LLNL NESHAPs 1993 Annual Report

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Table of Contents

SYNOPSIS.....	1
SECTION I. Facilities Information.....	1
Site Description	1
Livermore site.....	1
Site 300.....	4
Source Description.....	6
SECTION II. Air Emission Data.....	7
Sources.....	7
Effective Dose Equivalent (EDE) Calculations.....	7
Spreadsheet Interpretation Guidance	
(Attachment 1)	9
SECTION III. Dose Assessment.....	13
Description of Dose Model.....	13
Summary of Model Input Parameters	14
Compliance Assessment	16
SECTION IV. Additional Information.....	16
Construction and Modifications.....	16
Unplanned Releases.....	17
Diffuse Source Dose Assessments.....	17
Livermore Site Diffuse Sources.....	17
Building 292.....	17
Building 331.....	18
Building 514.....	18
Building 612 Yard	18
Southeast Quadrant	19
Site 300 Diffuse Sources.....	19
Pit 7 Complex.....	20
Well 8 Spring.....	20
Building 802.....	20
Building 850.....	20
Building 851.....	21
Resuspension of Depleted Uranium at Site 300	21
Total Dose Estimate and Comparison with Previous	
Year's Data	22
SECTION V. Certification	23
SECTION VI. Supplemental Information.....	24
Collective Effective Dose Equivalent.....	24
Compliance with 40 CFR 61 Subpart H (61.93)	24
Status of compliance with 40 CFR 61 Subpart Q-	
National Emission Standards for Radon Emissions	
From Department of Energy Facilities.....	25

Status of compliance with 40 CFR 61 Subpart T- National Emission Standards for Radon Emissions From the Disposal of Uranium Mill Tailings	25
Information on Radon-220 and Radon-222 Emissions	25
NESHAPs Continuous-Monitoring Requirements	26
Upgrades to Existing Sampling Systems	26
Site Periodic Confirmatory Measurements	27
Continuous Monitoring	27
Annual Effluent Sampling	27
General Surveillance Monitoring	27
Site-Specific Surveillance Monitoring	27
Status of the NESHAPs QA Program	28
Quality Control (QC) on 1993 Inventory and Modeling	29

ATTACHMENTS

- Attachment 1: 1993 LLNL NESHAPs Annual Report Spreadsheet
- Attachment 2: Surrogate Radionuclides List

List of Figures and Tables

Figure 1.	Wind rose showing the average annual wind speed, frequency of occurrence, and direction at the Livermore Site, 1993.....	3
Figure 2.	Wind rose showing the average annual wind speed, frequency of occurrence, and direction at Site 300, 1993.....	5
Figure 3.	Comparison of EDEs for Building 331 Stack 1 calculated with 1990 and 1993 wind data. The maximally exposed member of the public is located in an east-northeast (ENE) direction.....	9
Figure 4.	Location of Site-Wide Maximally Exposed Individual (SW-MEI) at the Livermore site, 1993.....	12
Figure 5.	Location of Site-Wide Maximally Exposed Individual (SW-MEI) at Site 300, 1993.....	13
Table 1.	Wind rose for LLNL's Livermore site during 1993 at the 10-m level. Values are frequency of occurrence (in percent).	4
Table 2.	Wind rose for LLNL's Site 300 at the 10-m level for 1993. Values are frequency of occurrence (in percent).....	6

LAWRENCE LIVERMORE LABORATORY 1993 NESHAPs REPORT

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

SYNOPSIS

The standard defined in NESHAPs 40 CFR Part 61.92 limits the emission of radionuclides to the ambient air from DOE facilities to those that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 mrem. The EDEs to the site-wide maximally exposed individual member of the public from Lawrence Livermore National Laboratory (LLNL) operations in 1993 were as follows: Livermore site: 0.066 mrem (0.66 μ Sv) (61% from stack emissions, 39% from diffuse source emissions); Site 300: 0.037 mrem (0.37 μ Sv) (30% due to emissions from explosives experiments, 70% from diffuse source emissions).

