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Environmental Protection Department

Operations and Regulatory Affairs Division

LLNL NESHAPs 1996 Annual Report

Lawrence Livermore National Laboratory
University of California Livermore, California 94550

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This annual report is prepared pursuant to the National Emissions Standards for Hazardous Air Pollutants (NESHAPs) 40 CFR Part 61, Subpart H; Subpart H governs radionuclide emissions to air from Department of Energy (DOE) facilities.

SYNOPSIS

NESHAPs limits the emission of radionuclides to the ambient air from DOE facilities to levels resulting in an annual effective dose equivalent (EDE) of 10 mrem (100 μSv) to any member of the public. The EDEs for the Lawrence Livermore National Laboratory (LLNL) site-wide maximally exposed members of the public from 1996 operations were

- Livermore site: 0.093 mrem (0.93 μSv) (52% from point-source emissions, 48% from diffuse-source emissions);
- Site 300: 0.033 mrem (0.33 μSv) (99% from point-source, 1% from diffuse-source emissions).

The EDEs were generally calculated using the EPA-approved CAP88-PC air-dispersion/dose-assessment model. Site-specific meteorological data, stack flow data, and emissions estimates based on radionuclide inventory data or continuous-monitoring systems data were the specific input to CAP88-PC for each modeled source.

SECTION I. Facilities Information

Site Description

The University of California operates LLNL for DOE. LLNL was established in 1952 to conduct weapons research and development. LLNL's mission is to serve as a national resource in science and engineering, with a special responsibility for nuclear weapons. Laboratory activities focus on global security, energy, global ecology, biomedicine, economic competitiveness, and science and mathematics education. The Laboratory's mission is dynamic and has been broadened over the years to meet new national needs. LLNL consists of two sites—the main laboratory site located in Livermore, California (Livermore site), and the Experimental Test Facility (Site 300) located near Tracy, California. Figure 1 shows the locations of the sites.

Livermore site: LLNL's Livermore site occupies an area of 3.3 km^2 located about 60 km east of San Francisco, California, adjacent to the City of Livermore in the eastern part of Alameda County. More than 6 million people live within 80 km of LLNL; approximately 65,000 of them live in the City of Livermore.

The Livermore site is located in the southeastern portion of the Livermore Valley, a topographical and structural depression oriented east-west within the Diablo Range of the California Coast Range Province. The Livermore Valley forms an irregularly shaped lowland area approximately 26 km long and an average of 11 km wide. The floor of the valley slopes from an elevation of approximately 200 m at the eastern end to approximately 90 m at the southwest corner.

The climate of the Livermore Valley is characterized by mild, rainy winters and warm, dry summers. The mean annual temperature is about 15°C. Temperatures typically range from –5°C during some pre-dawn hours during the winter, to 40°C on a few summer afternoons. The 1996 annual wind data for the Livermore site are shown in Table 1 and displayed as a wind rose in Figure 2. Although winds are variable, the prevailing wind direction is from the southwest, especially during the summer. However, during the winter, the wind often blows from the northeast. Most precipitation occurs as rain between October and April with very little rainfall during the summer months. In 1996, the Livermore site received 527 mm of precipitation.

Site 300: Site 300, LLNL's Experimental Test Site, is located 24 km east of the Livermore site in the Altamont Hills of the Diablo Range and occupies an

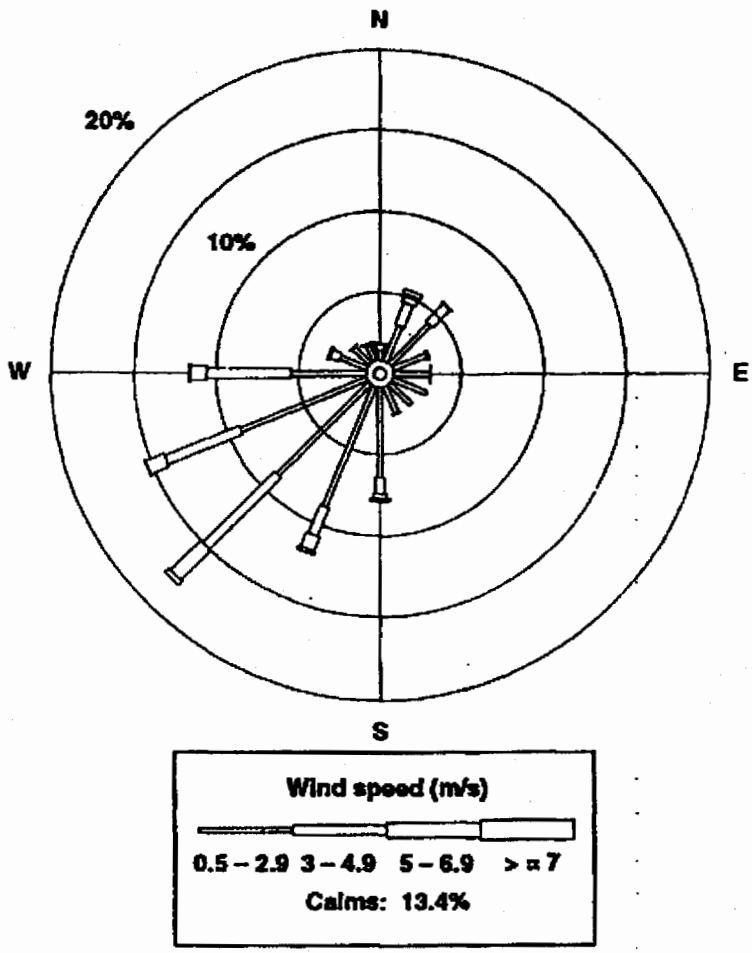

Figure 2. Wind rose showing the average annual wind speed, frequency of occurrence, and direction at the Livermore site, 1996.

surrounding area is in agricultural use, primarily pasture land for cattle and sheep. The nearest residential area is the City of Tracy (population approximately 45,000), located 10 km to the northeast.

The topography of Site 300 is much more irregular than that of the Livermore site; it consists of a series of steep hills and ridges, which are oriented along a generally northwest/southeast trend, separated by intervening ravines. The elevation ranges from approximately 540 m in the northwestern portion of the site to 150 m at the southeast corner. The climate at Site 300 is similar to that of the Livermore site, with mild winters and dry summers. The complex topography of the site significantly influences local wind and temperature patterns, making the temperature range somewhat more extreme than at the

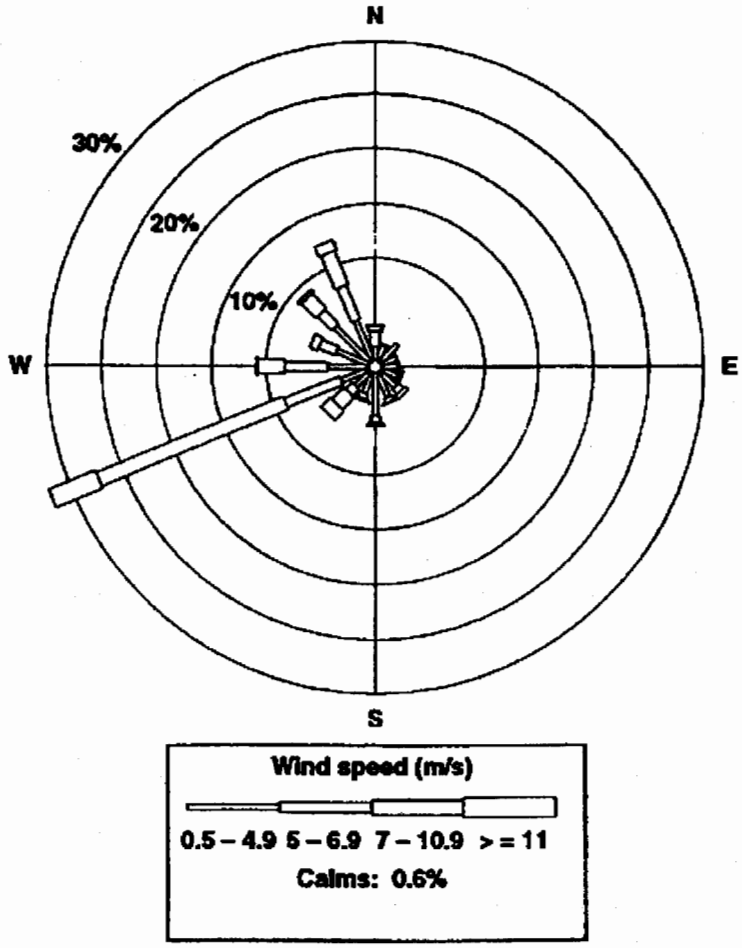

Figure 3. Wind rose showing the average annual wind speed, frequency of occurrence, and direction at Site 300, 1996.

Livermore site. The 1996 annual wind data for Site 300 are shown in Table 2 and displayed as a wind rose in Figure 3. Prevailing winds are from the west-southwest. As is the case at the Livermore site, precipitation is highly seasonal, with most precipitation occurring between October and April. The average annual rainfall over the past 20 years was 257 mm; Site 300 received 362 mm of precipitation during 1996.

Source Description

Many different radioisotopes are used at LLNL for research purposes, including transuranics, biomedical tracers, tritium, mixed fission products, and others (Table 3). Radioisotope-handling procedures and work enclosures

are determined for each project, depending on the isotopes, the quantities being used, and the types of operations being performed. Radioisotope handling and working environments include glove boxes, exhaust hoods, and laboratory bench tops. Exhaust paths to the atmosphere range from triple-HEPA (High-Efficiency-Particulate-Air)-filtered stacks, to roof vents and stacks lacking abatement devices, to direct dispersal of depleted uranium during explosives testing at Site 300, to a variety of diffuse-area sources.

Table 3. Radionuclides used at LLNL during 1996.

^{3}H	^{55}Fe	^{99}Tc	^{152}Eu	^{232}U	^{239}Pu
^{13}N	^{57}Co	^{106}Ru	^{154}Eu	^{233}U	^{240}Pu
^{14}C	^{59}Ni	^{124}Sb	^{155}Eu	^{234}U	^{241}Am
^{15}O	^{60}Co	^{125}I	^{214}Bi	^{235}U	^{242}Cm
^{22}Na	^{63}Ni	^{125}Sb	^{214}Pb	^{236}Pu	^{242}Pu
^{32}P	^{75}Se	^{129}I	^{218}Po	^{236}U	^{242}Am
^{33}P	^{88}Y	^{133}Ba	^{226}Ra	^{237}Np	^{243}Am
^{35}S	^{90}Sr	^{137}Cs	^{228}Th	^{238}Pu	^{244}Cm
^{40}K	^{90}Y	^{144}Ce	^{230}Th	^{238}U	^{252}Cf
^{54}Mn	^{95}Zr	^{147}Pm	^{232}Th	^{239}Np	

SECTION II. Air-Emission Data

Sources

At LLNL, areas where radioactive materials are used or stored, or where activation products occur, are called Radioactive Materials Management Areas (RMMAs). Detailed information is given in Attachment 1 for point-source emissions from the Livermore-site RMMAs in which radiological operations took place during 1996. Building 514 and five other Livermore-site sources external to buildings (including the RMMA at the Building 612 Hazardous Waste Management Yard) are treated as diffuse-area sources.

Similarly, detailed information is given in Attachment 1 for experiments at two Site 300 explosives-testing facilities (Buildings 801 and 851 and their associated firing tables). Six Site 300 sources, including the two firing tables where surface and subsurface contamination exists, are treated as diffuse-area sources.

1996 Inventory Update and Effective Dose Equivalent (EDE) Calculations

For this year's report, covering activities in 1996, we updated the radionuclide inventories in our key facilities, defined as those that accounted for 90% of the 1995 Livermore site radiological dose to members of the public. We also inventoried all RMMAs that began operations in 1996. Radionuclide inventory forms, with detailed guidance for completing them, were sent to the unmonitored facilities that contributed to 90% of the dose in 1995 and to new unmonitored facilities having the potential for radionuclide emissions to the air. The forms were completed by experimenters, and certified by facility managers. Radionuclide inventories for all Site 300 explosives experiments and assessments of source terms for known diffuse sources at both sites were also updated.

