4.10 AIR QUALITY

Air quality laws and regulations have been established to protect the public from harmful effects of air pollution. These rules take several forms. In some cases, the goal is to designate acceptable levels of pollution in ambient air, as in the establishment of ambient air quality standards (AAQSs). Other regulations establish limits on air pollutant emission sources or activities to reduce their impact. Still others establish jurisdictional authority to regulate air pollutant emission sources and enforce laws and regulations.

The following sections provide a general summary of air protection programs and ambient pollutant levels in the environs of LLNL:

- Section 4.10.1 highlights the regulatory authorities that oversee air protection programs.
- Section 4.10.2 provides summary information on the potential harmful effects of air pollutants, the primary sources, and recommended control measures.
- Section 4.10.3 provides more specific details on the requirements placed on facilities in order to control and remedy air pollutant problems.
- Section 4.10.4 details LLNL's air pollutant sources and emissions, the programs developed to manage these sources, and the program effectiveness.
- Section 4.10.5 discusses radiological air quality, providing information on LLNL's effluent monitoring and ambient air sampling programs, radionuclide emission estimates, as well as dose calculations for maximally exposed receptors and the populace.

4.10.1 Regulatory Authorities

EPA is charged with protecting the Nation's air resources. The authority is derived from the *Clean Air Act* and subsequent amendments, which provide the framework to protect the Nation's air resources. In addition to federally mandated air programs, the state of California has enacted legislation with the *California Clean Air Act* and the California Health and Safety Code to further protect the air resources. Some of these programs are similar to, but more stringent than, Federal counterparts, while others are unique to California.

Within California, the authority to administer both Federal and state air programs has been delegated to the California Air Resources Board (CARB), a department of the California EPA. The CARB, in turn, has further delegated the authority to regulate stationary air emissions sources (i.e., nonvehicular sources) to local air districts. Local program requirements must be at least as strict as any underlying state or Federal requirements.

Locally, the Bay Area Air Quality Management District (BAAQMD) and San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) hold jurisdiction. The Bay Area air basin includes Alameda County (home of the Livermore Site and a small portion of Site 300) and all or portions of eight other bay area counties. The San Joaquin Valley air basin extends to inland areas including San Joaquin County (home of Site 300) and all or portions of eight other counties. Each air district is required to assess the local air pollutant situation and to develop and implement programs to protect the air resource.

LLNL activities, therefore, are subject to air quality regulations and standards established under the *Clean Air Act,* by the State of California, and under the rules and regulations of the local air districts, as well as internal policies and requirements of NNSA and the University of California.

Summaries of program requirements and the LLNL air protection program are provided below. Table 4.10.1–1 provides a summary of air pollutant sources, potential health effects, and strategies for air pollutant prevention and control.

4.10.2 Public Health Criteria and Air Protection Programs

To support the protection of air resources, local air pollution control agencies routinely collect information related to air emission sources and measure ambient air pollutant levels. Air emission source information is collected in the form of an emissions inventory. Together, these data are used to assess and develop air pollutant programs targeted to local and regional pollutant problems and emission sources, and design long-range strategies for continued protection of the air resources while allowing for future growth.

Where air pollutant levels are problematic, more stringent requirements are placed on emission sources, and additional oversight is given to those sources responsible for a greater portion of the pollutant loading. In the development of emissions inventories, air districts work with affected facilities to gather necessary information. The task of preparing an emissions inventory involves a detailed evaluation of facility processes, hours of operation, equipment ratings, material throughput, operational efficiency, and control mechanisms. This information is used to quantify emission rates. Facilities must report all emission information for each air contaminant for which emission rates exceed a reporting threshold. The inventory process in California is quite extensive, and involves the collection of data on more than 300 compounds. Using this information, the air districts throughout the state are required to prioritize facilities for additional review. The inventory also provides a feedback loop to assist in the determination of the adequacy of placement and extent of air monitoring programs.

This section provides data developed in the air monitoring and inventory programs, specifically the criteria and toxic air pollutant programs. Locally, air pollutants are measured at air district monitoring stations in Livermore and Tracy, although monitoring in Tracy is not as extensive as that in Livermore. Both monitoring and emissions inventory data are compiled by the air districts and CARB and published in annual reports. This section draws heavily on data and assessments from these annual reports to provide an objective measure of the status of air quality.

4.10.2.1 *Criteria Air Pollutant Programs*

With the enactment of air protection programs, Congress established the National Ambient Air Quality Standards (NAAQS) for certain pervasive pollutants, termed criteria air pollutants, that were recognized as particular environmental concerns. These criteria air pollutants include sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, particulate matter, and lead. Standards for particulate matter were later refined to specify smaller size particles that are more easily inhaled and retained in the lungs. NAAQS are designed to protect public health and welfare. In addition, the State of California has promulgated State Ambient Air Quality Standards (SAAQS). California standards are equal to or more restrictive than Federal standards, and include additional air contaminants; specifically, hydrogen sulfide, sulfates, vinyl chloride, and visibility-reducing particles.

Air quality standards are expressed as an allowable volume of pollutant per million volumes of air (parts per million), or as micrograms of pollutant per cubic meter of air. Each NAAQS or SAAQS is related to an averaging time. Short-term averaging times of 1 to 24 hours are designed to protect against acute (short-term) exposures to relatively high pollutant levels. Longer-term averaging times of 1 month to 1 year are designed to protect against the ongoing or day-to-day exposure to relatively lesser pollutant levels.

Ambient air pollutant measurements are used in determining an area's status with respect to NAAQS or SAAQS (i.e., as an attainment or nonattainment area). Ozone and nitrogen dioxide are measured locally in Livermore and Tracy. Particulate matter and carbon monoxide are also measured in Livermore, as well as some toxic air contaminants (discussed in Section 4.10.2.2).

While attaining and maintaining compliance with NAAQS or SAAQS is a primary goal of all air pollution control agencies, both the Bay Area and San Joaquin Valley have been designated as nonattainment areas with respect to both the Federal ozone standard and the more stringent state standard. The Bay Area air district is classified as nonattainment with respect to California standards for particulates, attainment for the Federal PM_{10} annual standard, and unclassified for both $PM_{2.5}$ and 24-hour PM_{10} standards. The San Joaquin Valley air district is classified as nonattainment for state particulate matter standards and as a serious nonattainment area for Federal PM_{10} standards. The designation for the Federal $PM_{2.5}$ standard has not yet been determined (SJVUAPCD 2002). Although particulates are not measured in Tracy, it is recognized as a regional problem. The Bay Area has been a nonattainment area for carbon monoxide; however, in 1998, the Bay Area was redesignated as an attainment area for carbon monoxide, and further problems are not anticipated (BAAQMD 2003, 1999).