In August 1993, DOE and EPA signed a Federal Facility Compliance Agreement (FFCA) which established a schedule of work for LLNL to perform to demonstrate compliance with NESHAPs, 40 CFR Part 61, Subpart H. The progress in LLNL's NESHAPs program—evaluations of all emission points for the Livermore site and Site 300, evaluations of collective EDEs (population doses) for populations within 80 km of each site, status with regard to continuous monitoring requirements and periodic confirmatory measurements, improvements in the sampling and monitoring systems, and progress on a NESHAPs quality assurance program—is described in this annual report. In April 1994 the EPA notified DOE and LLNL that all requirements of the FFCA had been met, and that LLNL was in compliance with the NESHAPs regulations.

SECTION I. Facilities Information

Site Description

Lawrence Livermore National Laboratory (LLNL) is operated by the University of California for DOE. LLNL was established in 1952 to conduct weapons research and development. LLNL's current mission is to serve as a national resource in science and engineering, with a focus on national security, energy, the environment, biomedicine, economic competitiveness, and science and mathematics education. LLNL's mission is dynamic and over the years has been broadened to meet new national needs.

Livermore site: LLNL's Livermore site occupies an area of 3.3 km² located about 64 km east of San Francisco, California, adjacent to the City of Livermore on the eastern

edge of Alameda County. More than 6 million people live within 80 km of LLNL; approximately 61,000 of them live in 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 its drainage outlet, which is located near the southwestern 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. (For 1993, 14.8°C.) Temperatures typically range from -5°C during some pre-dawn hours during the winter, to 35°C on a few summer afternoons. The annual wind rose for the Livermore site is displayed in Figure 1 with supporting data shown in Table 1. Although winds are variable, the prevailing wind direction is from the southwest, especially during the summer. However, the wind often blows from the northeast, usually during the winter. Most precipitation occurs as rain between October and April with very little rainfall during the summer months. In 1993, the Livermore site received 402 mm of precipitation.

Figure 1. Wind rose showing the average annual wind speed, frequency of occurrence, and direction at the Livermore Site, 1993.

Table 1. Wind rose for LLNL's Livermore site during 1993 at the 10-m level. Values are frequency of occurrence (in percent).

Direction	Wind Speed (m/s)					Total
	0.0-0.4	0.5-2.9	3.0-4.9	5.0-6.9	≥7.0	
NNE	0.9	2.6	2.2	0.6	0.2	6.4
NE	0.9	4.3	2.4	0.1	0.0	7.7
ENE	0.9	3.1	0.1	0.0	0.0	4.0
E	0.9	2.5	0.0	0.0	0.0	3.3
ESE	0.9	2.5	0.0	0.0	0.0	3.4
SE	0.9	1.8	0.0	0.0	0.0	2.7
SSE	0.9	1.7	0.1	0.0	0.0	2.7
S	0.9	4.9	0.8	0.2	0.2	6.9
SSW	0.9	7.2	1.5	0.5	0.3	10.3
SW	0.9	7.1	6.2	2.5	0.3	17.0
WSW	0.9	7.0	4.4	1.1	0.1	13.5
W	0.9	5.0	5.3	1.1	0.0	12.3
WNW	0.9	1.9	0.6	0.1	0.0	3.5
NW	0.9	1.3	0.0	0.0	0.0	2.2
NNW	0.9	1.1	0.2	0.0	0.0	2.2
N	0.9	0.8	0.1	0.0	0.0	1.9
Total	13.7	54.6	24.1	6.5	1.0	100.0

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 area of 30.3 km². It is close to two other explosive testing facilities operated by Physics International and SRI International. A State of California vehicular recreation area is located nearby, and wind turbine generators line the surrounding hills. The remainder of the surrounding area is in agricultural use, primarily grazing for cattle and sheep. The nearest residential area is the town of Tracy (population 40,000), 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 Livermore site. The average annual temperature was 16.8°C in 1993. The annual wind rose is presented in Figure 2 with supporting data shown in Table 2. 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 315 mm of precipitation during 1993.

Table 2. Wind rose for LLNL's Site 300 at the 10-m level for 1993.
Values are frequency of occurrence (in percent).