Dose-assessment modeling runs were conducted for all diffuse sources and for all point sources using actual radionuclide releases to air, or potential releases based on radionuclide inventory data. The model used was CAP88-PC (see Section III); we incorporated 1996 on-site meteorological data (wind, precipitation, and temperature) along with the 1996 radionuclide inventory or monitoring data. Annual dose is reported as whole-body EDE expressed in units of mrem (followed by μSv). When reasonable to do so, modeling runs were combined by building, rather than a separate model run for each stack

1.0×10^{-3} was used; and for solids, 1.0×10^{-6} was used. In addition, emission-control abatement factors (40 CFR 61, Appendix D), when applicable, were applied. Each HEPA filter stage was given a 0.01 factor, electrostatic precipitators, as well as venturi scrubbers, were each given a 0.05 factor, and each activated-charcoal filter was given a 0.1 factor. (However, abatement factors were not used to evaluate compliance with the 0.1 mrem standard that determines the need for continuous monitoring at a facility.) The use of actual monitoring data is much more direct, and presumably more accurate, than using assumptions based on inventory, release fractions, and emission-control factors.

Site-Wide Maximally Exposed Individual: For LLNL to comply with the NESHAPs regulations, the LLNL site-wide maximally exposed individual cannot receive an EDE greater than 10 mrem/y (100 μSv/y). The site-wide maximally exposed individual (SW-MEI) is defined as the *hypothetical* member of the public at a single residence, school, business, or office who receives the greatest LLNL-induced EDE from the combination of all radionuclide source emissions.

To determine the location of the 1996 SW-MEI, CAP88-PC results from multiple sources were combined. Sources were selected to include those expected to give significant contributions to the EDE. These included Building 331 point and area sources, Building 514 Tank Farm, and Building 612 area source. Because EDE results from CAP88-PC are relative to the location of the specified source, direct summing of results from multiple sources can only be accomplished using an interpolation method. To do this, the location of each selected source relative to a common location (the Livermore-site center) and a set of receptor locations (where the combined EDEs from the selected sources were to be evaluated), also relative to the site center, were specified in the modeling efforts that supported determination of the SW-MEI. The receptor locations included 48 equally spaced directions from the site center and 4 additional receptor locations along the eastern and southern Livermore-site boundaries. The interpolation method was used to calculate the EDEs for the desired set of receptor locations for each source. These resulting interpolated EDEs for each source, now for the same set of locations, were then summed, and the SW-MEI determined.

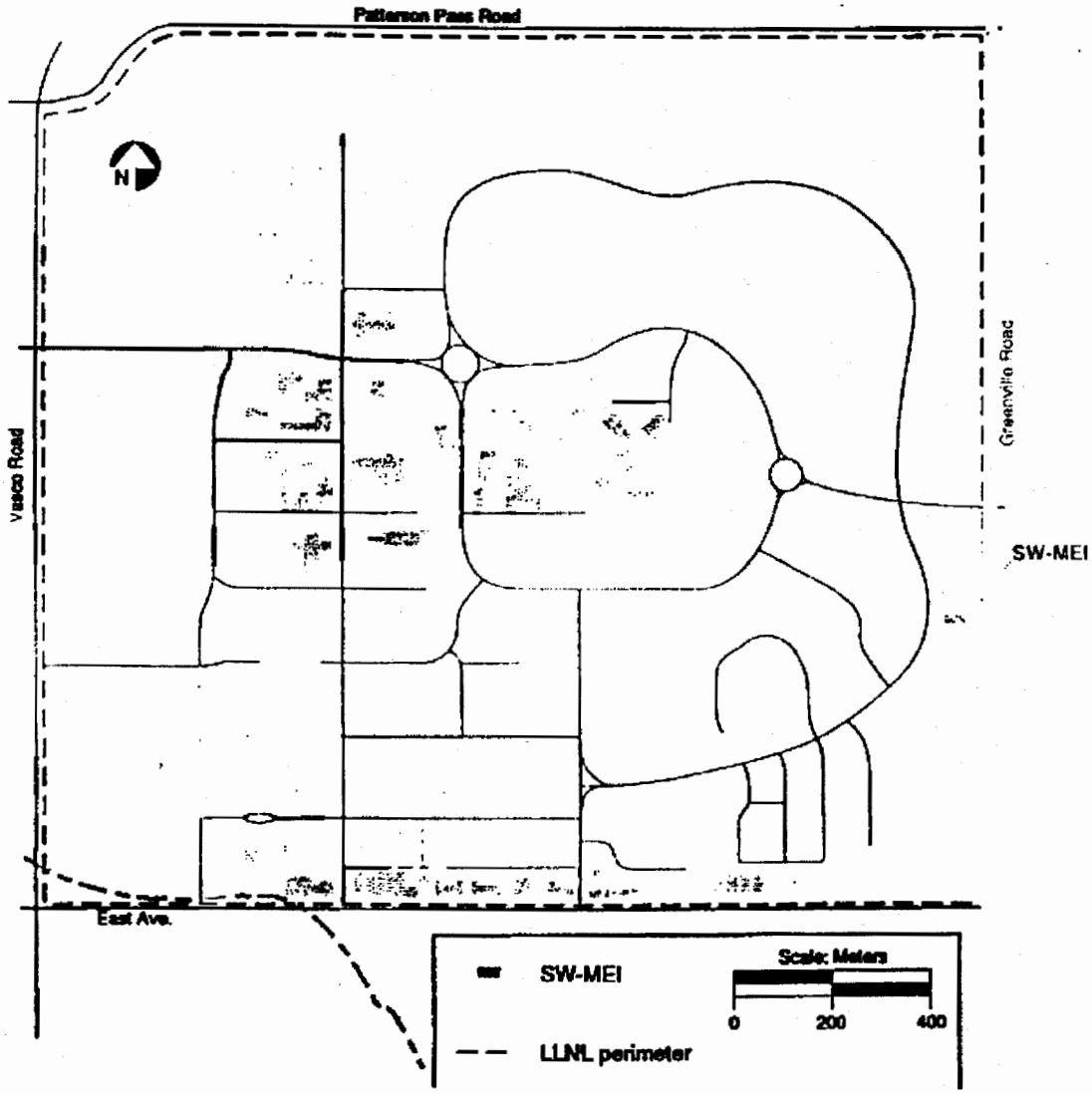

Figure 4. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at the Livermore site, 1996.

At the Livermore site, the SW-MEI for 1996 was located at the UNCLE Credit Union, about 10 m outside the controlled eastern perimeter of the site, as shown in Figure 4.

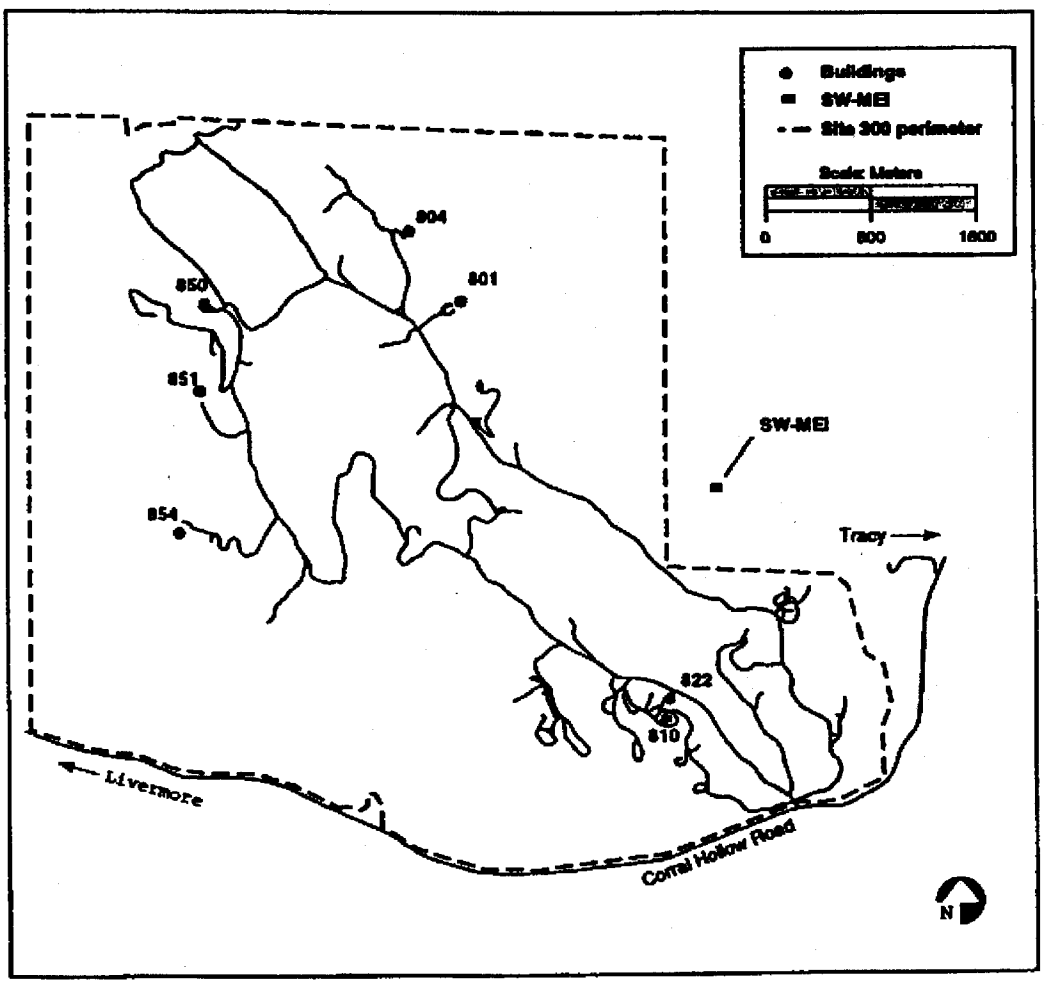

Figure 5. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at Site 300, 1996.

At Site 300, the 1996 SW-MEI was located in an experimental area termed "Bunker 2" operated by Primex Physics International. Bunker 2 lies about 300 m outside the east-central boundary of Site 300, as shown in Figure 5. This bunker is 2.4 km east-southeast of the principal firing table at Building 801.

In Attachment 1, the distance and direction to the respective SW-MEI are shown for each facility at each site. Doses to the site-specific SW-MEIs were evaluated for each source and then totaled for site-specific evaluations against the 10 mrem/y dose standard (see "Total Dose Estimate" in Section IV).

Maximally Exposed Public Individual: To assess compliance with the requirement for continuous monitoring (potential dose greater than 0.1 mrem/y {1.0 μSv/y}), emissions must be individually evaluated from each point source; the location of the maximally exposed public individual (MEI) is generally different for each emission point. The maximum dose at a location of unrestricted public access typically occurs at a point on the site perimeter. Therefore, it is often referred to as the maximum "fence line" dose, although the off-site maximum dose could occur some distance beyond the perimeter. (This could happen, e.g., when the perimeter is close to a stack; however, for all emission points at the Livermore site and Site 300, calculations show that ground-level concentrations of radionuclides decline monotonically beyond LLNL boundaries.) As stipulated by the regulations in 40 CFR Section 61.93 (b)(4)(ii), modeling for assessment of continuous monitoring requirements assumed unabated emissions (i.e., no credit was taken for emission abatement devices, such as filters), but physical-state factors were applied. Attachment 1 provides, for each point source, the dose to the MEI and the distance and direction to the LLNL fence line where the MEI is located.

Special Modeling Challenges: Among the sources at LLNL, explosives tests using depleted uranium at Site 300 and diffuse sources at the two sites required special attention.

