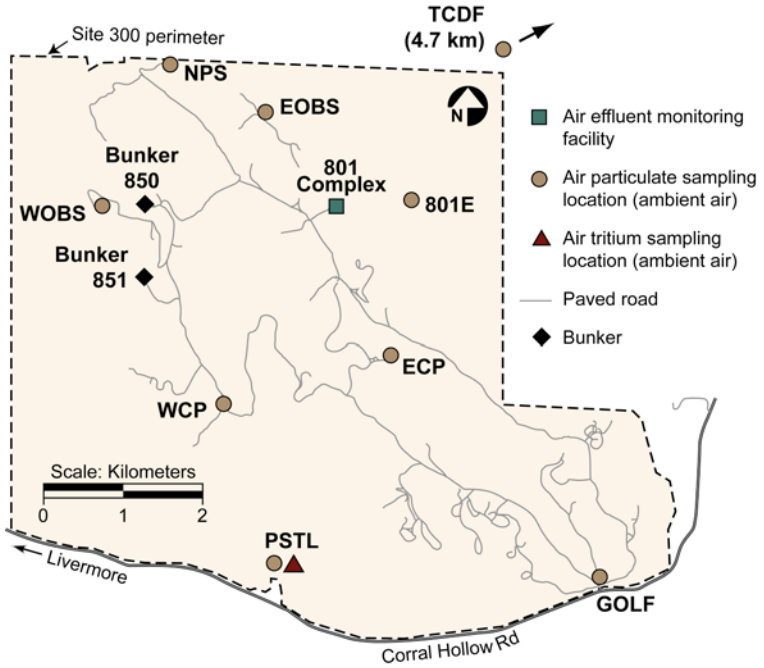

Figure 4-2. Air effluent and ambient air monitoring locations at Site 300, 2007.

4.1.2 Nonradiological Air Releases and Impact on the Environment

In 2007, the Livermore site emitted approximately 143 kg/d of regulated air pollutants as defined by the Clean Air Act, including nitrous oxides (NOx), sulphur oxides (SOx), particulate matter (PM-10), carbon monoxide (CO), and reactive organic gases/precursor organic compounds (ROGs/POCs) (see **Table 4-1**). The stationary emission sources that released the greatest amount of regulated pollutants at the Livermore site were natural gas fired boilers, internal combustion engines (such as diesel generators), solvent cleaning, and surface coating operations (such as painting). Pollutant emission information was primarily derived from monthly material and equipment usage records.

Table 4-1. Nonradioactive air emissions, Livermore site and Site 300, 2007.

	Estimated releases (kg/d)	
Pollutant	**Livermore site**	**Site 300**
ROGs/POCs	17.3	0.48
Nitrogen oxides	65.7	2.32
Carbon monoxide	52.3	0.51
Particulates (PM-10)	6.0	0.39
Sulfur oxides	1.5	0.21
Total	142.8	3.91

Livermore site air pollutant emissions were very low in 2007 compared to the daily releases of air pollutants from all sources in the entire Bay Area. For example, the average daily emission of NOx in the Bay Area was approximately 4.45×10^5 kg/d, compared to the estimated daily release from the Livermore site of 65.7 kg/d, which is 0.015% of total Bay Area source emissions for NOx. The 2007 BAAQMD estimate for ROGs/POCs daily emissions throughout the Bay Area was 3.32×10^5 kg/d, while the daily emission estimate for 2007 from the Livermore site was 17.3 kg/d, or 0.005% of the total Bay Area source emissions for ROGs/POCs.

Certain operations at Site 300 require permits from the SJVAPCD. The estimated daily air pollutant emissions during 2007 from operations (permitted and exempt stationary sources) at Site 300 are listed in **Table 4-1**. The stationary emission sources that release the greatest amounts of regulated air pollutants at Site 300 include internal combustion engines (such as diesel generators), a gasoline-dispensing facility, paint spray booths, and general machine shop operations. Combustion pollutant emissions, such as NOx, CO, SOx, and PM-10, increased at Site 300 in 2007 primarily from the required, periodic preventative maintenance of emergency stand-by diesel generators.

4.2 Ambient Air Monitoring

LLNL conducts ambient air monitoring at on- and off-site locations to determine whether airborne radionuclides or beryllium are being released to the environs in measurable quantities by LLNL operations. Ambient air monitoring also serves to verify the air concentrations predicted by air dispersion modeling and to determine compliance with NESHAPs regulations.