Direction	Wind Speed (m/s)					Total
	0.0-0.4	0.5-4.9	5.0-6.9	7.0-10.9	≥11.0	
NNE	0.1	1.3	0.1	0.0	0.0	1.5
NE	0.1	2.5	0.0	0.0	0.0	2.6
ENE	0.1	1.6	0.0	0.0	0.0	1.7
E	0.1	2.0	0.0	0.0	0.0	2.2
ESE	0.1	1.7	0.2	0.2	0.0	2.2
SE	0.1	2.6	0.4	0.4	0.0	3.5
SSE	0.1	2.5	0.1	0.1	0.0	2.9
S	0.1	4.1	0.8	0.4	0.1	5.5
SSW	0.1	2.0	0.2	0.3	0.0	2.7
SW	0.1	2.2	1.0	1.6	0.5	5.5
WSW	0.1	3.6	5.6	15.3	3.3	27.9
W	0.1	4.8	3.4	1.4	0.0	9.8
WNW	0.1	3.8	1.3	0.3	0.0	5.6
NW	0.1	6.3	2.0	1.4	0.1	9.8
NNW	0.1	5.6	3.8	2.4	0.6	12.5
N	0.1	2.0	1.5	0.4	0.1	4.1
Total	1.8	48.6	20.5	24.3	4.8	100.0

Source Description

A wide variety of radioisotopes are used at LLNL, including transuranics, biomedical tracers, tritium, mixed fission products, and others, for research purposes. Radioisotope handling procedures and work enclosures are determined for each project, depending on the isotope, the quantity being used, and the type 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.

The potential emitted radioisotopes from LLNL facilities for 1993 include:

H-3	N-13	C-14	O-15	Na-22	P-32	S-35	Cl-36
Sc-46	Mn-54	Co-57	Co-58	Fe-59	Co-60	Ni-63	Zn-65
Rb-83	Sr-85	Nb-95	Zr-95	Mo-99	Tc-99	Tc-99m	Ru-103
Sb-125	Cs-134	Cs-136	Cs-137	Ba-140	Ce-141	Ce-144	Eu-152
Eu-154	Eu-155	Eu-156	Tm-171	Bi-207	Ra-226	Th-228	Th-232
Pa-231	U-233	U-234	U-235	Pu-236	Np-237	Pu-234	Pu-238
U-238	Pu-239	Pu-240	Am-241	Am-242m	Pu-242	Am-243	Pu-244
Cm-246	Cm-248	Cf-252					

SECTION II. Air Emission Data

Sources

Information regarding radionuclide air emissions for each of 56 buildings containing Radioactive Materials Management Areas (RMMAs; where radionuclides are used or activation products occur) and 11 diffuse sources at LLNL is given in the enclosed spreadsheet (Attachment 1).

Detailed information is given for all point source emissions from 44 Livermore site buildings. Three Livermore site facilities containing RMMAs (Buildings 363, 365, and 366) are incorporated by reference because operations using radionuclides no longer occur in those buildings, or the radionuclides are encapsulated or sealed. One facility (Building 514) and four other Livermore site sources external to buildings are treated as diffuse area sources. Detailed information is given for experiments at three Site 300 explosive testing facilities (Buildings 801, 850, and 851 and their associated firing tables). Five other Site 300 facilities containing RMMAs (Buildings 804, 810A, 810B, 822B, and 854F) are included by reference because radionuclides are not in use in those buildings, are encapsulated, or are sealed. Six Site 300 sources, including the three firing tables where surface and subsurface contamination exists, are treated as diffuse area sources.

Effective Dose Equivalent (EDE) Calculations: In calendar year 1992, LLNL completed its evaluation of all facilities having a potential to discharge radionuclides to the atmosphere to show compliance with NESHAPs (40 CFR 61 Subpart H), and reported the results in last year's NESHAPs Annual Report. In general, 1990 wind data were used to ensure consistency with previous calculations, and the best available radionuclide inventory data at the time of the model runs, typically 1992 and 1991, were used. Annual dose was reported as whole-body effective dose equivalent (EDE) expressed in units of mrem (μSv) in compliance with the regulations.

For this year's report, covering activities in 1993, we updated the radionuclide inventories in our key facilities, defined as those that accounted for 90% of the 1992 Livermore site radiological dose to members of the public. Inventory forms, accompanied by detailed guidance for completing them, were sent to these facilities. The forms were completed by experimenters, certified by facility managers, and returned. We also updated our inventories for all Site 300 explosive experiments (the major source of off-site dose during 1992 at Site 300) and our assessments of source terms for known diffuse sources at both sites. New dose-assessment modeling runs for these three categories of facilities were conducted using 1993 meteorological data (wind, precipitation, and temperature) along with the 1993 radionuclide inventory or monitoring data.