Site 300 Explosives Experiments: During Site 300 explosives experiments, the device containing depleted uranium is placed on an open-air firing table and detonated. Only limited data are available to characterize the initial state of the cloud of explosive decomposition products created by the detonation because properties of the cloud are not routinely measured in the experiments. Empirical scaling laws can be used, however, to define the cloud using the radionuclide and explosives inventories. Isotopic ratios for depleted uranium are used; the three uranium isotopes with atomic weights 238, 235, and 234 occur in the weight percentages 99.8, 0.2, and 5×10^{-4}, respectively. Their masses are multiplied by their respective specific activities to determine the total number of curies for each isotope in the cloud. It is assumed that all the uranium is dispersed into the cloud, and the median particle size is assumed to be the CAP88-PC default value of 1 μm. The assumption that all uranium is aerosolized and dispersed as a cloud results in a highly conservative off-site dose estimation—we believe a more realistic release-to-air fraction for the uranium is no greater than 0.2, but we lack sufficient data to use a value other than 1.0. CAP88-PC simulates each shot as a low-level, steady-state, stack-type emission occurring over one year. An alternative modeling methodology for treating these short-duration

explosive events was submitted for approval in 1992, but LLNL was directed by EPA to use the CAP88-PC code for these calculations.

Diffuse Sources: Diffuse emissions are generally area sources external to buildings, as discussed in Section IV, below. The dose assessments for diffuse sources can be derived from modeling based on radionuclide-inventory data, or can be determined from environmental-surveillance monitoring data.

Modeling Documentation: Copies of individual model runs, including input parameters and resultant calculated doses, are on file with the Terrestrial & Atmospheric Monitoring & Modeling Group (TAMM) of the Environmental Protection Department at LLNL.

Point Source Summary

The 1996 calculated EDE to the SW-MEI from Livermore-site point sources was 0.048 mrem (0.48 μSv). Emissions from the two 30-meter stacks at the LLNL Tritium Facility (Building 331) accounted for 0.045 mrem (0.45 μSv). In 1995, emissions from the Tritium Facility resulted in a modeled dose of 0.017 mrem (0.17 μSv). The relative increase in 1996 in emissions and dose occurred primarily as a result of glovebox decontamination and decommissioning activities.

The calculated EDE to the SW-MEI at Site 300 was calculated to be 0.033 mrem (0.33 μSv) from point-source emissions. All of this EDE resulted from Building 801 and Building 851 firing-table emissions in the course of explosives experiments—55% from the former and 45% from the latter. This is an increase over the 0.020 mrem (0.20 μSv) dose modeled for 1995; the increase is the result of an increase in the amount of depleted uranium used in experiments at the site.

All the dose evaluations from point-source emissions, and those from most diffuse sources discussed below, were made using the EPA-mandated CAP88-PC dispersion model. They result in levels of public exposure well below the EPA standard, which limits the whole-body EDE to members of the public from DOE activities to 10 mrem/y (100 μSv/y). Discussion of the contribution to EDE to members of the public from diffuse sources is presented in Section IV.

and the standard-man breathing rates of 8.4×10^9 mL/y were used to calculate the estimated EDE of 7.8×10^{-4} mrem (7.8×10^{-3} μSv) for 1996.

Site 300 Diffuse Sources

Diffuse sources at Site 300 involve tritium and uranium. During remediation efforts at Site 300, LLNL completed a contaminant screening to identify potential routes of migration from soil to air and other environmental media of these radionuclides and other contaminants. Information provided in the Final Site Wide Remedial Investigation Report (Webster-Scholten, Ed., 1994, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-108131) was used in the diffuse-source evaluations. In the course of the remedial investigation, the rate of intermedia migration and the exposure-point concentrations of contaminants were evaluated. Tritium and ^{238}U were identified as contaminants of potential concern at six locations.

Tritium contamination is well characterized at Site 300. Five diffuse tritium sources are discussed individually. Uranium, on the other hand, is not as well characterized. Diffuse uranium sources were treated collectively in a resuspension calculation, presented following the individual tritium discussions below.

Tritium gas and solid tritium (Li^3H) were components of explosives assemblies tested on the firing tables during past experiments. Most of the gaseous tritium escaped to the atmosphere during the tests, but some of the solid Li^3H remained as residue in the firing table gravel. Rainwater and dust-control rinse water percolated through the gravel, causing the tritium to migrate into the subsurface soil and, in some cases, eventually to the ground water. Tritium-contaminated gravel was removed from the firing tables in 1988 and disposed in the Pit 7 landfill. Tritium in landfills, firing-table soils, and ground water are source terms for diffuse emissions of tritium to the atmosphere at Site 300.

Pit 7 Complex: The Pit 7 Complex is an area where four landfills were established. All the pits contain gravel and debris generated from explosives tests conducted at the Building 850 and 851 firing tables. Tritium is a known residue in this waste, and tritium contamination in both subsurface soils and ground water in the area has been characterized. Tritium in subsurface moisture can evaporate to the atmosphere. The affected area is estimated at 18,000 m^2. Tritium flux was calculated from tritium activity data obtained from subsurface soil samples collected at depths from 0.15 to 3 m, and was

estimated to be 8.3×10^{-1} Ci (3.1×10^{10} Bq) for 1996. A correction (decrease) in source term from the time the samples were taken accounts for both radioactive decay and loss of the original tritium activities in the soil due to evapotranspiration. In addition, well purge water (water collected from wells and left to evaporate to the atmosphere before ground water sampling) in this area often contains elevated levels of tritium. During 1996, ground water monitoring operations involved purging three wells with tritium levels above 20,000 pCi/L (740 Bq/L). The evaporation of this water to the atmosphere represents another component of the Pit 7 diffuse emission source term; it was estimated to contribute 1.3×10^{8} pCi (4.8×10^{6} Bq) during 1996. This emission estimate is based on the total volume of water purged during monitoring activities and the detection levels reported in the 1996 LLNL Site 300 Compliance Monitoring Program Report (Christofferson and MacQueen, 1997, Lawrence Livermore National Laboratory, UCAR-10191-96-4). The 1996 calculated EDE to the SW-MEI from the combined tritium emissions at the Pit 7 Complex was 3.0×10^{-5} mrem (3.0×10^{-4} µSv).

Well 8 Spring: Tritium released to the soils, and eventually to the ground water, near the Building 850 firing table has been transported to areas where ground water flows near the surface and can evaporate to the atmosphere. Such is the case at the Well 8 Spring, where ground water is very shallow. To estimate tritium flux from this spring, tritium activity data obtained from water samples collected at the spring were used. These data were corrected for radioactive decay, but not for removal by evapotranspiration because the spring was assumed to have a continuous source of tritiated water for the period in question. The affected area of the spring was estimated at 9.3 m^2, and the 1996 source term was estimated to be 2.1×10^{-3} Ci (7.8×10^{7} Bq). The 1996 calculated EDE to the SW-MEI from tritium emissions at the Well 8 Spring was 1.3×10^{-7} mrem (1.3×10^{-6} µSv).

Building 802: Tritium in the subsurface soils near the Building 802 firing table may evaporate to the atmosphere. The affected area was estimated to be 900 m^2. Tritium flux was calculated from tritium activity data obtained from subsurface soil samples collected at depths from 0.15 to 3 m. The tritium emission rate from subsurface soils to air was the product of the spatial-average tritium flux, the natural flux of water, the fraction of tritium in the water, and the affected surface area. The 1996 tritium emissions from this source were estimated to be 5.0×10^{-4} Ci (1.9×10^{7} Bq). The 1996 calculated EDE to the SW-MEI from tritium emissions at Building 802 was 5.4×10^{-8} mrem (5.4×10^{-7} µSv).

Building 850: Approximately 2.1×10^4 Ci (7.8×10^{14} Bq) of tritium was expended in explosives tests at the Building 850 firing table in the past. Although a significant source of tritium (firing-table gravel) was removed from the area during 1988, tritium remains in subsurface soils beneath the Building 850 firing table, sand pile area, and lower corporation yard. Tritium in the subsurface soils in the vicinity can evaporate to the atmosphere. The affected area was estimated to be 20,000 m^2. The tritium flux and tritium emission rate from subsurface soil to air were calculated as in the Building 802 case. The 1996 tritium emissions from this source were estimated to be 1.0×10^{-1} Ci (3.7×10^9 Bq). The 1996 calculated EDE to the SW-MEI from tritium emissions at Building 850 was 5.7×10^{-6} mrem (5.7×10^{-5} µSv).

Building 851: About 1.0×10^3 Ci (3.7×10^{13} Bq) of tritium were expended during past explosives research conducted at the Building 851 firing table. Although gravel was removed routinely from the area, subsurface soil below the firing table contains residual tritium in soil moisture that can evaporate to the atmosphere. The affected area was estimated to be 470 m^2. The tritium flux and tritium emission rate from subsurface soil to air were calculated as in the Building 802 case. The 1996 tritium emissions from this source were estimated to be 2.9×10^{-4} Ci (1.1×10^7 Bq). The 1996 calculated EDE to the SW-MEI from tritium emissions at Building 850 was 1.8×10^{-8} mrem (1.8×10^{-7} µSv).

Resuspension of Depleted Uranium at Site 300: Like tritium, depleted uranium has been used as a component of explosives-test assemblies. It remains as a residue in surface soils, especially near the firing tables. Because surface soil is subject to resuspension by the action of wind, rain, and other environmental disturbances, the collective effects of surface soil uranium residuals on off-site doses were evaluated.

For the 1995 NESHAPs annual report, we developed calculations to separate the contribution to measured uranium activities from naturally occurring uranium (NU) (Gallegos et al., 1996, Lawrence Livermore National Laboratory, UCRL-ID-113867-96). We base our dose estimate for resuspended depleted uranium (DU) on the measured environmental surveillance monitoring total concentration in air of uranium-238, subtracting out the part contributed by NU, from the following equation:

SECTION V. Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein, and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

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Signature: Ray Corey **Date:** 6/19/97
Ray Corey

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

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Signature: Dennis K. Fisher **Date:** 6/13/97
Dennis K. Fisher

Table 6. Population distribution for LLNL's Livermore site, based on 1990 census information. Values are population in sector segments bounded by the indicated inner and outer radii, for each of sixteen 22.5°-sector directions.

	Range of distance from site (km)					
Direction	0-16	16-32	32-48	48-64	64-80	Total
N	4811	10411	57302	4584	1224	78332
NNW	1068	2754	111707	1258	166469	283256
NW	1426	31936	248376	135833	91385	508956
WNW	14358	61815	300908	520216	122985	1020282
W	49751	128129	212882	473559	407860	1272181
WSW	25518	171772	67983	274932	19296	559501
SW	5238	93798	279561	61204	2796	442597
SSW	593	49137	563182	260261	61181	934354
S	241	200	167093	101614	44877	314025
SSE	291	49	3	3821	18998	23162
SE	385	219	11	41	576	1232
ESE	382	141	249	12884	12584	26240
E	1778	8552	7127	42834	241920	302211
ENE	1135	30417	26376	61945	6467	126340
NE	1556	837	6320	250835	60168	319716
NNE	4688	8051	3952	3598	17370	37659
Total	113219	598218	2053032	2209419	1276156	6250044

Table 7. Population distribution for LLNL's Site 300, based on 1990 census information. Values are population in sector segments bounded by the indicated inner and outer radii, for each of sixteen 22.5°-sector directions.