The derived concentration guides (DCGs) in DOE Order 5400.5 specify the concentrations of radionuclides that can be inhaled continuously 365 days a year without exceeding the DOE primary radiation protection standard for the public, which is 1 mSv/y (100 mrem/y) effective dose equivalent.

Beryllium is the only nonradiological emission from LLNL that is monitored in ambient air. LLNL requested and was granted a waiver by the BAAQMD for source-specific monitoring and record keeping for beryllium operations, provided that LLNL can demonstrate that monthly average beryllium concentrations in air are well below regulatory limits of 10,000 pg/m^3. LLNL meets this requirement by sampling for beryllium at perimeter locations.

Based on dispersion modeling using site-specific meteorological data, the ambient air samplers, particularly those on the site perimeters, have been placed to monitor locations where elevated air concentrations due to LLNL operations may occur. Sampling locations for each monitoring network are shown in **Figures 4-1**, **4-2**, and **4-3**.

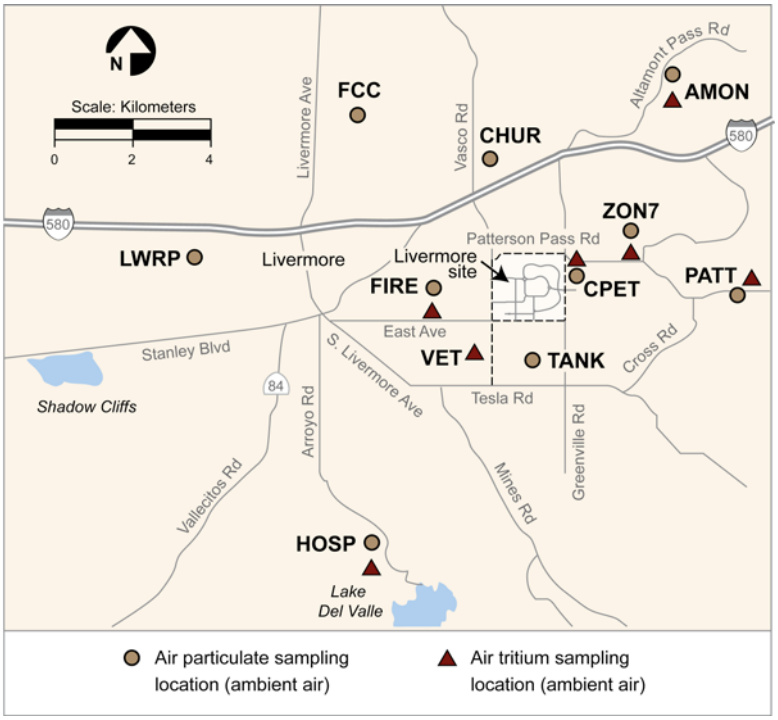

Figure 4-3. Air particulate and tritium monitoring locations in the Livermore Valley, 2007.

4.2.1 Ambient Air Radioactive Particulates

By analyzing air samples for gamma-emitting radionuclides, LLNL verifies that there is no evidence of release of the small inventories of mixed-fission products and radiochemical tracers used by LLNL. Composite samples for the Livermore site and Site 300 were analyzed for an environmental suite of gamma-emitting radionuclide concentrations in air that include fission products, activation products, actinides, and naturally occurring products. The isotopes detected at both sites in 2007 were beryllium-7 (cosmogenic), lead-210, and potassium-40, all of which are naturally occurring in the environment.

Plutonium-239+240 was detected in 8 out of 216 samples taken in 2007. The highest values and percentage of the DCG were as follows:

- Livermore site perimeter: 15 nBq/m^3 (0.41 aCi/m^3); 0.002% of the DCG
- Livermore off-site locations: 28 nBq/m^3 (0.76 aCi/m^3); 0.0038% of the DCG
- Site 300 composite: 6.8 nBq/m^3 (0.18 aCi/m^3); 0.00092% of the DCG

The plutonium-239+240 detection at Site 300 is calculated to be from resuspended fallout from historic aboveground nuclear testing. Site 300 does not use or store plutonium on-site.