We did not remodel the remaining, relatively insignificant, LLNL sources of radionuclide releases to air, unless a significant increase had occurred. Instead, we

used previously calculated doses for these sources in our 1993 assessment. Although 1992, and in some cases 1991, inventory data were used in the calculation of dose, many of the inventories have decreased in the interim, making such calculations conservative. In addition, inventories in LLNL facilities are limited by Facility Safety Procedures, and a review process is in place which allows the Environmental Protection Department to comment on or model any significant changes in operations and/or inventories (see Section IV). We plan to extend our inventory updating process to these other facilities, beginning in the fall of 1994.

The previously calculated doses from these small sources used meteorological data from previous years. To evaluate the impact of this practice on the 1993 assessment, its effects on calculated doses were examined. We consider the effect of different years' wind data to be negligible so long as they produce a change in the EDE that is small compared with 0.01 mrem (0.1 μ Sv). Such a screening criterion is consistent with the DOE guidance to report EDEs to two significant figures. Figure 3 compares doses resulting from tritium emissions from one of the two Building 331 stacks (one of the largest point-emission sources at the site). The inventories and stack parameters were held constant in a pair of CAP88-PC runs, while contrasting the results using wind data from 1990 and 1993. Calculated EDEs differed by only 7% in the direction of the site-wide maximally exposed individual member of the public (SW-MEI; defined below) using the different wind data. Examples involving other emission points gave similar differences in EDE. Given that the small sources, for which older wind data apply, account only for approximately 10% of the total off-site dose, a 7 to 10% wind-data-differences effect results in about a 1% difference in the calculated total off-site dose.

Figure 3: Comparison of EDEs for Building 331 Stack 1 calculated with 1990 and 1993 wind data. The maximally exposed member of the public is located in an east-northeast (ENE) direction.

Spreadsheet Interpretation Guidance (Attachment 1): The following information is shown for each listed emission point or stack:

- Building and room numbers
- Specific stack identification code
- Generalized facility operations
- Utilized radionuclides
- Estimated or measured annual emissions
- Control devices and efficiency (when utilized)
- Type of stack monitoring (when utilized)
- Physical stack parameters
- Distance to the site-wide maximally exposed individual (SW-MEI)
- Calculated EDE
- EDE category as explained below

In order to provide as much specific information as possible for each emission point, limited grouping or combining of emission points was performed.

The radionuclides shown in the spreadsheet are those found in the respective facilities. For Building 231, Room 1128 (a Materials Management vault that is used for receipt, shipment, and storage of sealed radioactive sources), the variety and turnover of radionuclides makes a listing of individual radionuclides impractical. This area is continuously monitored, and emissions are therefore directly determined.

Reported annual releases are based on inventory data and unabated EPA potential release fractions for unmonitored and non-continuously monitored sources, and on actual emission measurements for continuously monitored facilities. The continuously monitored facilities at LLNL are Buildings 175, 231-vault, 251, 331, 332, 419, 490, and 491. Many of the monitored facilities show zero emissions. These data are largely based on limit-of-sensitivity (LOS) results from the analysis of air filter samples. Use of zero values for LOS data in this case can be justified based on facility knowledge, the use of tested multiple-stage High Efficiency Particulate Air (HEPA) filters (see below) in all significant release pathways, and alpha-spectroscopy-based isotopic analyses of selected filters. These isotopic analyses demonstrate that detected activity on filters comes from naturally-occurring radionuclides, such as radon-daughters, e.g., polonium. Accordingly, given the level of HEPA filtration, it is likely that actual concentrations are closer to zero than they are to the LOS. Furthermore, even if the LOS values are substituted in screening dose calculations, a very conservative assumption, the total dose attributable to LLNL activities is not significantly affected.

Some emission points from unmonitored facilities also show zero emissions in the spreadsheet (Attachment 1). Radionuclide operations occurred in these areas during 1992, and hence they were reported in last year's report; however, no radionuclide operations took place during 1993 at these locations. We include the zero emission data for the sake of continuity. Similarly, emission points for which we reported zero emissions last year that continued to have zero emissions during 1993 were removed from the spreadsheet.

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 tested on a routine basis. The 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 a portion of Building 251.