	Range of distance from site (km)					
Direction	0-16	16-32	32-48	48-64	64-80	Total
N	720	4105	2330	3327	6034	16516
NNW	87	4029	75298	4094	33281	116789
NW	63	502	23434	255247	94706	373952
WNW	152	21706	89386	295835	535792	942871
W	502	75338	144290	304121	420057	944308
WSW	49	70	189976	252976	160554	603625
SW	54	72	358903	631861	20294	1011184
SSW	4	3	74404	173195	23493	271099
S	52	242	3	28705	43197	72199
SSE	33	5	2	14	59	113
SE	33	4	55	5949	6480	12521
ESE	33	766	13067	25674	49409	88949
E	157	2206	83264	177422	11635	274684
ENE	3564	12829	44972	24814	3852	90031
NE	30508	11457	91318	8889	2943	145115
NNE	2078	1214	171880	76719	21699	273590

0.1 mrem/y (1 μSv/y) for the emissions from each of these facilities. While this monitoring also will be continued, it is not required under NESHAPs.

For facilities having discharge points without continuous monitoring, the requirement for continuous monitoring was individually evaluated. The evaluation was based on unabated emissions, even if emission-control systems existed. No additional facilities at either LLNL site were found to require continuous monitoring.

Status of compliance with 40 CFR 61 Subpart Q - National Emission Standards for Radon Emissions from Department of Energy Facilities

LLNL does not have storage and disposal facilities for radium-containing materials that would be a significant source of radon.

Status of compliance with 40 CFR 61 Subpart T - National Emission Standards for Radon Emissions from the Disposal of Uranium Mill Tailings

LLNL does not have or store any uranium mill tailings.

Information on Radon-220 and Radon-222 Emissions

Radon emissions occur naturally by emanation from the earth. Radon-222 emissions that were reported in past NESHAPs annual reports from research experiments at the Livermore site did not occur in 1996.

Site Periodic Confirmatory Measurements

LLNL uses a graded approach to determine the required level of periodic confirmatory measurements. The greater the calculated EDE, the more intensive the measurements will be. LLNL invokes a four-tier approach: (1) continuous monitoring at selected facilities, (2) annual effluent sampling, (3) general surveillance monitoring, and (4) site-specific surveillance monitoring, as described below.

Continuous Monitoring: There are currently nine buildings (Buildings 166, 175, 231, 251, 331, 332, 419, 490, and 491) at the LLNL site that have radionuclide air-monitoring systems. These buildings are listed in Table 8, along with the number of samplers, the types of samplers, the analytes of interest, and the number of monitored discharge points at the building. In all,

there are 103 samplers operating continuously. Many would operate from emergency power systems if normal power were lost.

Table 8. Air-effluent sampling locations and systems.

Building	Facility	Analytes	Sample type	Number of samplers	Number of discharge points
166	Pyrochemical Demonstration Facility	Gross α, β on particles	Filters	1	1
175	MARS	Gross α, β on particles	Filters	6	6
231	Vault	Gross α, β on particles	Filter	1	1
251	Heavy Elements				
	Unhardened area	Gross α, β on particles	Filters	44	55[a]
	Hardened area	Gross α, β on particles	Filters	4	4
	Hardened area	Gross α, β on particles	CAM[b]	4	4
331	Tritium	Tritium	Ionization Chamber[b]	4	4
		Gaseous tritium/ tritiated water vapor	Molecular sieves	4	2
332	Plutonium	Gross α, β on particles	CAM[b]	12	11
		Gross α, β on particles	Filters	16	11
419	Decontamination	Gross α, β on particles	Filters	2	2
490	USEC Laser Isotope Separation	Gross α, β on particles	Filters	4	4
491	USEC Laser Isotope Separation	Gross α, β on particles	Filters	1	1

Note: "CAM" denotes Eberline continuous air monitors.
[a] Alternate blower system measured by the same sampler.
[b] Alarmed systems.

Air samples for particulate emissions are extracted downstream of HEPA filters and prior to the discharge point to the atmosphere. Particles are collected on membrane filters. The sample filters are removed and analyzed for gross alpha and beta activity on a weekly or bi-weekly frequency depending on the facility. In most cases, simple filter-type aerosol collection systems are used. However, in some facilities, alpha continuous-air monitors

inventory-based approach. CAP88-PC modeling of the workplace-based source term as an area-type release resulted in an MEI dose of 8.3×10^{-4} mrem and a SW-MEI dose of 1.9×10^{-5} mrem. Therefore, no continuous sampling of these operations is required.

Building 490: At Building 490, we performed periodic confirmatory measurements of a vacuum pump exhaust from an operation using uranium. Since this type of exhaust is intermittent depending on the operation of the process, a special, HEPA-filtered sampling train was placed on the exhaust to facilitate continuous sampling. The sampling train provided filtered air for the continuous sampler during times when there was little or no flow from the pump exhaust. Four samples were taken over a 2-week period while experimental operations in the facility were being conducted. Background measurements taken of the sampling train without the vacuum pump exhaust connected were also made. Samples of particulate emissions were collected on either 47-mm diameter cellulose membrane or glass fiber filters. The filters were analyzed for gross alpha and gross beta activity and for total uranium by ICPMS. The average measured concentration as determined by ICPMS results was not distinguishable, or statistically different, from the background measurements. (As for continuously monitored stacks, for which measured emissions are not significantly higher than background, these emissions are considered to be zero.) Since the background concentration measurements have a lower limit of sensitivity that would result in a MEI dose far less than the 0.1 mrem requirement for continuous sampling, the exhaust from this operation does not require continuous sampling. Similarly, there is no significant contribution to the SW-MEI dose.

General Surveillance Monitoring: Surveillance air monitoring for tritium and radioactive particles has been in place since the 1970s and will continue. LLNL currently maintains eight continuously operating, high-volume, air-particulate samplers on the Livermore site, nine in the Livermore Valley, eight at Site 300, and one in Tracy. LLNL also maintains eleven continuously operating airborne-tritium samplers on the Livermore site and six samplers in the Livermore Valley. The samplers are positioned to ensure reasonable probability that any significant airborne concentration of particulate and tritium effluents resulting from LLNL operations will be detected. The data from this monitoring network provide continuous measurements of the concentrations of radionuclides present in the air at the Livermore site, Site 300, and in the surrounding areas. This network allows for direct measurements of the overall impact of LLNL operations. Data from

number of presentations during the course of the inspection including summaries of stack monitoring systems, the HEPA filter testing program, the Hazards Control Radiological Measurements Laboratory operations, Building 332 operations overview and facility tour, and NESHAPs compliance overview. LLNL was found to be in compliance with 40 CFR 61 Subpart H and no additional compliance activities were required.

In December 1996, LLNL held an informational meeting with U.S. EPA Region IX staff to discuss planned construction of the Decontamination Waste Treatment Facility at the Livermore site and Contained Firing Facility at Site 300. Potential NESHAPs issues and plans for monitoring at the facilities were discussed. Additional subjects covered at the meeting included periodic confirmatory measurements, the potential for the use of *de minimis* values in determining NESHAPs compliance, and the status of the delegation of NESHAPs regulatory oversight to the State of California.

Uranium Physical State Exemption

In discussions between LLNL and U.S. EPA staff, LLNL personnel pointed out the burden of assuming, as required by 40 CFR Part 61 Subpart H Appendix D, that all materials heated in excess of 100°C are in a gaseous physical state. Such an assumption is quite unrealistic for uranium and other refractory metals. Uranium has a melting point of 1132°C and a boiling point of 3818°C. The effect of the assumption that all materials are gaseous when at temperatures above 100°C is to apply a physical state factor of 1, rather than 1×10^{-3} for liquids and 1×10^{-6} for solids. Evaluation of a new source which involved heating of uranium, and using the required physical state factor, could lead to a dose estimate that requires continuous monitoring of the source, whereas using a physical state factor based on the actual physical state of the materials would not. On July 25, 1996, LLNL requested an exemption from the temperature-based physical state assumptions for uranium. U.S. EPA granted approved alternative emissions factors for elemental uranium as follows: an emission factor of 1×10^{-6} can be used for elemental uranium heated at temperatures below 1100°C, an emission factor of 1×10^{-3} can be used for elemental uranium heated at temperatures below 3000°C, and an emission factor of 1 shall be used for temperatures greater than 3000°C. These factors are allowed provided that the uranium is not intentionally dispersed to the environment and that the processes do not alter the chemical form of the uranium. We are working towards similar exemptions for uranium compounds.

Attachment 1. 1996 LLNL NESHAPs Annual Report Spreadsheet

Guidance for Interpreting Attachment 1

A generalized description of each facility and its operations is provided on the spreadsheet. In addition, the following information is shown for each listed emission point or stack:

- Building and room number(s)
- Specific stack identification code(s)
- Generalized operations in the room(s) or area(s)
- Radionuclides utilized during 1996
- Annual radionuclide inventory with potential for release (by isotope, in curies)
- Physical-state factors (by isotope)
- Stack parameters
- Emission-control devices and emission-control-device abatement factors
- Estimated or measured annual emissions (by isotope)
- Distance and direction to the site-wide maximally exposed individual (SW-MEI)
- Calculated EDE to the SW-MEI
- Distance and direction to the maximally exposed individual for that specific source (MEI)
- Calculated EDE to the MEI (source term not adjusted for emission controls)
- Source category
- Below Appendix E Quantity (Y or N)

Radionuclides: The radionuclides shown in the spreadsheet are those from specific emission points where air emissions were possible. If radionuclides were present, but encapsulated or sealed for the entire year, radionuclides, annual inventories, and emissions are not listed.

Radionuclide Inventories with Potential for Release: The annual radionuclide inventories for point-source locations are based on data from facility experimenters and managers. For Buildings 251 (hardened area) and 332, classification issues regarding transuranic-radionuclide inventories make use of the inventory/modeling approach impractical. However, all such affected emission points in these buildings are continuously monitored, and emissions are therefore directly determined. LLNL conducted a complete radionuclide-inventory update in 1994. Because of the magnitude of effort

required to complete a site-wide inventory, the 1996 inventory was conducted for all new sources and for those sources that cumulatively contributed to 90% or more of the dose for 1995.

Physical-State Factors: The physical-state factors listed are EPA potential-release fractions from 40 CFR 61, Appendix D, whereby emissions are estimated from radionuclide inventories depending on their physical states for use in dispersion/dose assessment modeling. A physical-state factor of 1.0×10^{-6} is used for solids, 1.0×10^{-3} is used for liquids and powders, and 1.0 is used for unconfined gases.

Stack Parameters: Engineering surveys conducted from 1990 through 1992 form the basis for the stack physical parameters shown, which were checked and validated by facility experimenters and managers for 1994 and 1995. Stack physical parameters for new sources in 1996 were provided by experimenters and managers for those facilities.

Emission-Control Devices: High-Efficiency-Particulate-Air (HEPA) filters are used in many LLNL facilities to control particulate emissions. For some discharge points, scrubbers and electrostatic precipitators aid the control of emissions. The operational performance of all HEPA filtration systems is routinely tested. The required efficiency of a single-stage HEPA filter is 99.97%. Double-staged filter systems are in place on some discharge points. Triple-stage HEPA filters are used on glove-box ventilation systems in the Building 332 Plutonium Facility and in the hardened portion of Building 251.

Control-Device Abatement Factors: Similar to physical-state factors, control-device abatement factors, from Table 1 in 40 CFR 61, Appendix D, are those associated with the listed emission-control devices, and are used to better estimate actual emissions for use in dispersion and dose models. By regulation, each HEPA filter stage is given a 0.01 factor (even though the required test efficiency that all LLNL HEPA filters must maintain would yield a factor of 0.0003), venturi scrubbers and electrostatic precipitators are each given a 0.05 factor, and each activated-charcoal filter is given a 0.1 factor.

Estimated Annual Emissions: For unmonitored and non-continuously monitored sources, estimated annual emissions for each radionuclide are based on the product of (1) inventory data, (2) EPA potential-release fractions (physical-state factors), and (3) applicable emission-control-device abatement factors.

Actual emission measurements are the basis for reported emissions from continuously monitored facilities. LLNL facilities that have continuous monitoring systems are Buildings 166, 175, 231-vault, 251, 331, 332, 419, 490, and 491. See pages 9-10 for a discussion of the use of emissions measurements for monitored sources.