Regionally, the most complex air quality problem has been ozone. Ozone is not regulated directly because it is formed in the atmosphere by photochemical reactions (i.e., in the presence of sunlight). Nitrogen oxides and many organic compounds are precursors to the formation of ozone. For this reason, air districts are particularly interested in reducing precursor organic compounds and nitrogen oxides. As discussed in Section 4.7.5, the local topography, meteorology, and proximity to large metropolitan areas upwind, contribute to the buildup of air pollutants in the Livermore Valley. This area, in fact, experiences a disproportionate number of exceedances of NAAQS. Because it takes some time for the photochemical reactions to occur, emissions of precursors, primarily from motor vehicles and the morning commute, are transported away from their sources and affect ozone concentrations in downwind areas. Although the Bay Area's highest ozone levels can fluctuate from year to year depending on weather conditions, ambient ozone standards are exceeded most often in the Santa Clara, Livermore, and Diablo valleys. These same locations typically register the highest particulate matter levels as well, although in this case, the high levels are due to the dry conditions and limited mixing within the sheltered terrain (BAAQMD 1999). The basin-wide annual criteria pollutant emissions inventory projected for years 2005 and 2010 is shown in Figure 4.10.2–1. The contribution attributable to motor vehicles is highlighted to show the dominance of this source category. Figure 4.10.2–2 provides a 7-year profile of the number of exceedances.

With the goal of expeditiously attaining conformance with NAAQS, the *California Clean Air Act* requires air districts to reduce emissions of nonattainment pollutants or precursors by 5 percent per year, and requirements are adopted within each air district's clean air plan. The stringency of requirements within each local clean air plan and subsequent implementing air regulations is based on the severity of the problem and projected timeframe when the area is expected to achieve attainment. As part of this process, both the BAAQMD and SJVUAPCD have adopted "no net increase" provisions within their clean air plans. The "no net increase" programs require that, as a precondition to the issuance of an air permit for a significant new or modified emission source, any increases in emissions of nonattainment pollutants or precursors be offset by mandatory reductions in emissions of other sources onsite or potentially at other facilities. In the BAAQMD, the offset requirement is triggered for mid-size facilities (emissions of 15 tons per year or more of nonattainment pollutants), and a greater burden is placed on large facilities (emissions of 50 tons per year or more). These large facilities must offset any proposed emission increases by a slightly greater decrease, at a ratio of 1.15 to 1.0. The added 15-percent in part satisfies the 5-percent annual emission reduction requirement of nonattainment areas (LLNL 2002e). The Livermore Site falls into the mid-size facility category and must abide by the requirements of the BAAQMD for emission offsets. Site 300, the majority of which lies within San Joaquin County, is under the jurisdiction of the SJVUAPCD.[1] In SJVUAPCD, offset requirements are triggered at 10 tons per year. Although this level is much lower than that established by the BAAQMD, emissions at Site 300 are substantially less than the offset trigger level (LLNL 2002e). Additional information on emission levels and the offset management program are provided in Section 4.10.4.

4.10.2.2 *Toxic Air Pollutant Programs*

Programs regulating toxic air contaminants differ from those regulating criteria air pollutants. Rather than establishing standards, regulating air toxics is based on managing risk. Risk can be thought of as a probability of harm. That probability can be determined for any air toxicant based on its toxicity, airborne concentration, and exposure rate. The California Office of Environmental Health Hazard Assessment classifies and determines compound toxicity. Air toxics are generally classified as carcinogenic (based on evaluations related to the substance's expected potency as a cancer-causing agent) or noncarcinogenic.

Noncarcinogenic health impacts may involve either transient or long-term impacts to either one or a number of individual organs (e.g., skin or eye irritations, kidney damage, etc.) or systems (respiratory, nervous, cardiovascular, reproductive, etc.). Noncarcinogens are further classified as acute or chronic, based on the ability to cause harm due to either short-term exposures to high levels or long-term, repeated exposure to lower levels. Many substances are classified as both acutely and chronically toxic and also have been categorized as carcinogens. Impacts of toxic air contaminants are typically evaluated cumulatively (i.e., as the sum of the impact of each air toxicant with similar effects). For example, the impact to the respiratory system is calculated as the sum of the impacts of each air toxicant identified as a respiratory irritant.

The California Office of Environmental Health Hazard Assessment has also developed standardized methods used to evaluate human health risk. The methods are designed to be conservative so as to not underestimate the risk. For carcinogens, the risk is expressed as either

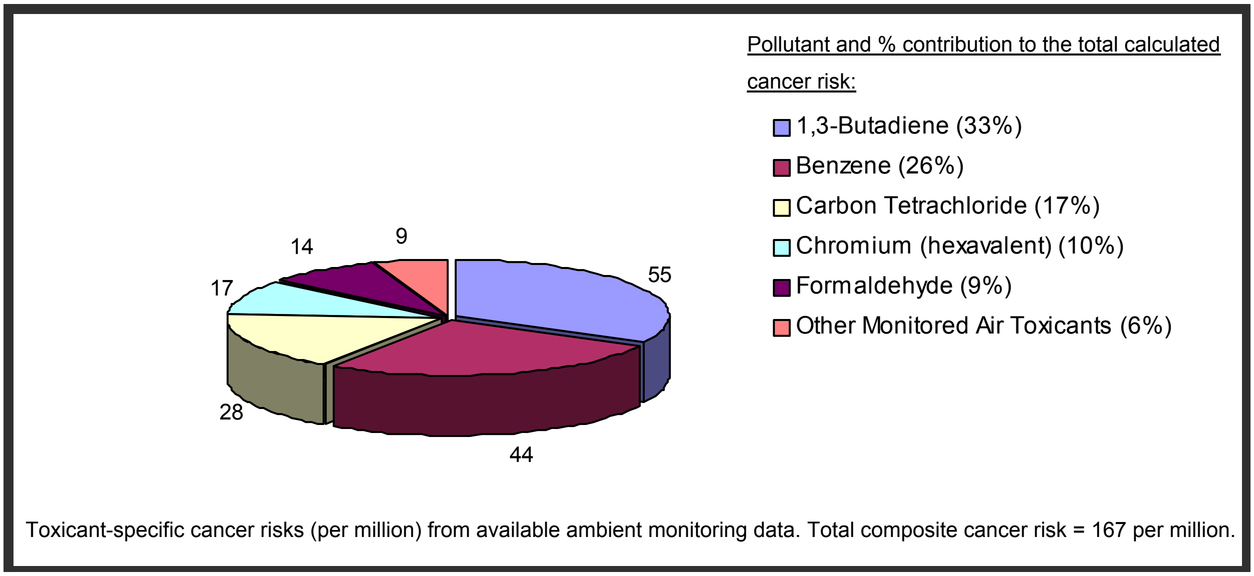
[1] As stated in Section 4.10.1, a small portion of Site 300 falls within Alameda County, which is under the jurisdiction of the BAAQMD.

an individual excess lifetime cancer risk or a population risk. Excess is used here to refer to a risk above background (generally assumed to be 1 in 3). Cancer risk is typically calculated assuming a full-time (70-year) exposure period. In many cases, the risk is stated as a risk per million.

A cancer risk of one in one million (1×10^{-6}) is generally considered negligible. For non-cancer, the risk is presented as a health hazard index (HHI). It is simply the ratio, summed over all contaminants, of the amount of contaminant to the level of that contaminant below which health impacts are not expected to occur. An HHI less than 1 is generally acceptable; no impact is expected. The air districts, together with guidance from state agencies and considering all public input, determine generally acceptable risk levels.