The site-wide maximally exposed individual (SW-MEI) is defined as the hypothetical member of the public at a single location who receives the greatest

LLNL-induced EDE from all sources. At the Livermore site, the SW-MEI is located at the U.N.C.L.E. Credit Union, about 10 m outside the controlled eastern perimeter of the site, as shown in Figure 4. This location lies 948 m from the principal radionuclide source, the Tritium Facility (Building 331), in an east-northeast direction (the prevailing wind direction). Winds at the Livermore site in 1993 were more southerly than usual, as Figure 3 indicates, but the location of the SW-MEI did not change, because of the greater distance to reach a residence, school, or publicly-accessible business in the southerly direction.

At Site 300, the SW-MEI is located in an experimental area termed "Bunker 2" operated by Physics International. Bunker 2 lies about 300 m outside the east-central boundary of Site 300, as shown in Figure 5. This bunker is 2.38 km southeast of the principal firing table at Building 801. In Attachment 1, the distance to the respective SW-MEI is shown for each facility at each site.

The distance from the emission point to the SW-MEI as shown in the spreadsheet for some facilities may not be that associated with the presented EDE (refer to EDE Category 2, defined below). In these cases, the EDE is that calculated to the MEI for that individual source, in any direction, which may not be the SW-MEI. However, such a practice ensures that the stated EDE is conservative; the contribution of a given source to the EDE of the SW-MEI would actually be less than or equal to that stated.

We have classified LLNL facilities into five EDE categories: (1) Unmonitored or non-continuously monitored Livermore site facilities (buildings) which have at least one stack emission point with a potential for producing an EDE to the SW-MEI greater than 0.001 mrem/y (0.01 μ Sv/y); (2) Unmonitored or non-continuously monitored Livermore site facilities having no emission point with a potential for producing an EDE as large as 0.001 mrem/y (0.01 μ Sv/y) to the SW-MEI; (3) Continuously-monitored Livermore site facilities; (4) Site 300 explosives experiments; and (5) Diffuse sources at the Livermore site and Site 300.

The EDE category for each source is indicated by the number in the last column of the spreadsheet. Updated inventory or emission data were obtained for all Category 1, 3, 4, and 5 sources, which together accounted for 90% of the total Livermore site dose and all of the Site 300 dose in 1992. More than 50 new modeling runs were carried out using 1993 wind, precipitation, and annual-average temperature data. Buildings included in Category 1 are the Livermore site Buildings 151, 177, 194, and 222. The principal facilities in Category 3 are Buildings 175, 251, 331, and 490. The dominant contributor, by far, to Category 4 is the firing table associated with Building 801 at Site 300. The diffuse sources in Category 5, described more fully in Section IV below, are the waste treatment tanks in Building 514, the Building 612 Yard, soils exterior to Buildings 292 and 331, the southeast quadrant of the Livermore site, and several ground areas at Site 300. Category 2 facilities generally were not reinventoried or remodeled.

Figure 4. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at the Livermore site, 1993.

Figure 5. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at Site 300, 1993.

SECTION III. Dose Assessment

Description of Dose Model

Our estimates of individual and collective radiological doses to the public resulting from LLNL operations were obtained using the EPA-developed computer code CAP88-PC, available since April 1992. (Exceptions: a few of the calculations we report in EDE Category 2 were made with the AIRDOS-PC code, which is included in modified form as one of the subroutines in CAP88-PC.) The four principal pathways—internal exposures from inhalation of air and ingestion of foodstuffs and drinking water, and external exposures through irradiation from contaminated ground and immersion in contaminated air—are evaluated by CAP88-PC. The doses

are expressed as whole-body effective dose equivalents (EDEs), in units of mrem/y (1 mrem = 10 μ Sv). We report separate doses for the Livermore site and Site 300.

Three potential doses are emphasized: (1) The dose to the "site-wide maximally exposed individual member of the public," denoted as the SW-MEI, which combines the effects of all emission points, for evaluation under the 10 mrem/y standard; (2) the maximum dose to any member of the public, in any direction, due to each unabated emission point on the site for evaluation of the need to conduct continuous monitoring; and (3) the collective dose to the populations residing within 80 km of the two LLNL sites, adding the products of individual doses received times the number of people receiving them.

Summary of Model Input Parameters

Attachment 1 details the key identifiers and input parameters for the CAP88-PC (or AIRDOS-PC) model runs. These include building number; stack ID; isotope(s); emission rate in curies per year (1 Ci = 3.7×10^{10} Bq); and stack parameters, including height, diameter, and emission velocity.