10 mrem/y Site-Wide Dose Requirement: For LLNL to comply with the NESHAPs regulations, the LLNL site-wide maximally exposed individual (SW-MEI; defined as the hypothetical member of the public at a single residence, school, business, or office who receives the greatest LLNL-induced EDE from the combination of all radionuclide source emissions) cannot receive an EDE greater than 10 mrem/y (100 μSv/y).

In Attachment 1, the distance and direction to the respective SW-MEI are shown for each facility at each site. Doses to the site-specific SW-MEIs were evaluated for each source and then totaled for site-specific evaluations against the 10 mrem/y dose standard (see "Total Dose Estimate" in Section IV).

0.1 mrem/y Monitoring Requirement: To assess compliance with the requirement for continuous monitoring (potential dose greater than 0.1 mrem/y [1.0 μSv/y]), emissions must be individually evaluated from each point source; the location of the maximally exposed public individual (MEI) is generally different for each emission point. The maximum dose at a location of unrestricted public access typically occurs at a point on the site perimeter. Therefore, it is often referred to as the maximum "fence line" dose, although the off-site maximum dose could occur some distance beyond the perimeter. (This could happen, e.g., when the perimeter is close to a stack; however, for all emission points at the Livermore site and Site 300, calculations show that ground-level concentrations of radionuclides decline monotonically beyond LLNL boundaries.) As stipulated by the regulations, modeling for assessment of continuous monitoring requirements assumed unabated emissions (i.e., no credit was taken for emission abatement devices, such as filters), but physical-state factors were applied.

The unabated EDE cannot be calculated for monitored facilities. Because the monitoring equipment is placed after HEPA filtration, there is no way to obtain an estimate for what the emissions might have been had there been no filtration. It is not reasonable to apply factors for the effects of the HEPA filters on the emission rate because most of what is measured on the HEPA filters is the result of the radioactive decay of radon, which is capable of penetrating the filter. Attachment 1 gives, for each inventoried point source, the dose to

the MEI and the distance and direction to the LLNL fence line where the MEI is located. However, for monitored sources, no value is shown.

Source Categories: LLNL radionuclide air-emission sources have been classified into six source categories, indicated by the number in the next to last column of the spreadsheet: (1) Unmonitored or non-continuously monitored Livermore-site facilities that have had a radionuclide-inventory update for 1996; (2) Unmonitored or non-continuously monitored Livermore site facilities with a previous (1994 or 1995) radionuclide-inventory update; (3) Continuously monitored Livermore-site facilities; (4) Site 300 explosives experiments; (5) Diffuse sources where emissions and subsequent doses were estimated using inventory processes; and (6) Diffuse sources where emission and dose estimates were supported by environmental-surveillance measurements.

Below Appendix E Quantity: In 1995, DOE and EPA entered into a memorandum of understanding that, among other things, made the contents of 40 CFR 61, Appendix E acceptable "other procedures" for DOE facilities to establish compliance with Section 61.93(a) of Subpart H. Part of Appendix E is a list of "Annual Possession Quantities for Environmental Compliance." Facilities having less than these quantities of radionuclides need not report to EPA under NESHAPs. A letter "Y" in this column denotes those inventoried sources at LLNL facilities that contain radionuclides in amounts below the annual possession quantities listed in Appendix E.

Attachment 1 - 1996 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/yr Effective Dose Assessment Distance to MEI (m)	Direction to MEI	EDE (mrem)	0.1 mrem/yr Effective Dose Assessment Distance to MEI (m)	Direction to MEI	Evaluated EDE (mrem)	Source Category	Other App. E Quantity
NOTE: GAPER-PC requires activity rates of curies/year and gives doses in dose/year. To convert curies to becquerels use 1 Ci=3.7E+10 Bq and to convert millirem to sieverts use 1 Sv=1.0E+05 mrem.																				
LAWRENCE LIVERMORE NATIONAL LABORATORY																				
Building 131 complex is a large silicon/laboratory facility housing both Mechanical Engineering and Electrical Engineering Division.																				
131	Vault	Room Air	Temporary Storage	U-238	3.3E-07	1.0E-03	NA	NA	NA	None	1	3.3E-10	1320	E	1.8E-11	569	SW	8.0E-11	2	Y
				U-235	4.6E-09	1.0E-03						4.6E-12								Y
				U-234	3.3E-08	1.0E-03						3.3E-11								Y
131	1281	Room Air	Temporary Storage	U-238	6.3E-02	1.0E-03	NA	NA	NA	None	1	6.3E-05	1329	E	4.8E-06	363	SSW	6.7E-06	2	Y
				U-235	1.1E-03	1.0E-03						1.1E-06								Y
				U-234	7.7E-06	1.0E-03						7.7E-09								Y
131	2250	Room Air	Processing systems	U-238	3.3E-01	1.0E-03	NA	NA	NA	None	1	3.3E-07	1324	E	1.8E-06	563	SSW	3.8E-04	2	Y
				U-235	4.5E-03	1.0E-03						4.5E-06								Y
				U-234	3.1E-02	1.0E-03						3.1E-05								Y
Building 191 houses the Isotope Sciences Division which applies nuclear and isotope element to a wide range of problems, including stockpile stewardship, nonproliferation, safeguard technologies, forensic science, and waste characterization and analysis.																				
Building 191 also contains the Chemistry and Materials Sciences Environmental Services laboratory (room 2117) where samples of waste streams and environmental media (air, water, soil etc.) are analyzed for their radionuclide content.																				
191	1033	FHE-0	Drying of new drying samples from MTS	Pu-239	8.0E-09	1.0E-03	7.6	0.61	3.1	None	1	8.0E-09	1308	E	1.8E-06	584	WNW	8.0E-06	1	Y
				Cs-137	4.0E-09	1.0E-03						4.0E-09								Y
				Sr-90	1.7E-08	1.0E-03						1.7E-08								Y
				Am-241	2.0E-09	1.0E-03						2.0E-09								Y
				H-3	2.3E-04	1.0E+00						2.3E-04								Y
191	1039	FHE-04	Aliquot Extraction	Sr-90	3.0E-09	1.0E-03	10.2	0.61	10.4	None	1	3.0E-11	1308	E	3.4E-11	1128	NNE	6.7E-11	2	Y
				Ru-106	3.0E-10	1.0E-03						3.0E-12								Y
				Cs-137	3.0E-09	1.0E-03						3.0E-11								Y
				Ce-144	3.0E-10	1.0E-03						3.0E-12								Y
				Pm-147	1.0E-08	1.0E-03						1.0E-11								Y
191	1049	FHE-0	Core Dissolution	Sr-90	3.4E-08	1.0E-03	7.6	0.46	2.8	None	1	3.4E-09	1308	E	3.2E-09	584	WNW	1.4E-05	1	Y
				Ru-106	3.3E-10	1.0E-03						3.3E-12				840	W			Y
				Cs-137	6.3E-08	1.0E-03						6.3E-09								Y
				Ce-144	3.3E-10	1.0E-03						3.3E-12								Y
				Pm-147	1.0E-06	1.0E-03						1.0E-11								Y
				Pu-239	1.7E-06	1.0E-03						1.7E-09								Y
				Am-241	5.0E-06	1.0E-03						5.0E-09								Y
				H-3	4.5E-04	1.0E+00						4.5E-04								Y
191	1145	FHE-04	Sample Preparation	Pu-239	3.0E-06	1.0E-03	10.2	0.61	2.6	None	1	3.0E-11	1308	E	4.0E-08	1125	NNE	8.0E-08	2	Y
				U-234	9.0E-07	1.0E-03						9.0E-10								Y
				U-235	3.0E-08	1.0E-03						3.0E-11								Y
				U-238	1.0E-07	1.0E-03						1.0E-10								Y
191	1241	FHE-09	Sample Preparation	Pu-239	2.0E-06	1.0E-03	11.0	0.61	1.4	None	1	2.0E-11	1308	E	4.2E-06	584	WNW	1.7E-07	1	Y
				U-234	9.0E-07	1.0E-03						9.0E-10								Y
				U-235	3.0E-08	1.0E-03						3.0E-11								Y
				U-238	1.0E-07	1.0E-03						1.0E-10								Y
191	1318	FHE-09	Sample Preparation	Pu-239	1.0E-09	1.0E-03	10.2	0.41	4.0	None	1	1.0E-12	1308	E	1.3E-10	1125	NNE	2.0E-10	2	Y
				Am-241	2.0E-10	1.0E-03						2.0E-13								Y
				Cm-244	1.0E-10	1.0E-03						1.0E-13								Y
				I-129	6.0E-11	1.0E-03						6.0E-14								Y
191	1372	FHE-32	Sample Processing	Sr-90	1.0E-08	1.0E-03	11.0	0.61	2.2	None	1	1.0E-12	1308	E	2.4E-08	584	WNW	8.0E-08	1	Y
				Ru-106	1.0E-11	1.0E-03						1.0E-14								Y
				Cs-137	1.0E-08	1.0E-03						1.0E-13								Y
				Ce-144	1.0E-11	1.0E-03						1.0E-14								Y
				Pm-147	6.0E-10	1.0E-03						6.0E-13								Y
				Pu-239	1.0E-07	1.0E-03						1.0E-10								Y
				Am-241	1.0E-07	1.0E-03						1.0E-10								
191	1326	FHE-40	Sample Analysis	Sr-90	3.0E-08	1.0E-03	10.2	0.41	3.0	None	1	3.0E-12	1308	E	4.0E-08	1125	NNE	1.3E-07	2	Y
				Ru-106	3.0E-11	1.0E-03						3.0E-14								Y
				Cs-137	3.0E-08	1.0E-03						3.0E-13								Y
				Ce-144	3.0E-11	1.0E-03						3.0E-14								Y
				Pm-147	1.0E-09	1.0E-03						1.0E-12								Y
				Pu-239	2.0E-07	1.0E-03						2.0E-10								Y
				Am-241	2.0E-07	1.0E-03						2.0E-10								