Air districts monitor toxic air contaminant levels and use the data to estimate background risk. The BAAQMD monitors a number of air contaminants throughout the Bay Area and has compiled a composite cancer risk for exposure to air toxics. Figure 4.10.2–3 shows the individual excess cancer risk calculated from average measured ambient concentrations of air toxics in the Bay Area. Of the pollutants for which monitoring data[2] are available, 1,3-butadiene and benzene (which are emitted primarily from motor vehicles) account for over one-half of the average calculated cancer risk. The BAAQMD reports that ambient benzene levels declined dramatically in 1996 with the advent of reformulated gasoline, with significant reductions in ambient 1,3-butadiene levels also occurring. Due largely to these observed reductions in ambient benzene and 1,3-butadiene levels, the calculated average cancer risk has been significantly reduced in recent years. Based on 2000 ambient monitoring data, the calculated cancer risk is 167 in one million, which is about 45 percent less than that observed 5 years earlier (BAAQMD 2001). The calculated risk in and around the city of Livermore is likely to be similar, or slightly less than this composite value (on the basis of ambient levels of gaseous carcinogens monitored in Livermore in 2000, and default Bay Area composite values for substances not monitored locally). Although data are not available for Site 300 environs or the city of Tracy, ambient levels of gaseous carcinogens are likely to be lower in these less densely populated areas.

[2] Ambient monitoring data are available for a limited number of toxic air contaminants. Diesel particulate matter, recently listed by the State of California as carcinogenic, is not included in the referenced evaluation.



Source: BAAQMD 2001.

FIGURE 4.10.2–3.—*Cancer Risk Due to Average Ambient Concentrations of Toxic Air Contaminants Measured in the Bay Area in 2000*

In addition to monitoring ambient levels, air districts develop air toxic emissions inventories. The inventory is part of California's comprehensive Air Toxics "Hot Spots" program, whereby industrial facilities and air districts are required to inventory emissions of some 300 toxic air contaminants and evaluate potential risks posed by their emissions. Where the risk is considered significant, the air districts must notify the exposed public and expeditiously reduce the risk. Facilities must report all emission information for each air contaminant for which emission rates exceed a reporting threshold. Each pollutant-specific reporting threshold reflects the emission level that is estimated to result in a *de minimis* (negligible) level of health risk based on a series of conservative risk assessment assumptions (e.g., lifetime exposure and close proximity to the emission source). For carcinogens, the threshold reporting levels have been set at the emission level that corresponds to a cancer risk of one in one million (1×10^{-6}). Noncarcinogen reporting levels represent the amount estimated to result in an HHI of 1. Using this information, air districts throughout the state are required to prioritize facilities for additional review. High-priority facilities are required to submit detailed health risk assessments. Both the Livermore Site and Site 300 are ranked by the air districts as low-risk facilities (LLNL 2003l).

4.10.2.3 *National Emission Standards for Hazardous Air Pollutants*

The Federal EPA has also established programs to reduce emissions of approximately 200 hazardous air pollutants (HAPs). The National Emission Standards for Hazardous Air Pollutants (NESHAP) include requirements categorized by pollutant type, emissions level, and/or industrial category. For the most part, these standards apply to major sources of HAPs, emitting 10 tons per year or more of any single HAP, or 25 tons per year or more in the aggregate.[3] In addition to the state air toxic program, local air districts administer many of the federally mandated programs,

[3] Radiological NESHAP are detailed in Section 4.10.5.

although in most cases the local or state program has been deemed equivalent or more restrictive, and therefore supercedes Federal requirements.

4.10.3 Source Evaluation and Control

In addition to air program development and assessment, local air districts must

- Evaluate air emission sources.
- Issue air permits with operating terms and conditions.
- Inspect sources routinely to determine compliance.
- Take necessary enforcement actions.

This section summarizes some of the more specific aspects of the programs. Emphasis is placed on elements pertinent to LLNL activities.

4.10.3.1 *Permit Program and New Source Review*

All activities with the potential to emit and/or control air pollutants must operate under the requirements of the air permit, unless the activity has been specifically determined to be exempt. In fact, for most operations, a preconstruction review and permit to construct must first be issued.[4] In order to receive a permit to operate, a facility must submit all pertinent data to the air district to demonstrate equipment will be operated, or the facility will be managed, in a manner that complies with all air pollutant control regulations (local, state, and Federal). The air district must evaluate the source and make a determination that reinforces compliance, and the district will specify equipment standards and/or operating conditions within the permit. Major aspects of the review include the following:

Evaluation of Best Available Control Technology (BACT) and No-Net-Increase Program for Nonattainment Pollutants

Many sources are required to incorporate a very stringent level of control. This requirement stems, in part, from the no-net-increase program for nonattainment pollutants. In addition, sources may be required to offset new emissions by incorporating reductions in other sources. The analysis will also evaluate a facility's status with respect to threshold levels that may trigger additional requirements, such as requirements to provide a higher level of offsets. Additional air protection program requirements are triggered for larger emitting facilities. These programs include the Federal Title V Operating Permit Program and major source requirements under NESHAP.

Assessment of Potential Health Impacts of Toxic Air Contaminants and Adherence to District Risk Management Criteria

Many sources are required to incorporate a very stringent level of control on air toxic sources, commonly referred to as Toxic Best Available Control Technology (TBACT).

[4] The air districts have evaluated certain types of activities and have determined that either due to the scale of the operation (many activities have threshold levels for raw material throughput or equipment rating [horsepower or British thermal units]) or to the nature of the activity (e.g., some research activities are exempt), these activities are exempt. Exempt sources are listed in air district rules, but in some cases, in particular for unique operations, a facility may ask the district to review a source and make a case-by-case determination.

Conformity

Proposed activities that may generate an increase in air pollutants are reviewed for consistency with local, state and Federal air regulations. The local air district will issue operating permits for equipment only after demonstration that the equipment complies with all applicable district regulations, and the owner or operator provides assurance that the equipment will be operated in compliance with imposed conditions.

In addition to their authority for stationary source emission control programs, local regulatory agencies are afforded an additional level of control over Federal projects through the requirements for conformity as codified under the Federal *Clean Air Act.* The conformity evaluation considers project emissions as a whole, including motor vehicle emissions. The underlying basis for the conformity demonstration is to preclude actions that would generate growth in air pollutants to a degree that is inconsistent with the local clean air plan, and thereby frustrate regional efforts to attain and maintain the NAAQS. Within the Bay Area, projects that generate emissions of precursor organic compounds, oxides of nitrogen, or carbon monoxide in excess of 100 tons per year are required to fully offset or mitigate the emissions caused by the action. This includes both direct emissions and indirect emissions over which the Federal Agency has some control (BAAQMD 1999).

4.10.3.2 *Continuing Source Assessment and Compliance*

Air districts use various measures to monitor facility compliance with district rules and operating requirements. The emissions inventory is a key component. Facilities are required to submit emissions information to the air districts on a routine basis; typically this is done annually as part of the permit renewal application. The district evaluates this information and makes a determination prior to permit renewal. The district also routinely inspects air emission sources, and if applicable, reviews operating logs and conducts emissions tests. If a source is operating out of compliance, applicable enforcement actions, which may include fines, imposition of additional oversight, revocation of a source's operating permit, and other measures will be imposed.