Uranium-235 and uranium-238 were detected at all sample locations. Uranium ratios are used to determine the type of uranium present in the environment. Natural uranium has a mathematical uranium-235/uranium-238 ratio of 0.00725, and depleted uranium has a uranium-235/uranium-238 ratio of 0.002. Uranium isotopes are naturally occurring. The annual median uranium-235/ uranium-238 isotopic ratios for 2007 were as follows:

- Livermore site perimeter composite: 0.00737
- Site 300 perimeter: 0.00724
- Site 300 off-site location: 0.00734

The annual uranium-235/uranium-238 isotopic ratio medians are consistent with naturally occurring uranium. All of the individual uranium-235 and uranium-238 results were less than one-tenth of one percent of the DCG as shown in **Appendix A**, **Section A.2**.

Gross alpha and gross beta were sampled for at all locations. The primary sources of alpha and beta activities are naturally occurring radioisotopes. Routine isotopic gamma results indicate the activities are the result of naturally occurring isotopes (uranium, thorium, potassium, and lead), which are also routinely found in local soils. See **Appendix A, Section A.2**.

4.2.2 Ambient Air Tritium Concentrations

The biweekly air tritium data that are provided in **Appendix A**, **Section A.2** are summarized in **Table 4.2**. In 2007, as expected, the highest concentrations of tritium were found near area (diffuse) sources near the Tritium Facility and in the Building 612 yard on the Livermore site. Area sources include stored containers of tritium waste or tritium-contaminated equipment from which HTO diffuses into the atmosphere. These diffuse-source sampling locations were

discontinued mid-year. Air concentrations measured at sampler locations near the Livermore site perimeter were the next highest after those near diffuse sources; the concentrations near the perimeter were, on average, less than 5% of those near the diffuse sources. Location POOL exhibited the highest biweekly concentration of the perimeter locations. With the exception of the downwind sampling location CPET, all of the median concentrations in the Livermore Valley were below the minimum detectable concentration (MDC) in 2007. Given the low tritium concentrations observed at the Livermore site sample locations, remote sample concentrations are readily observed to be below the MDC. Similarly, because no operations at Site 300 released tritium to the environment in 2007, the 6 of 26 sample concentrations measured above the MDC at PSTL is likely an artifact of scintillation counting with a high counter background.

Table 4-2. Air tritium sampling summary for 2007.

Sampling locations	Detection frequency	Concentration (mBq/m^3)				Median % DCG[(a)]	Dose (nSv)
		Mean	Median	IQR	Maximum		
Diffuse on-site sources	18 of 18	730	700	310	1200	0.019%	154
Livermore site perimeter[(b)]	175 of 231	36.1	26.9	30.3	212	0.00073%	7.61
Livermore Valley	80 of 179	17.8	13	19.7	218	0.00035%	3.75
Site 300	6 of 26	5.67	6.46	13.4	23.2	0.00017%	1.19

(a) DCG = derived concentration guide of 3.7×10^6 mBq/m^3 for tritium in air.

(b) Locations COW, DWTF, MET, and POOL are considered near perimeter locations.

For a location at which the mean concentration is at or below the MDC, inhalation dose from tritium is assumed to be less than 5 nSv/y (0.5 µrem/y) (i.e., the annual dose from inhaling air with a concentration at the MDC of about 25 mBq/m^3 [0.675 pCi/m^3]).

4.2.3 Ambient Air Beryllium Concentrations

LLNL measures the monthly concentrations of airborne beryllium at the Livermore site, Site 300, and at the off-site sampler northeast of Site 300. The highest value at the Livermore site in 2007 for airborne beryllium was 16 pg/m^3. This value is only 0.16% of the BAAQMD ambient concentration limit for beryllium (10,000 pg/m^3). These data are similar to data collected from previous years.

There is no regulatory requirement to monitor beryllium in San Joaquin County; however, LLNL analyzes samples from three Site 300 perimeter locations as a best management practice. The monthly median beryllium concentration for these locations was 6.5 pg/m^3. The monthly median concentration for the off-site location was 11 pg/m^3. See **Appendix A, Section A.2**.

4.2.4 Impact of Ambient Air Releases on the Environment

LLNL operations involving radioactive materials had minimal impact on ambient air during 2007. The measured radionuclide particulate and tritium concentrations in air at the Livermore site and

Site 300 were all less than one-tenth of one percent of the DCG. These levels do not indicate the presence of a threat to the environment or public health.

Beryllium is naturally occurring and has a soil concentration of approximately 1 part per million. The sampled results are believed to be from naturally occurring beryllium that was resuspended from the soil and collected by the sampler. Even if the concentrations of beryllium detected were from LLNL activities, the amount is still less than one percent of the BAAQMD ambient air concentration limit, and as such, does not present a concern for public safety or the environment.