Attachment 1 - 1996 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for * Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/yr Site-Wide Dose Assessment: Distance to SWMB (m)	Direction to SWMB	EDE (mrem)	0.1 mrem/yr Maximum Residential: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category	Meter App. E Quantity
151	2309	FHE-16	Experimental Laboratory with Glove Boxes	Th-232	3.6E-10	1.0E-03	11.9	0.61	2.6	Double HEPA	0.0001	3.6E-17	1300	E	9.4E-09	584	WNW	3.0E-09	1	Y
				Np-237	7.6E-06	1.0E-06						7.6E-12								Y
				Pu-242	8.6E-07	1.0E-03						8.6E-14								Y
151	2318	FHE-01	Experimental Laboratory with Glove Boxes	Pu-242	3.0E-08	1.0E-03	11.9	0.61	2.6	Double HEPA	0.0001	3.0E-16	1300	E	2.7E-09	584	WNW	1.5E-09	1	Y
				U-233	1.0E-08	1.0E-03						1.0E-16								Y
		FHE-17		Pu-242	3.0E-08	1.0E-03	11.9	0.61	2.6	None	1	3.0E-11								
				U-233	3.0E-10	1.0E-03						3.0E-13								
151	2322	FHE-01	Chemical Extraction	Gross alpha	9.0E-07	1.0E-03	11.6	0.61	2.4	None	1	9.0E-10	1300	E	8.0E-08	544	WNW	2.8E-07	1	Y
				Gross beta	9.0E-07	1.0E-03						9.0E-10				1185	NNE	2.6E-07		Y
151	2329	FHE-09	Chemical Analysis of Waste	Gross alpha	1.0E-06	1.0E-03	11.6	0.61	2.4	None	1	1.0E-09	1300	E	1.0E-07	584	WNW	4.0E-07	1	Y
				Gross beta	1.0E-06	1.0E-03						1.0E-09								Y
151	2344	FHE-05	Chemical Analysis	Gross alpha	1.0E-06	1.0E-03	11.9	0.61	2.4	None	1	1.0E-09	1300	E	1.4E-07	584	WNW	4.7E-07	1	Y
				Gross beta	1.0E-06	1.0E-03						1.0E-09								Y
Building 151 is part of LLNL's Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program, now affiliated with The United States Enrichment Corporation (USEC).																				
*Gross alpha and gross beta emissions are continuously monitored at the stack. Monitoring data, rather than the inventory approach, are used to determine emissions.																				
**Because monitoring takes place after HEPA filration, an unabated EDE cannot be determined (see discussion on page 41.)																				
166	valley	Stack	Conversion of uranium to halides and oxides of uranium	Gross alpha	*	N/A	7.9	0.25	3.9	HEPA	0.01	0.0E+00	1291	E	0.0E+00	**	**	**	3	N/A
				Gross beta	*	N/A						0.0E+00								N/A
						N/A														
Building 175 is part of LLNL's Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program, now affiliated with The United States Enrichment Corporation (USEC).																				
*Gross alpha and gross beta emissions are continuously monitored at the stack. Monitoring data, rather than the inventory approach, are used to determine emissions.																				
**Because monitoring takes place after HEPA filration, an unabated EDE cannot be determined (see discussion on page 41.)																				
175		Stack 1	Cleaning & Refurbishment of Parts	U-238	*	N/A	13.0	0.71	9.1	HEPA	0.01	2.1E-07	1336	SSE	2.3E-04	**	**	**	3	N/A
		Stack 2		U-235	*	N/A	10.0	0.39	5.1	HEPA		6.9E-11								N/A
		Stack 3		U-234			13.0	0.61	8.6	HEPA		2.5E-06								N/A
Building 177 is part of LLNL's Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program, now affiliated with The United States Enrichment Corporation (USEC).																				
177	1000	Room Air	Corrosion studies of liquid uranium	U-238	9.3E-04	1.0E-03	N/A	N/A	N/A	None	1	9.3E-07	1350	SSE	2.9E-03	568	W	8.2E-03	1	Y
				U-236	1.3E-06	1.0E-03						1.3E-09								Y
				U-234	7.0E-06	1.0E-03						7.0E-09								Y
177	1012	Room Air	Corrosion studies of liquid uranium	U-238	3.3E-04	1.0E-03	N/A	N/A	N/A	None	1	3.3E-07	1350	SSE	1.0E-03	568	W	2.9E-04	1	Y
				U-236	5.8E-06	1.0E-03						5.8E-09								Y
				U-234	3.1E-06	1.0E-03						3.1E-09								Y
177	1014	FHE-10	Cleaning Parts and Process Uranium Oxide Powders	U-238	1.0E-04	1.0E-03	5.6	0.41	2.4	HEPA	0.01	1.0E-09	1350	SSE	1.0E-07	568	W	1.7E-04	1	Y
				U-235	2.7E-06	1.0E-03						2.8E-10				515	WNW	1.7E-04		Y
				U-234	4.0E-04	1.0E-03						4.0E-09								Y
177	1016	FHE-07	Sample Preparation	U-238	2.5E-05	1.0E-03	7.6	0.56	13.9	HEPA	0.01	2.5E-10	1350	SSE	3.3E-10	764	NNE	7.3E-07	1	Y
				U-235	7.0E-07	1.0E-03						7.0E-10								Y
				U-234	1.7E-05	1.0E-03						1.7E-10								Y
177	1021	FHE-04	Sample Preparation	U-238	1.3E-04	1.0E-03	11.0	0.41	7.6	HEPA	0.01	1.3E-09	1350	SSE	4.4E-08	764	NNE	6.7E-04	2	Y
		FHE-25		U-235	4.3E-06	1.0E-03	6.1	0.39	8.0	HEPA		4.3E-10								Y
				U-234	9.0E-04	1.0E-03						9.0E-09								Y
Building 194 is operated by H-Division for the Physics and Space Technology Directorate. The facility houses a high-energy linear accelerator (LINAC) and research laboratories.																				
The accelerator beam can produce small quantities of short-lived air activation products.																				
194	Target Exhaust	TE-PE4	Positron Beam Generation	C-11	2.3E-05	1.0E+00	30.5	1.37	4.6	None	1	2.3E+00	1524	SSE	2.2E-05	838	NE	2.4E-03	2	N/A
				H-13	4.4E+00	1.0E+00						4.4E+00								N/A
194	1131	1131-RA	Positron Lifetime Experiments	Na-22	2.0E-03	1.0E-03	9.5	0.50	0.5	None	1	2.0E-06	1524	SSE	1.0E-04	412	NNE	3.1E-05	2	Y
Building 212 is administered by the Physics and Space Technology Directorate (formerly the Physical Sciences Directorate) for miscellaneous physics experiments.																				
The current radionuclide emissions are due to contamination from past operations of the rotating target neutron source, which is no longer in operation.																				
212	174	FHE-7	Contamination	H-3	1.1E-02	1.0E-03	4.3	0.50	0.5	None	1	1.1E-06	1276	ENE	8.0E-12	30	SW	4.1E-10	2	Y
212	184	212-184-RA	Compensation	H-3	1.1E-02	1.0E-03	4.3	0.50	0.5	None	1	1.1E-06	1276	ENE	8.0E-12	30	SW	4.1E-10	2	Y

Attachment 1 - 1996 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclide	Annual Inventory with Potential for Release (Ci)	Physical Base Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/y Site-Wide Dose Requirement: Distance to MEI (m)	Direction to MEI	MEI (mrem)	5.1 mrem/y Maximum Requirement: Distance to MEI (m)	Direction to MEI	Unabated EDE (mrem)	Source Category	Below Appl. Quantity
Building 298 is operated by the Chemistry and Materials Science Directorate. The facility houses chemistry laboratories that prepare and analyze various media such as soil, vegetation, and water samples for tritiated and radioactivity analysis.																				
Radioactive material can enter in the facility, either in the sample or in the prepared standards.																				
***Emissions from stacks in Building 298 have been combined, as permitted by the EPA/DOE Memorandum of Understanding.																				
298	106***	FE-1	Sample preparation	Gross Alpha	8.0E-12	1.0E-03	6.4	0.10	11.1	None	1	8.0E-15	1155	ENE	1.0E-16	320	SSW	4.7E-10	1	Y
				Gross Beta	8.0E-12	1.0E-03						8.0E-15								Y
	106***	FE-2	Sample preparation	Gross Alpha	8.0E-10	1.0E-03	5.8	0.20	7.5	None	1	8.0E-13							1	Y
				Gross Beta	8.0E-10	1.0E-03						8.0E-13								Y
Building 327 is part of the Chemistry and Material Sciences Directorate. No NESHAPs regulated activities were conducted in this building in 1996.																				
The 231 complex houses research and development activities conducted by the Chemistry and Materials Science Directorate, Engineering, Weapons Engineering, and Safeguards and Security Upgrade Management Division.																				
Management oversight for Building 231 is provided by the Engineering Directorate through the Engineering Sciences Division.																				
*Gross alpha and gross beta emissions are conservatively monitored at the stack. Monitoring data, rather than the inventory approach, are used to determine emissions.																				
**Storage cupboards have glass after HEPA filtration, or unabated EDE cannot be determined from filtration on page 41.)																				
231	1125	FHE-31-1,2	Storage of Radionuclides	Gross Alpha	*	NA	12.2	0.41	12.0	HEPA	0.01	0.0E+00	1167	E	0.0E+00	**	**	**	3	N/A
231	1606	Room Air	Tensile testing	U-234	1.4E-08	1.0E-06	NA	NA	NA	None	1	1.4E-13	1167	E	2.8E-10	568	SW	1.7E-09	2	Y
				U-235	2.0E-08	1.0E-06						2.0E-14				gnd				Y
				U-238	1.0E-08	1.0E-06						1.0E-13				675	W	1.7E-09		Y
231	1737	FHE-34	Electron beam welding	U-238	3.0E-08	1.0E-06	10.1	0.46	1.5	HEPA	0.01	3.0E-13	1167	ENE	2.4E-11	725	WNW	5.3E-09	1	Y
				U-235	4.0E-07	1.0E-06						4.0E-16								Y
				U-234	3.0E-08	1.0E-06						3.0E-14								Y
				U-232	8.4E-11	1.0E-06						8.4E-16								Y
				U-236	1.0E-16	1.0E-06						1.0E-17								Y
				U-234	8.0E-16	1.0E-06						8.0E-17								Y
231	1737C	FHE-5	Spin Forming	U-238	3.3E-08	1.0E-06	9.6	0.46	3.0	HEPA	0.01	3.3E-14	1167	ENE	2.9E-12	725	WNW	6.10E-12	1	Y
				U-235	2.0E-09	1.0E-06						2.0E-16								Y
				U-234	2.1E-07	1.0E-06						2.1E-15								Y
231	1860HB	FHE-7H	Storage	U-234	1.9E-10	1.0E-06	2.4	0.20	14.4	None	1	1.9E-16	1167	ENE	2.0E-13	568	SW	5.5E-13	2	Y
				U-235	2.0E-11	1.0E-06						2.0E-17								Y
				U-238	2.0E-09	1.0E-06						2.0E-16								Y
231	1944	FHE-12	Heat treatment studies	U-234	1.9E-10	1.0E-06	2.4	0.36	40.4	HEPA	0.01	1.9E-18	1167	ENE	1.3E-15	568	SW	2.3E-13	2	Y
				U-235	2.0E-11	1.0E-06						2.0E-18								Y
				U-238	2.0E-09	1.0E-06						2.0E-17								Y
231	1945	FHE-40	Sample preparation	U-234	1.9E-10	1.0E-06	10.7	0.36	3.0	None	1	1.9E-16	1167	ENE	1.4E-13	568	SW	4.1E-13	2	Y
				U-235	2.0E-11	1.0E-06						2.0E-17								Y
				U-238	2.0E-09	1.0E-06						2.0E-16								Y
231	1945A	Room Air	Scanning electron microscopy	U-234	1.9E-10	1.0E-06	NA	NA	NA	None	1	1.9E-16	1167	ENE	2.2E-16	430	NNW	1.7E-15	2	Y
				U-235	2.0E-14	1.0E-06						2.0E-20								Y
				U-238	2.0E-12	1.0E-06						2.0E-18								Y
231	1945B	FHE-40	Metallography sample preparation	U-234	1.3E-10	1.0E-03	10.0	0.41	4.0	None	1	1.3E-13	1167	ENE	9.7E-11	430	SSW	1.0E-10	1	Y
				U-235	1.7E-11	1.0E-03						1.7E-14				725	WNW	1.0E-10		Y
				U-238	1.0E-09	1.0E-03						1.0E-12				671	W	1.0E-10		Y
				U-234	2.0E-08	1.0E-06						2.0E-14								Y
				U-235	1.3E-08	1.0E-06						1.3E-16								Y
				U-238	4.0E-08	1.0E-06						4.0E-14								Y
231	1945C	Room Air	Microscopy	U-234	1.9E-10	1.0E-06	NA	NA	NA	None	1	1.9E-16	1167	ENE	2.2E-16	430	SSW	1.7E-15	2	Y
				U-235	2.0E-14	1.0E-06						2.0E-20								Y
				U-238	2.0E-12	1.0E-06						2.0E-18								Y
231	1945D	Room Air	Metallographic analysis	U-234	1.9E-10	1.0E-06	NA	NA	NA	None	1	1.9E-16	1167	ENE	2.2E-13	430	SSW	1.7E-12	2	Y
				U-235	2.0E-11	1.0E-06						2.0E-17								Y
				U-238	2.0E-09	1.0E-06						2.0E-15								Y
231	1945E	Room Air	Wet grinding/polishing	U-234	1.9E-07	1.0E-03	NA	NA	NA	None	1	1.9E-10	1167	ENE	2.2E-07	430	SSW	1.7E-06	2	Y
				U-235	2.0E-08	1.0E-03						2.0E-11								Y
				U-238	2.0E-06	1.0E-03						2.0E-09								Y
231	1945A	FHE-42	Metal cutting	U-238	3.0E-04	1.0E-06	8.5	0.46	12.8	HEPA	0.01	3.0E-12	1167	ENE	1.3E-08	430	SSW	2.0E-07	1	Y
				U-235	3.0E-06	1.0E-06						3.0E-14								Y
				U-234	2.0E-05	1.0E-06						2.0E-13								Y
				U-236	1.0E-06	1.0E-06						1.0E-11								
				U-235	2.3E-06	1.0E-03						2.3E-13								
				U-234	1.7E-07	1.0E-03						1.7E-12								