4.10.4 Lawrence Livermore National Laboratory Air Protection Program

4.10.4.1 *Source Evaluation and Regulatory Assessment*

All LLNL activities with the potential to produce air pollutant emissions are evaluated to determine the need for air permits and assessed for continued compliance. LLNL also monitors existing and pending environmental legislation to assess potential impacts to ongoing and proposed operations. LLNL staff also work with air district representatives to evaluate and understand LLNL emission sources (e.g., LLNL Environmental Protection Department [EPD] staff worked with the SJVUAPCD to develop criteria for an explosives testing exemption rule). Sources that have been determined to be exempt from permit requirements are monitored to substantiate that each source operates in agreement with exemption specifications (e.g., throughput remains within the limits of a specified exempt quantity).

4.10.4.2 *Permitted Equipment*

As stated, air permits are obtained from the BAAQMD for the Livermore Site and from the SJVUAPCD for Site 300. In 2002, the BAAQMD issued 199 permits for operation of various types of equipment at the Livermore Site, and SJVUAPCD issued air permits for 44 air emission sources for Site 300. A general listing of air permits is provided in Table 4.10.4.2–1.[5]

4.10.4.3 *Air Pollutant Emissions Inventory*

Criteria Air Pollutants

As part of the annual permit renewal process, facilities supply information to the district on material throughput and/or usage for permitted sources at their sites. This information is entered into the district's database where it is used to estimate air emissions. The emissions inventory serves as a means to determine facility category (small, medium, or large) and thereby dictate requirements, such as those under the no-net-increase programs. The inventory and LLNL's status with respect to facility categorization is of great importance. To encourage good air protection practices, the district allows mid-size facilities, which meet stringent control requirements, to borrow offset credits from the district bank. The Livermore Site meets the emission limits for a mid-size facility in terms of the BAAQMD's no net increase programs, and the district has determined that this facility has emission controls on its precursor organic compound and nitrogen oxide emission sources, which satisfy the stringent control eligibility requirement to receive credits from the district. The conditions associated with obtaining credits from the district include continued compliance with stringent control requirements, and maintaining emissions below the 50-tons-per-year threshold.[6] Requirements to maintain emission levels below applicable thresholds are also dictated within the Livermore Site Synthetic Minor Operating Permit which was finalized by the BAAQMD in November 2002 and forwarded to EPA for review. The Synthetic Minor Operating Permit includes requirements that limit nitrogen oxide emissions from combustion sources to less than 50 tons per year, and precursor organic compound emissions from solvent evaporating sources to less than 50 tons per year. The 50-ton-per-year emission limits within the Synthetic Minor Operating Permit establishes the Livermore Site as a minor source, which is not subject to the federally based Title V Operating Permit program. Permit conditions also require LLNL to prepare an annual emissions report for each year (LLNL 2003l).

---

[5] The number of permitted units may vary substantially from year to year. Changes in air district regulations, which categorize the types of equipment and activities that are exempt from the requirement to obtain an air district operating permit, may trigger the need to obtain permits for sources that were previously exempt. In other cases, improvements in technology or air district passage of a prohibitory rule may obviate the need for air permits for a particular source category.

[6] If emissions should rise above the 50-ton-per-year threshold, the facility must immediately repay all borrowed credits. Repayment of borrowed credits must be in the form of credits obtained from another facility; it cannot be in cash. Future market values of offset credits are unknown, but current values are on the order of $10,000 per ton per year.

TABLE 4.10.4.2–1.—*Summary of Lawrence Livermore National Laboratory Permits Active in 2002*

Category	Permitted Units: Livermore Site	Permitted Units: Site 300
Coating, printing, and adhesives	Paint spray booths Adhesives operations Optic coating operations Printing press operations Silk-screening operations Silk-screen washers	Paint spray booth
Combustion	Boilers Generators Diesel air-compressor engines	Boilers Generators
Explosives testing	Fire test cells and firing tanks	Contained Firing Facility
Gasoline dispensing	Gasoline dispensing operation	Gasoline dispensing operation
Machining	Metal machining and finishing operations	-
Ovens	Ovens	Drying ovens
Remediation and waste management	Groundwater air strippers/dryers Oil and water separator Sewer diversion system Drum crusher Paper-pulverizer system	Groundwater air strippers Soil vapor extraction units Explosive waste treatment units Woodworking cyclone (exhaust system control device)
Solvent cleaning	Cold cleaners Ultrasonic cleaners Degreasers Manual wipe-cleaning operations	-
Miscellaneous	Storage tanks with volatile organic compound content in excess of 1% Plating tanks Semiconductor operations Image tube fabrication Material-handling equipment	Fire hazard management prescribed burning permit (see Section 4.10.4.7)
Total Permitted Units	**199**	**44**

Source: LLNL 2003l.

Site-wide criteria pollutant emission rates for LLNL are provided in Table 4.10.4.3–1. The Livermore Site currently emits approximately 109 kilograms per day of criteria air pollutants from both permitted and exempt sources. The largest sources of criteria pollutants from the Livermore Site are surface coating operations, internal combustion engines, solvent operations, and natural gas-fired boilers. The largest sources at Site 300 are internal combustion engines, boilers, a gasoline-dispensing operation, open burning of brush for fire hazard management, paint spray booths, drying ovens, and soil vapor extraction operations (LLNL 2003l). Even though the SJVUAPCD no-net-increase threshold is much lower than the BAAQMD threshold, Site 300 is currently well below both the precursor organic compound and nitrogen oxide emission thresholds that trigger requirements for no net increase and should remain so in the foreseeable future (LLNL 2002e).

TABLE 4.10.4.3–1.—*Emission Rates for Criteria Air Pollutants and Precursors*

Pollutant [b]	Estimated releases (kilograms per day) [a]									
	Livermore Site					Site 300				
	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002
Precursor organic compounds	25	24	20	19	16	0.90	1.2	0.4	0.1	0.23
Nitrogen oxides	56	81	54	52	67	2.1	3.2	2.3	0.9	1.1
Carbon monoxide [c]	11	24	14	14	17	0.48	0.71	0.5	1.1	1.0
Particulates (PM_{10})	5.7	8.6	5.5	5.5	6.1	0.53	0.33	0.2	0.3	0.09
Oxides of sulfur	0.72	0.98	0.6	0.6	2.8	0.15	0.28	0.2	0.1	0.07

Source: LLNL 2003l, LLNL 2002cc, LLNL 2001v, LLNL 2000g, LLNL 1999c.

[a] One kilogram equals 2.2 pounds.

[b] Individual air pollutants, or pollutant categories listed above, are those which are most widely regulated in air protection programs aimed at controlling sources and ambient levels of criteria air pollutants, both Federal and State of California. Organic compounds are regulated (and listed above) as precursors to the formation of the criteria air pollutant ozone. Other criteria air pollutants (state and Federal) are listed in Table 4.10.1-1.

[c] In 1999, the emission factor used to calculate carbon monoxide was 0.035 pound per 1,000 cubic feet for large boilers and 0.021 pound per cubic foot for small boilers. In previous years, the emission factor used was 0.017 pound per cubic foot for both large and small boilers. This resulted in a significant change in carbon monoxide emissions reported for 1999.