Attachment 1 - 1998 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclide	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 meters Site-Wide Dose Assessment: Distance to MEI (m)	Direction to MEI	ICE (percent)	0.1 meters Maximum Assessment: Distance to MEI (m)*	Direction to MEI	Unabated ICE (percent)	Source Category	Below App. E Quantity
231	2034	FHE-28	Lapping/polishing/etching	U-234	3.7E-07	1.0E-03	12.0	0.35	1.7	None	1	3.7E-10	1107	ENE	2.2E-07	548	SW	7.8E-07	2	Y
				U-235	6.1E-08	1.0E-03						6.1E-11								Y
				U-238	4.0E-08	1.0E-03						4.0E-08								Y
Building 235 is part of the Chemistry and Materials Science Directorate. Operations in the facility include examination of material structure, surface, and substructure, precision cutting, ion implanting, and metallurgical studies.																				
Most of the depleted uranium in this building is from ion chemical/physical studies; some is used for ion beam implantation experiments. Chemical characterization studies take place in rooms 1100, 1234, and 1236.																				
Up to 500 grams each of depleted uranium and thorium might be present in each of these rooms.																				
235	1131	FHE-2	Metallographic sample preparation	U-234	1.8E-04	1.0E-05	8.2	0.31	12.9	None	1	1.8E-10	1065	ENE	2.7E-08	556	SW	7.4E-08	2	Y
				U-235	7.9E-06	1.0E-05						7.9E-12								Y
				U-238	1.7E-04	1.0E-05						1.7E-10								Y
235	1133	Room Air	Microstructure examination	U-234	5.3E-06	1.0E-04	NA	NA	NA	None	1	5.3E-12	1065	ENE	1.3E-09	556	SW	8.5E-09	2	Y
				U-235	2.3E-07	1.0E-04						2.3E-13								Y
				U-238	5.0E-06	1.0E-04						5.0E-12								Y
235	1135	FHE-1001/HD-13	Sample preparation	U-234	2.1E-07	1.0E-03	9.8	2.30	2.4	HEPA	0.01	2.1E-15	1065	ENE	1.0E-10	487	SSW	1.0E-11	1	Y
				U-235	2.0E-09	1.0E-03						2.0E-17								Y
				U-238	2.0E-08	1.0E-03						2.0E-16								Y
235	1224	FHE-1001/HD-21	Sputter coating	U-234	1.7E-05	1.0E-05	9.8	2.30	2.4	HEPA	0.01	1.7E-15	1065	ENE	1.4E-10	556	SW	3.1E-09	2	Y
				U-235	2.4E-08	1.0E-05						2.4E-14								Y
				U-238	1.8E-04	1.0E-05						1.8E-12								Y
235	1226	FHE-1001/HD-22	Target cleaning	U-234	1.7E-05	1.0E-05	9.8	2.30	2.4	HEPA	0.01	1.7E-15	1065	ENE	1.4E-10	556	SW	3.1E-09	2	Y
				U-235	2.4E-08	1.0E-05						2.4E-14								Y
				U-238	1.8E-04	1.0E-05						1.8E-12								Y
Building 241 is administered by the Chemistry and Material Sciences Directorate for material preparation research and testing. Radiologic emissions result from contamination from past operations that have been discontinued.																				
241	1440	FGBE-45	Oxidation of uranium	U-238	1.0E-09	1.0E-03	12.8	0.30	9.8	HEPA	0.01	1.0E-19	1140	E	4.2E-15	581	SW	1.0E-12	2	Y
241	1620	Room Air	X-ray diffraction analysis	U-238	9.0E-11	1.0E-03	NA	NA	NA	None	1	9.0E-14	1140	E	4.2E-12	697	W	3.6E-11	2	Y
241	1622	Room Air	X-ray diffraction analysis	U-238	2.0E-08	1.0E-03	NA	NA	NA	None	1	2.0E-14	1140	E	1.4E-12	697	W	1.2E-11	2	Y
241	1639	FGBE-9 & 10	Ceramic waste form research	U-238	6.0E-08	1.0E-03	12.2	0.40	1.6	HEPA	0.01	6.0E-13	1140	E	2.7E-10	581	SSW	9.2E-09	1	Y
Building 251, the Heavy Element Facility, is managed by the Physics and Space Technology Directorate for the Institution as a non-operational facility in which transuranic isotopes are stored until they can be disposed.																				
One area of the facility has been "hardened" to resist damage from earthquakes. Room exhausts from the hardened area are double HEPA filtered; glove box exhausts are triple HEPA filtered.																				
Exhausts from the hardened area are continuously monitored by alpha alarm detectors (CAMs). Exhausts from the unhardened area, also HEPA filtered, are continuously sampled by simple filter systems.																				
*Air exhausts of the Building 251 hardened area are required to have continuous monitoring; measured emissions, rather than the inventory approach, are used to determine annual emissions.																				
**Because monitoring takes place after HEPA filtration, an unabated ICE cannot be determined (see discussion on page 41.)																				
***Stack emissions have been combined as permitted by the EPA/DOE Memorandum of Understanding.																				
	Unhardened Area***																			
251	1150	FFE-15	Contaminated enclosure	Gross Alpha	*	NA	4.3	0.31	7.6	HEPA	0.01	4.7E-07	1156	E	7.7E-06	**	**	**	3	N/A
	1301	FHE-16	Welding	Gross Beta			4.3	0.36	6.0	HEPA	0.01	4.8E-06								
	1310	FHE-18	Hoods removed				4.3	0.31	9.1	HEPA	0.01									
	Unhardened Area***																			
251	1003	FHE-8	General Chemistry	Gross Alpha	*	NA	4.3	0.25	8.6	Double HEPA	0.0001	6.0E+00	1156	E	8.0E+06	**	**	**	3	N/A
	1003	FHE-4		Gross Beta			4.3	0.27	4.2			6.0E+00								
	1108	FFE-7					5.5	0.33	1.1											
	1117	FFE-6					4.3	0.31	7.6	HEPA										
	1117	FGBE-21,22,23,24	Glove boxes removed CY96				5.5	0.11	7.6											
	1117	FGBE-25,26	Glove boxes removed CY96				5.5	0.10	12.8											
	1142	FHE-9					4.3	0.37	4.1											
	1143	FHE-6					4.3	0.26	9.1											
	1142	FHE-10					4.3	0.22	18.7											
	1156	FGBE-33,34	Material removed CY98				5.0	0.15	13.8											
	1165	FFE-14					4.3	0.34	1.0											
	1166	FGBE-31,32					5.5	0.07	0.1											
	1211	FHE-5	Material removed CY96				5.4	0.26	8.0											
	1211	FHE-7					5.4	0.22	4.3											
	1212	FGBE-15,16					5.5	0.10	8.0											
	1219	FGBE-37,38	Out of Service				5.5	0.76	0.8											
	1232	FHE-38,39					7.2	0.15	5.1											
	1234	FFE-9					4.3	0.19	14.7											
	1235	FFE-12					4.3	0.25	7.8											
	1236	FGBE-29,30					5.5	0.13	7.1											

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Building	Room/Area	Stack ID	Operation	Radionuclide	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Device(s)	Control Device Abatement Factor	Estimated Annual Emissions (Ci)	10 mrem/yr Site-Wide Dose Requirement: Distance to maxdl (m)	Direction to maxdl	MDE (mrem)	0.1 mrem/yr Maximum Requirement: Distance to MEI (m)	Direction to MEI	Unabated MDE (mrem)	Source Category	Below App. E Quantity
251 (cont.)	1319	FHE-14	Hood removal				4.3	0.31	9.1											
	1331	FFE-01					4.3	0.34	8.1											
	1363	FGBE-40,50					4.3	0.15	51.2											
	1368	FHE-12					4.3	0.34	8.1											
	1363	FHE-13					4.3	0.40	6.3											
	1364	FFE-05					4.3	0.34	8.1											
	2128	FFE-06					4.3	1.00	1.0											
	1314, 1364	FGBE-44,49	Glove boxes removed CY96				10.3	0.15	56.3											
	Hot cells	FGBE-40,41					5.5	0.23	6.8											
	Hot cells	FGBE-42,45					5.5	0.36	12.7											
	Mezzanine	FFE-04					4.3	0.65	2.7											
	Hemp	FFE-10					4.5	0.29	6.0											
251	Hardened Area	FGBE-1000	Transuranic Research	Gross alpha	*	NA	7.6	0.30	4.8	Triple HEPA	0.000001	0.0E+00	1100	S	0.0E+00	**	**	**	3	N/A
	Room Exhaust 5	FGBE-6000		Gross beta			7.6	0.30	4.8			0.0E+00								
	Glove Boxes***	FFE-1000					7.6	0.90	11.7											
		FFE-2000					7.6	0.50	11.7											
Building 253 houses the Hanford Control Department, and the facility includes laboratories for the chemical analysis and counting of radioactive samples.																				
253	1722A	FHE-04	Liquid scintillation counting	H-3	2.0E-11	1.0E-03	7.0	0.30	6.8	None	1	2.0E-14	1116	E	3.7E-17	1079	NNE	1.0E-06	2	Y
253	1728	FHE-05	HNO3 digestion of samples above 100 deg. C.	Gross Alpha	1.0E-13	1.0E-03	6.1	0.30	7.1	None	1	1.0E-16	1116	E	3.0E-14	800	WSW	5.0E-04	2	Y
				Gross Beta	2.1E-13	1.0E-03						2.1E-16								Y
				Th-230	1.0E-13	1.0E-03						1.0E-16								Y
				Cs-137	8.0E-14	1.0E-03						8.0E-17								Y
253	1734	Room Air	Distillation of spikes and cover samples	H-3	8.0E-10	1.0E-03	NA	NA	NA	None	1	8.0E-13	1116	E	6.3E-15	736	W	4.7E-12	2	Y
				Pu-238	2.0E-12	1.0E-03						2.0E-15								Y
				Sr-90	1.3E-11	1.0E-03						1.3E-14								Y
253	1734A	FGBE-140	Glove cell samples	Pu-238	2.7E-10	1.0E-03	6.1	0.10	23.6	HEPA	0.01	2.7E-13	1116	E	4.2E-16	1079	NNE	1.1E-13	2	Y
				Sr-90	4.0E-10	1.0E-03						4.0E-13								Y
253	1734B	FHE-2	Samples and standards plated and flamed	Cs-137	1.7E-11	1.0E-03	6.4	0.30	8.7	None	1	1.7E-14	1116	E	2.1E-15	1079	NNE	5.0E-12	2	Y
				Th-230	2.2E-12	1.0E-03						2.2E-15								Y
				Pu-239	1.3E-11	1.0E-03						1.3E-14								Y
				Sr-90	1.7E-12	1.0E-03						1.7E-15								Y
				Y-90	7.0E-13	1.0E-03						7.0E-16								Y
				Np-237	6.4E-12	1.0E-03						6.4E-15								Y
				H-3	4.3E-12	1.0E-03						4.3E-15								Y
253	1734C	FHE-4	Quality control sample aliquoting	H-3	2.2E-14	1.0E-03	6.4	0.30	7.2	None	1	2.2E-17	1116	E	1.9E-18	1079	NNE	5.0E-13	2	Y
				Np-237	3.0E-13	1.0E-03						3.0E-16								Y
				Sr-90	2.5E-12	1.0E-03						2.5E-15								Y
				Y-90	2.0E-12	1.0E-03						2.0E-15								Y
				Cs-137	3.7E-12	1.0E-03						3.7E-15								Y
				Th-230	4.0E-13	1.0E-03						4.0E-16								Y
				Pu-239	7.0E-13	1.0E-03						7.0E-16								Y
253	1734D	FHE-11	Acid digestion for gross alpha/beta	H-3	6.0E-09	1.0E-03	10.4	0.30	12.2	None	1	6.0E-12	1116	E	7.7E-13	1079	NNE	2.0E-11	2	Y
				Pu-239	3.3E-11	1.0E-03						3.3E-14								Y
				Sr-90	2.0E-14	1.0E-03						2.0E-17								Y
				Y-90	2.0E-13	1.0E-03						2.0E-16								Y
				Np-237	3.1E-12	1.0E-03						3.1E-15								Y
253	1906	Room Air	Sample preparation for liquid scintillation counting	H-3	9.0E-09	1.0E-03	NA	NA	NA	None	1	9.0E-12	1116	E	4.0E-15	736	W	2.0E-14	2	Y
253	1907	FHE-10	Analysis of soils for radionuclides	H-3	1.3E-10	1.0E-03	2.1	0.37	5.5	None	1	1.3E-13	1116	E	8.3E-17	800	WSW	2.0E-15	2	Y
				U-234	8.3E-17	1.0E-03						8.3E-20								Y
				U-235	3.7E-18	1.0E-03						3.7E-21								Y
				U-238	7.0E-17	1.0E-03						7.0E-20								Y
253	1913	Room Air	Analysis of radon daughter samples	Po-214	7.0E-07	1.0E-03	NA	NA	NA	None	1	7.0E-10	1116	E	5.3E-10	736	W	4.0E-09	2	N/A
				Pb-214	7.0E-07	1.0E-03						7.0E-10								Y
				Bi-214	7.0E-07	1.0E-03						7.0E-10								Y
				Rn-220	4.0E-09	1.0E-03						4.0E-12								
253	1914	FEY-1	Aerosol attachment to radon daughter products	Rn-220	3.0E-08	1.0E-03	9.5	0.21	13.7	4 stage HEPA	0.00009091	3.3E-17	1116	E	2.5E-18	1079	NNE	6.0E-08	2	Y

Attachment 1 - 1996 LLNL NESHAPs Annual Report Spreadsheet

Building	Room/Area	Stack ID	Operation	Radionuclides	Annual Inventory with Potential for Release (Ci)	Physical State Factor	Stack Height (m)	Stack Diameter (m)	Stack Velocity (m/s)	Control Devices	Control Device Adjustment Factor	Estimated Annual Emissions (Ci)	10 meters Site-Wide Dose Assessment: Distance to SWMB (m)	Direction to SWMB	ICE (mrem)	0.1 meters Maximum Receptor: Distance to MEI (m)	Direction to MEI	Unabated ICE (mrem)	Source Category	Sulfur Act. E Controller
253	H914A	BLV-1	Annual attachment to radon daughter products	Po-218	7.8E-06	1.0E+00	6.4	0.46	3.3	HEPA	0.01	7.8E-07	1116	E	7.8E-10	736	W	2.6E-07	2	N/A
				Pb-214	7.8E-06	1.0E+00						7.8E-07				840	WNW	2.6E-07		Y
				Bi-214	7.8E-06	1.0E+00						7.8E-07								Y
Building 254 is run by Hazards Control for the purpose of conducting bioassays and providing analytical services.																				
254	105	Room Air	Analysis of urine for radionuclides	U-235	6.8E-17	1.0E-03	NA	NA	NA	None	1	6.8E-20	1052	E	1.1E-17	817	W	4.6E-17	2	Y
				U-236	2.6E-19	1.0E-03						2.6E-21								Y
				U-234	6.8E-17	1.0E-03						6.8E-20								Y
254	109	FHE-5	Analysis of urine for radionuclides	U-236	1.3E-14	1.0E-03	6.0	0.30	6.3	None	1	1.3E-16	1033	E	1.0E-17	1079	NNE	3.7E-17	2	Y
				U-235	5.3E-16	1.0E-03						5.3E-21								Y
				U-234	1.4E-15	1.0E-03						1.4E-15								Y
254	113	FHE-2	Analysis of urine for radionuclides	Am-243	1.1E-13	1.0E-03	6.0	0.30	6.3	None	1	1.1E-16	1035	E	2.0E-13	1079	NNE	6.0E-13	2	Y
				Pu-242	1.4E-12	1.0E-03						1.4E-15								Y
				Pu-239	2.3E-13	1.0E-03						2.3E-16								Y
254	113A	FHE-9	Analysis of urine for radionuclides	Am-241	8.2E-14	1.0E-03	6.0	0.30	6.3	None	1	8.0E-17	1032	E	6.0E-12	1079	NNE	1.4E-11	2	Y
				Am-243	2.4E-12	1.0E-03						2.4E-15								Y
				Cm-244	8.1E-15	1.0E-03						8.1E-18								Y
				Np-237	8.5E-15	1.0E-03						8.5E-18								Y
				Th-230	8.4E-12	1.0E-03						8.4E-15								Y
				Cf-252	8.4E-12	1.0E-03						8.4E-15								Y
				U-233	2.9E-14	1.0E-03						2.9E-17								Y
				U-234	1.1E-12	1.0E-03						1.1E-15								Y
				U-235	2.9E-14	1.0E-03						2.9E-17								Y
				U-236	8.8E-12	1.0E-03						8.8E-15								Y
				U-238	8.8E-12	1.0E-03						8.8E-15								Y
254	113B	FHE-4	Analysis of urine for radionuclides	P-32	5.0E-12	1.0E-03	6.0	0.30	6.3	None	1	5.0E-15	1032	E	9.7E-13	1079	NNE	2.1E-12	2	Y
				S-35	1.1E-13	1.0E-03						1.1E-16								Y
				C-14	3.3E-11	1.0E-03						3.3E-14								Y
				P-33	1.1E-09	1.0E-03						1.1E-12								Y
				I-125	1.7E-10	1.0E-03						1.7E-13								Y
				H-3	1.2E-10	1.0E-03						1.2E-13								Y
				Sr-90	2.7E-10	1.0E-03						2.7E-13								Y
				Y-90	2.7E-10	1.0E-03						2.7E-13								Y
Building 256 is operated by Hazards Control and houses a radiation calibration and standards laboratory. Many operations involve the use of sealed sources.																				
256	105	FHE-4	Analysis of urine for radionuclides	Am-241	9.0E-14	1.0E-03	6.0	0.30	6.1	None	1	9.0E-17	1034	E	6.4E-11	836	WNW	2.3E-10	2	Y
				Am-243	2.5E-12	1.0E-03						2.5E-15								Y
				C-14	3.3E-11	1.0E-03						3.3E-14								Y
				Cf-252	8.4E-12	1.0E-03						8.4E-15								Y
				Cm-243	9.1E-15	1.0E-03						9.1E-18								Y
				I-125	1.7E-10	1.0E-03						1.7E-13								Y
				Np-237	1.1E-10	1.0E-03						1.1E-13								Y
				Np-239	1.1E-10	1.0E-03						1.1E-13								Y
				P-32	2.0E-09	1.0E-03						2.0E-12								Y
				Po-210	2.3E-13	1.0E-03						2.3E-16								Y
				Pu-242	1.4E-12	1.0E-03						1.4E-15								Y
				S-35	1.2E-10	1.0E-03						1.2E-13								Y
				Sr-90	4.9E-14	1.0E-03						4.9E-17								Y
				Th-230	8.4E-12	1.0E-03						8.4E-15								Y
				U-233	2.9E-14	1.0E-03						2.9E-17								Y
				U-234	1.1E-12	1.0E-03						1.1E-15								Y
				U-235	2.9E-14	1.0E-03						2.9E-17								Y
				U-236	8.7E-10	1.0E-03						8.7E-13								Y
				U-238	2.7E-15	1.0E-03						2.7E-18								Y
				Y-90	4.9E-14	1.0E-03						4.9E-17								Y
256	180	FHE-6	H-3 gas monitor calibrations	H-3	2.5E-02	1.0E+00	6.1	0.31	6.3	None	1	2.5E-05	1058	E	1.0E-08	1130	NNE	3.3E-08	2	Y
Building 281 is part of the Chemistry and Materials Science Directorate. In rooms 1311 and 1318, there are a number of sources, both as solids and in solution, which are kept and used in glove boxes. There are HEPA filters between the glove boxes and the vent stack. Room 1323 is used for collection of Nuclear Test Site groundwater samples. These samples contain some tritiated water.																				
281	1164	FHE-22	Solution chemistry of the actinides	Pu-242	3.7E-07	1.0E-03	6.7	0.30	7.1	Double HEPA	0.0001	3.7E-14	1032	NE	4.1E-12	579	NNE	9.2E-07	3	Y
				Am-241	3.7E-07	1.0E-03						3.7E-14								Y

Attachment 2. Surrogate Radionuclides List

Although CAP88-PC supports calculations for many radionuclides, there are some in use at LLNL that are not included in CAP88-PC. Consequently, this list of surrogate radionuclides has been developed to account for the contribution of those radionuclides.

Table 2-1. List of surrogate radionuclides.

Radio-nuclide	Half-life	Lung Class[a]	ALI (inh), µCi	DAC, µCi/cm³	Surrogate	Correction Factor[b]
^{108m}Ag	127 y	Y	20	1×10^{-8}	^{60}Co	
^{207}Bi	38 y	W	400	1×10^{-7}	^{214}Bi	
^{45}Ca	163 d	W	800	4×10^{-7}	^{90}Sr	
^{109}Cd	464 d	D	40	1×10^{-8}	^{60}Co	
^{249}Cf	351 y	Y	0.01	4×10^{-12}	^{241}Am	
^{250}Cf	13.1 y	W	0.009	4×10^{-12}	^{241}Am	
^{36}Cl	3.01×10^{5} y	W	200	1×10^{-7}	^{137}Cs	
^{254}Es	276 d	W	0.07	3×10^{-11}	^{239}Pu	
^{149}Eu	93.1 d	W	3000	1×10^{-6}	^{156}Eu	
^{148}Gd	93 y	D	0.008	3×10^{-12}	^{140}La	1×10^{5}
^{185}Os	94 d	D	500	2×10^{-7}	^{99}Mo	
^{33}P	25.4 d	D	8000	4×10^{-6}	^{32}P	
^{184}Re	38.0 d	W	1000	6×10^{-7}	^{99}Mo	
^{75}Se	120 d	W	600	3×10^{-7}	^{32}P	
^{85}Sr	64.8 d	Y	2000	6×10^{-7}	^{90}Sr	
^{182}Ta	115 d	Y	100	6×10^{-8}	^{99}Mo	
^{157}Tb	150 y	W	300	1×10^{-7}	^{140}La	
^{158}Tb	150 y	W	20	8×10^{-9}	^{140}La	50
^{204}Tl	3.78 y	D	2000	9×10^{-7}	^{214}Pb	
^{168}Tm[c]	85 d	W	2000	8×10^{-7}	^{140}La	
^{171}Tm	1.92 y	W	300	1×10^{-7}	^{140}La	5
^{88}Y	1.06.64 d	Y	200	1×10^{-7}	^{90}Y	

a D = days, W = weeks, Y = years.

b The annual inventory is multiplied by the correction factor, and a resulting surrogate equivalency is used for the modeling calculation.

Source: Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion and Ingestion, Federal Guidance Report No. 11, EPA-520/1-88-020, U.S. Environmental Protection Agency, 1988.