Toxic Air Contaminants

LLNL also compiles an inventory of toxic air contaminants under the California Air Toxics "Hot Spots" program (see Section 4.10.2.2). Of the more than 300 hot spot chemicals, only a few are emitted from LLNL processes at levels that exceed the *de minimis* reporting threshold. On the basis of the air toxics inventories, BAAQMD and SJVUAPCD have ranked LLNL as a low-risk facility for nonradiological air emissions (LLNL 2003l).

Hazardous Air Pollutants

A separate Federal listing of approximately 200 compounds is evaluated to confirm applicability under NESHAP. Thresholds defining a major source under NESHAP are 10 tons per year for a single hazardous air pollutant or 25 tons per year for a combination of hazardous air pollutants. Emission rates at both LLNL sites are less than one-half of these thresholds (LLNL 2002e). The Livermore Site Synthetic Minor Operating Permit (discussed above) includes a limitation on total HAP emissions (less than 23 tons per year) and annual reporting requirements, which establishes LLNL's minor source status. Although, LLNL is not a major facility in terms of HAP emission rates, specific NESHAP programs apply for beryllium (discussed in Section 4.10.4.8) and radionuclides (Section 4.10.5).

4.10.4.4 *Annual Compliance Inspections and Enforcement Actions*

Each year, BAAQMD and SJVUAPCD officials inspect operations at the Livermore Site and Site 300, respectively. Annual compliance inspections entail a review of permitted and exempt equipment, including documentation to demonstrate adherence to prohibitions; operating, record keeping, and notifications requirements; and emissions limitations. New equipment is also inspected prior to issuance of a new permit to operate, to ensure that equipment specifications comply with conditions specified in the authority to construct permit. In the last several years, there have been no enforcement actions or deficiencies noted; however, LLNL received a Notice of Violation from the BAAQMD on April 9, 2003, for an alleged record keeping violation during the period September 2002 through February 2003. The Notice of Violation was resolved by LLNL's payment of a monetary penalty to BAAQMD (LLNL 2003l, LLNL 2002cc, LLNL 2001v, LLNL 2000g, and LLNL 1999c).

4.10.4.5 *Lawrence Livermore National Laboratory Air Emissions Offsets Management Plan*

The LLNL Air Emissions Offsets Management Plan establishes responsibilities for LLNL's management of air emissions and emission credits necessary to meet offset requirements of the regional air districts (LLNL 2002e). The plan specifically states that:

> BAAQMD emissions will be maintained below the 50 tons per year pollutant-specific threshold, and SJVUAPCD emissions will be maintained below the 10 tons per year pollutant-specific threshold. Emission sources may be prioritized in the future, so that some emission sources are curtailed to allow replacement by new sources in order to maintain overall emissions below the thresholds.

The system is guided by the principal of maintaining emissions as low as reasonably achievable (ALARA) and managing emissions on the basis of cost effectiveness to obtain maximum benefit to LLNL, meet or exceed the intent of the *California Clean Air Act*, provide for timely permitting of new projects, and avoid the necessity for additional permitting associated with major source programs.

4.10.4.6 *Integrated Air Pollution Prevention Programs*

Pollution prevention is a cross-disciplinary program implemented at LLNL. Examples of LLNL pollution prevention and waste minimization activities with resultant benefit to the air resources include transportation demand management, reduced precursor organic solvent use and recycling programs, programs to substitute steel weight (rather than lead weight) at the Site 300 firing table, energy conservation, and programs to reduce the use of stratospheric ozone-depleting substances sitewide (LLNL 1997a). These are part of the Environmental Management System (EMS) and Integrated Safety Management System (ISMS) programs at LLNL, which are discussed in detail in Appendix O.

4.10.4.7 *Controlled Burning Operations at Site 300*

Site 300 has conducted controlled burns (i.e., prescribed burns) throughout its 40+ year history for wildfire control. The annual prescribed burn can cover up to 2,100 acres, which is divided into control plots ranging from less than 1 acre to 600 acres. Daily prescribed burn acreage can range between approximately 10 acres to 1,200 acres. Annual prescribed burning typically takes place from mid-May through July when the grass (i.e., fuel) is dry enough to sustain a burn and not too dry to present uncontrollable fire risk. Prior to the prescribed burn each year, LLNL submits a prescribed burn/smoke management plan to both the SJVUAPCD and BAAQMD and meets each air district's planning and reporting requirements.

Planning and coordination with both air districts is critical. Each district imposes stringent review and approval requirements before allowing prescribed burn activities to take place to meet their smoke management objectives. In addition, each air district prioritizes burn activities requested within their air basin and provides daily burn allocations to the requesting facility based on air quality, weather conditions, declared burn days, and other scheduled burn activities. In addition to meeting air district requirements, LLNL conducts prescribed burns to meet DOE wild land management requirements and follows best management practices to minimize the creation of smoke and ensure safe burn conditions.

Annual prescribed burn areas are shown in Figure 4.10.4.7–1. Prescribed burning conducted at Site 300 is considered a long-term asset to air quality as it reduces the potential for destructive wildfires. In addition, fires remove potential airborne residues that accumulate, such as pollen and other respirable matter. The principal objectives of the LLNL Site 300 Explosive Test Facility Prescribed Burn/Smoke Management Plan (LLNL 2003q) are to:

- Minimize the occurrence of unnaturally intense fires by reducing the amount of vegetation that can fuel larger, more catastrophic fires.
- Preserve the capability to safely test explosives while protecting the environment.
- Minimize the occurrences of fires that could leave the Site 300 boundaries and impact neighbors and limit the extent of prescribed fires, which could reduce the air quality for neighbors.
- Use minimum impact prescribed burns and fire suppression techniques, and rehabilitate areas to protect natural and cultural resources from adverse impacts attributable to wildfire suppression activities.

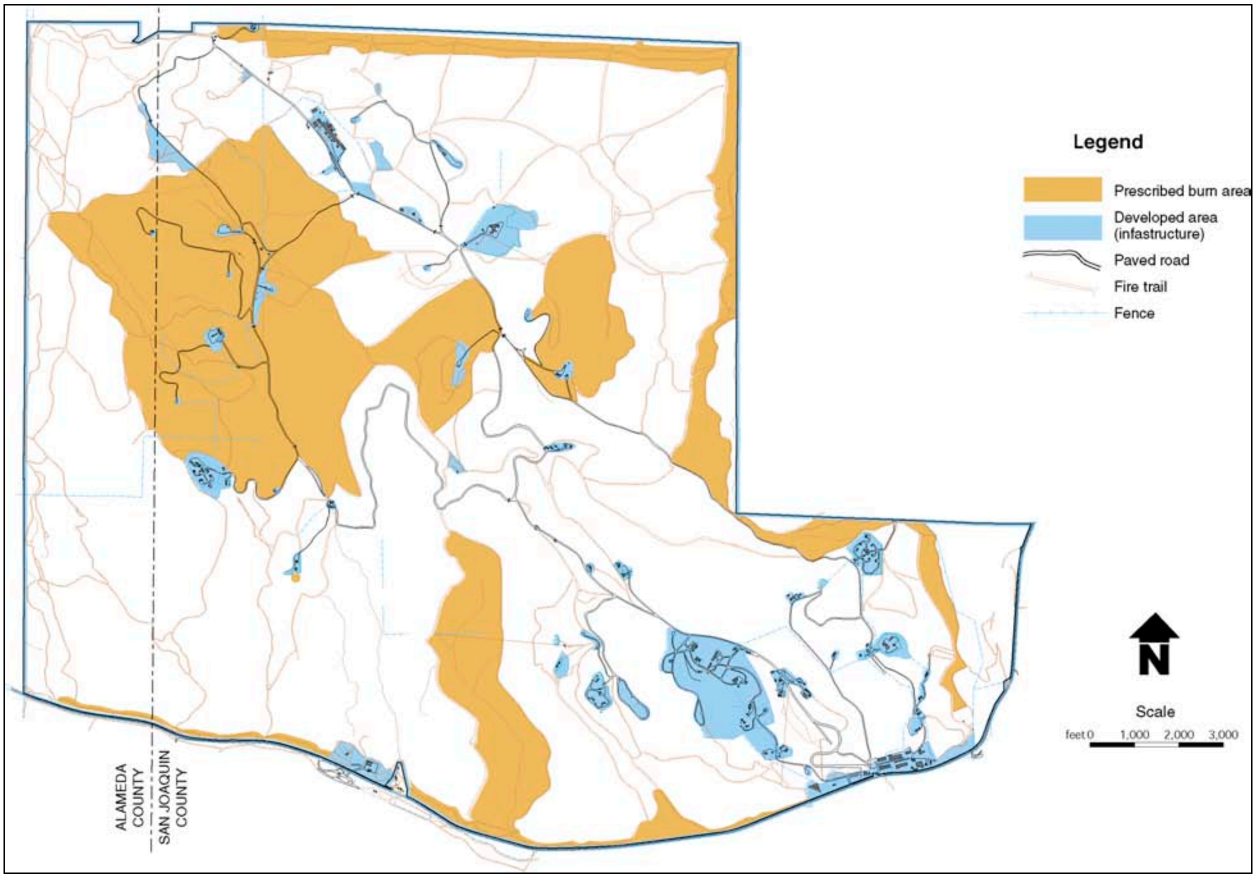
Fire has been one of the primary forces that created and maintains the biodiversity and specialized wildlife habitats throughout Central California. Alternatives to prescribed burning have been researched. Livestock grazing was found to be nonbeneficial due to its threat to native grasses, wetlands, and endangered species and is also limited in value due to the restriction of areas available for grazing. Disking was found to have limited benefit but has been used on an infrequent basis on a small portion of the site perimeter in lieu of controlled burning to avoid the spread of fire to adjacent private lands. Mowing is not suited for most areas because of the terrain. Herbicides are used around facilities where controlled burning could pose a threat to the facility, but herbicides are not used in the large tracts of land where controlled burning is employed because they limit plant ecosystem diversity, unlike controlled burning which fosters the growth of native plants. The planting of fire-resistant, nonnative species would pose a further threat to native grasses, which prove a more favorable habitat for other native flora and fauna (LLNL 2001c).

4.10.4.8 *Beryllium Monitoring and Exposure Evaluation*

Beryllium metal, alloys, and compounds are used at LLNL. Although LLNL is not a major facility in terms of HAP emission rates, specific NESHAP requirements (40 CFR Part 61, Subpart C) apply for beryllium. Beryllium is identified with respiratory and immune system toxicity, and is regulated under both state and Federal programs. The State of California has identified a reference exposure level (air concentration) associated with long-term (chronic) exposures to the public. Chronic exposure to concentrations in excess of this level (0.007 micrograms per cubic meter)[7] require the implementation of air toxic risk reduction measures.

---

[7] The chronic reference exposure level for beryllium (previously 0.01 $\mu g/m^3$) was reevaluated and revised by the State of California Office of Environmental Health Hazard Assessment, December 2001(OEHHA 2003).



Source: LLNL 2001c.

FIGURE 4.10.4.7–1.—*Site 300 Annual Prescribed Burn Areas*

LLNL measures beryllium at fenceline locations, both at the Livermore Site and Site 300, and within the city of Tracy.[8] All air samplers are positioned to provide reasonable probability that any significant concentration of beryllium effluents from LLNL operations will be detected. The median beryllium concentration for Livermore Site perimeter locations for 2002 was 1.4×10^{-5} micrograms per cubic meter, and the highest value was 2.8×10^{-5} micrograms per cubic meter. At Site 300, the median was 6.8×10^{-6} micrograms per cubic meter, and the maximum was 2.0×10^{-5} micrograms per cubic meter. The median concentration in Tracy over the same period was about 30 percent higher than that at Site 300, and the maximum value was almost 60 percent higher than the level recorded at Site 300. This is believed to be the result of the location of the sampler which is situated in a congested part of town, and therefore accumulates more industrial particulate pollutants. When compared to the reference concentration level, all values are less than one-half of one percent of this standard, and do not indicate the presence of a threat to the environment or public health. The concentrations of beryllium at both sites can be attributed

[8] To satisfy beryllium reporting requirements and determine the effects of the Laboratory's beryllium operations, LLNL conducted a technical assessment of the beryllium monitoring locations at Site 300 in 1997. Although there is no requirement to sample for beryllium at Site 300, LLNL has decided, as a best management practice, to continue beryllium monitoring at three locations onsite and at one location in the city of Tracy.

primarily to resuspension of surface soil containing naturally occurring beryllium. Local soils contain approximately 1 parts per million of beryllium (LLNL 2003l, LLNL 2003cb).

4.10.5 Radiological Air Quality

Some LLNL facilities discharge low quantities of radionuclides to the air. These releases can be evaluated according to the individual and population dose they create. The degree of hazard to the public is directly related to the type and quantity of the radioactive materials released. Dose estimates are modeled from emissions determined at each facility or, in the case of diffuse sources such as soil resuspension, from air sample measurements. Separate doses are calculated for the Livermore Site and Site 300 because of their spatial separation and are compared to regulatory dose limits for the protection of public health. Historically, doses have never exceeded regulatory limits. Recent annual doses to the hypothetical site-wide maximally exposed individual (see Table 4.10.5–2) have been less than 2 percent of a chest x-ray (West and Coronado 2003).

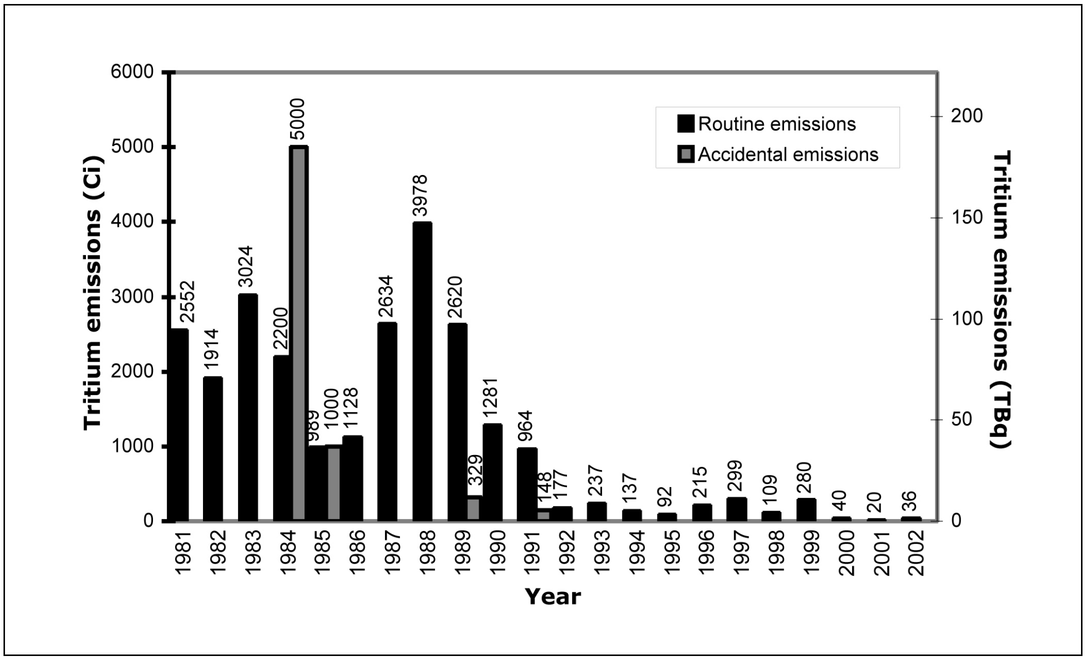
New, modified, and ongoing LLNL projects having potential radiological impact on the public and the environment are identified and assessed in NEPA reviews and Integration Work Sheets (IWSs). Such projects are documented each year in LLNL's NESHAP Annual Report and SAER. Facilities with designated Radioactive Materials Management Areas (RMMAs) report usage of radioactive materials that have potential for emission to air. Facility documents such as Safety Analysis Reports (SARs), Facility Safety Plans (FSPs), and Operational Safety Plans (OSPs) describe administrative controls designed to keep radiation exposures to workers, the public, and the environment as low as reasonably achievable.

4.10.5.1 *Radioactive Airborne Emissions*

LLNL monitors the stack effluent from its principal facilities and measures concentrations of radionuclides in ambient air both on and offsite, to determine if radionuclides are being released and in what concentrations. LLNL performs research using a variety of radioactive materials, including tritium, uranium, plutonium and other transuranic radionuclides, biomedical tracers, and mixed fission products. The contribution to the offsite dose is predominated by tritium from the Livermore Site and depleted uranium from Site 300 (see Section 4.10.5.2). Although even less important than these, other radionuclides such as carbon-14, strontium-90 and other beta emitters, and transuranics such as plutonium-239, americium-241 and other alpha emitters can also be released. A complete list of radionuclides which can potentially be emitted can be found in the NESHAP Annual Report (LLNL 2002bb).

In 2002, 74 systems sampled radioactivity from air exhausts at 7 Livermore Site facilities (MARS, Extractor Test Facility, Chemistry and Materials Science, Heavy Elements, Tritium, Plutonium, and Laser Isotope Separation) (LLNL 2003l). The only Site 300 effluent sampling, at Building 801, was installed in 2002 to measure releases from the Contained Firing Facility (LLNL 2003l).

In 2002, 36 curies of tritium were released, 90 percent of it as tritiated water, from the Tritium Facility. Emissions from this facility continued to remain considerably lower than those during the 1980s due to a reduction in programmatic work. Figure 4.10.5–1 illustrates these historical releases. None of the facilities monitored for gross alpha and beta had emissions in 2002 (LLNL 2003l).



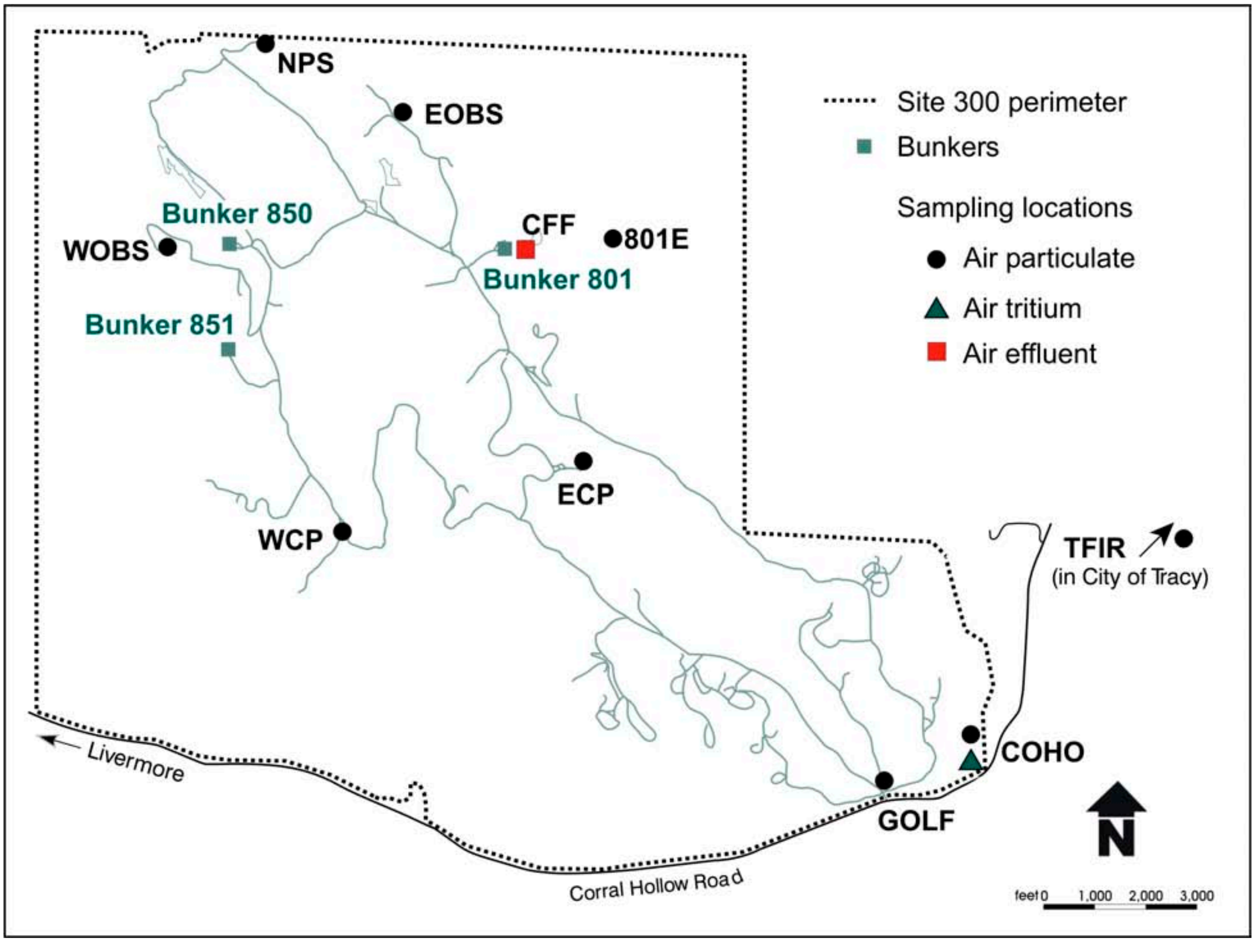
Source: LLNL 2003z.
Ci = curies; TBq = terabecquerel.

FIGURE 4.10.5–1.—*Tritium Emissions From the Tritium Facility, 1981-2002*

Ambient air is monitored by a network of air particulate and tritium samplers located on the Livermore Site (7 particulate samplers and 12 tritiated water vapor samplers), in the Livermore Valley (9 and 6, respectively), at Site 300 (8 and 1, respectively), and in Tracy (1 particulate sampler) (LLNL 2002cc). The samplers are positioned so that there is a reasonable probability that any potential release from LLNL operations would be detected (LLNL 2002bb). Figures 4.10.5–2 and 4.10.5–3 (LLNL 2001v) illustrates the effluent and ambient air sampling locations for the Livermore Site and Site 300, respectively.

Annual median concentrations of tritium (as tritiated water), plutonium-239 and 240, and uranium-238 reported at any Livermore Site location for the 5-year period beginning in 1998 range up to 4.5×10^{-10}, 1.1×10^{-18}, and 2.4×10^{-17} curies/cubic meter. Site 300 locations show even lesser concentrations of tritium and plutonium (LLNL 1999c, LLNL 2000g, LLNL 2001v, LLNL 2002cc, LLNL 2003l). The annual median concentration of uranium-238 reported at any Site 300 location for the same period is 3.0×10^{-17} curies/cubic meter.

Due to a recent refinement in the methodology to quantify tritium air samples (LLNL 2002bb), it is likely that tritium measurements made by site boundary and offsite tritium samplers prior to 2001 were a factor of up to 2 too low. This methodology change does not apply to effluent measurements, such as shown in Figure 4.10.5–1. Since calculations of dose to individuals and the public prior to 2001 are most significantly based on effluent releases (only the component of dose due to diffuse releases would be impacted by this concentration correction), conclusions based on the doses reported for years prior to 2001 are still valid.



Source: LLNL 2001v.

FIGURE 4.10.5–3.—*Site 300 Radiation Effluent and Air Sampling Locations*

4.10.5.2 *Radiation Dose to Members of the Public*

The maximally exposed individual (MEI) is a hypothetical member of the public at a fixed location who, over an entire year, receives the maximum effective dose equivalent (summed over all pathways) from a given source of radionuclide releases to air. The site-wide MEI is located where the composite dose from all site sources is greatest.

Dose is a measure of the quantity of radiation absorbed. Health effects from exposure to radiation can be estimated from this quantity (see Section 4.16.2). The radiation doses received by individual members of the public are bounded by the Livermore and Site 300 site-wide MEI. The LLNL sites, Livermore and Site 300, are far enough apart that the site-wide MEI from each site does not affect the other. Hence, a separate site-wide MEI is defined for each of the two LLNL sites.

The site-wide MEI dose is obtained by using the information gathered from effluent monitoring of point sources, knowledge of facility inventories for non-monitored locations, and ambient monitoring of diffuse sources, and then using this information in computer codes that model atmospheric dispersion, environmental transport, and human exposure. The site-wide MEI dose is also used to demonstrate compliance with 40 CFR Part 61, Subpart H (40 CFR Part 61).

The population dose to a distance of 50 miles from each site, characterizes the total dose received by the surrounding resident population. A population dose is presented for each site. In addition, a total population dose from all LLNL operations is presented as the sum of the two individual site collective doses.

The site-wide MEI can change from one year to the next, chiefly as a result of varying quantities and locations of releases. The Livermore Site site-wide MEI has been located at the UNCLE Credit Union, about 10 meters outside the controlled eastern perimeter of the site, for the past dozen years or more (LLNL 2002bb).

The Site 300 site-wide MEI has been located on the south-central boundary of the site bordering the Carnegie State Vehicular Recreation Area, approximately 3.2 kilometers south-southeast of the firing table at Building 851 (LLNL 2002bb), since the year 2000. Prior to 2000, the Site 300 site-wide MEI was located in an area operated by Primex Physics International (presently by Fireworks America), 300 meters outside the east-central boundary of Site 300 (2.4 kilometers east-southeast of the present Building 801 Contained Firing Facility) (LLNL 2000h).

Table 4.10.5–1 gives annual radiological releases over the most recent 5-year period from the important dose (site-wide MEI) contributing site locations. It is generally found that a few sources (less than a dozen out of nearly 200 emissions sources at the Livermore Site) contribute over 90 percent of the individual and collective doses.

The contribution of tritium releases from Building 331 to the Livermore site-wide MEI dose is evident from Table 4.10.5–1. In 2000, 2001, and 2002 the releases from this building were markedly decreased from prior years. This decrease resulted in the Building 612 storage yard release becoming a relatively greater contributor (in terms of percent of total) to the site-wide MEI dose because of its ground-level release (as opposed to the elevated stack release from Building 331) and its proximity to the site boundary.

Doses are calculated from the releases using the CAP88-PC computer code. The code's database includes dosimetric and health affects data. It also accommodates site-specific input data characterizing meteorological conditions and population distributions for both individual and collective (population) doses (CAP88-PC 2000). Table 4.10.5–2 shows the individual (site-wide MEI) and collective doses for the recent 5-year period. The total population dose from all LLNL operations is the sum of the two site population doses shown in the table. The total population dose over the 5 years has ranged from 3.0 to 12.7 person-rem.

The EPA's radiation dose standard that applies to air emissions limits the dose (effective dose equivalent) to members of the public caused by operations to 10 mrem/yr (40 CFR 61). The individual doses from LLNL are two to three orders of magnitude below this standard. The latter is verified by site ambient air measurements. An individual breathing air for 24 hours a day, 365 days per year containing the annual Livermore Site median concentrations of tritium, plutonium-239 and 240 and uranium-238 described in Section 4.10.5.1 would be exposed to a dose of 0.2, 0.001, and 0.06 mrem/yr, respectively. These values occur at different locations around the Livermore Site. Such doses are 2, 0.01, and 0.6 percent of the NESHAP limit. Site 300 doses from measured uranium concentrations would be even less. The corresponding Site 300 dose for uranium-238 would be 0.08 mrem/yr, 0.8 percent of the NESHAP limit. The population doses can be compared with background radiation doses; population doses due to LLNL releases are approximately 200,000 times less than that received by the population from background radiation. Section 4.16.2 (Human Health and Worker Safety – Radiological Effects) describes the health effects associated with these doses.

TABLE 4.10.5–2.—*Dose to the Site-Wide Maximally Exposed Individual (Site-Wide MEI) and to the Population from LLNL Releases, 1998-2002*

Year	Livermore Site		Site 300		Total Population Dose[a]
	Site-wide MEI Dose (mrem)	Population Dose (person-rem)	Site-wide MEI Dose (mrem)	Population Dose (person-rem)	
1998	0.055	0.68	0.024	11	11.68
1999	0.12	1.7	0.035	11	12.7
2000	0.038	0.47	0.019	2.5	2.97
2001	0.017	0.16	0.054	9.4	10.1
2002	0.023	0.50	0.021	2.5	3.0

Source: LLNL 1999a, LLNL 2000h, LLNL 2001n, LLNL 2002bb, LLNL 2003z.
[a] Total population dose includes Livermore Site and Site 300 population doses.