All model runs used actual Livermore site and Site 300 meteorological data, collected from the respective on-site meteorological towers. Wind speed and direction are sampled every few seconds, temperature every minute; and all are averaged into quarter-hour increments, time-tagged, and computer-recorded. The data are converted into a CAP88-PC input wind file in accordance with EPA guidelines.

Model input data regarding local agricultural characteristics and land use are characterizations established by the EPA, and the particular designation selected can strongly influence the ingestion dose received by the neighboring population. We select the "local" agriculture option—the most conservative of the six possibilities—wherein we assume that all foodstuffs consumed by the exposed population are locally grown and maximally affected by radionuclide releases from emission points at the site.

Population distributions centered on the two LLNL sites were compiled from 1990 census data. Key population centers affected are the relatively nearby communities of Livermore and Tracy, and the more distant metropolitan areas of Oakland, San Francisco, and San Jose, as well as the San Joaquin Valley communities of Modesto and Stockton. Within the 80 km outer distance specified by the EPA, there are 6.3 million residents included for the Livermore site collective dose determination, and 5.4 million for Site 300.

Because the EPA-mandated models CAP88-PC and AIRDOS-PC do not contain all the radionuclides present at LLNL, it was necessary in a few cases to use surrogate radionuclides to estimate EDEs. Attachment 2 shows the surrogate radionuclide lists for AIRDOS-PC and CAP88-PC. In selecting the surrogates, we used the most

restrictive lung class (whether clearance from the lungs takes place in days, weeks, or years). When possible, we used a surrogate radionuclide with similar lung clearance class chemistry and similar values for "annual limits of intake via inhalation and derived air concentration," as specified in the EPA's Federal Guidance Report No. 11. CAP88-PC contains a library of about 265 radionuclides—substantially more than the AIRDOS-PC code. By rerunning calculations in CAP88-PC that were previously modeled with AIRDOS-PC, we have found that the use of surrogates in the calculations generally results in conservative estimates of EDEs.

The source term(s) from each emission point in the calculations was determined by one of two methods: For monitored sources, the continuous sampling data on curies released per unit time for each radionuclide were used directly. For unmonitored facilities, we relied on inventories, together with the EPA-specified fractions for potential release to air of materials in different physical states (solid, liquid, powder, or gas), in accordance with 40 CFR Part 61 Appendix D. We used the state-dependent release fraction to adjust (by multiplication) the total annual inventory to give the potential annual release to air. If the material is an unconfined gas, then the fraction 1.0 was used; for liquids and powders, 1.0×10^{-3} was used; and for solids, 1.0×10^{-6} was used. In addition, no credit was taken for radionuclide emission control devices such as stack filters; emissions were assumed to be unabated. Hence, where control devices were present, actual emissions, resultant exposures, and doses were much lower than the calculated doses we report. The use of actual monitoring data is much more direct, and presumably more accurate, than using assumptions based on inventory and release fractions.

Among the five EDE categories defined above, Category 4 (explosive tests using depleted uranium at Site 300) and Category 5 (diffuse sources at the two sites) required special attention.

During Site 300 explosives experiments, the device containing depleted uranium is placed on an open-air firing table and detonated. We have only limited data to characterize the initial state of the cloud of explosive decomposition products created by the detonation because properties of the cloud are not typically measured in the experiments. Empirical scaling laws can be used, however, to define the cloud using the radionuclide and explosive 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. We assume all of 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 justification 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.

EDE Category 5 is reserved for diffuse emissions, generally area sources external to buildings, as discussed in Section IV below.

Copies of individual model runs, including input parameters and resultant calculated doses, are on file in the Environmental Monitoring Section of the Environmental Protection Department at LLNL.

Compliance Assessment

The 1993 calculated EDE to the site-wide maximally exposed member of the public from Livermore site point sources was 0.040 mrem (0.40 μ Sv). Emissions from the two 30-meter stacks at the LLNL Tritium Facility (Building 331) accounted for 87.5% of this total, or 0.035 mrem (0.35 μ Sv). No other source at the Livermore site contributed as much as 10% to the total EDE from point source emissions.

The calculated EDE to the site-wide maximally exposed member of the public at Site 300 was calculated to be 0.011 mrem (0.11 μ Sv) from point source emissions. Virtually all the EDE resulted from Building 801 firing table emissions. Other Site 300 point source emissions did not result in significant dose contributions.

All LLNL EDE point source evaluations, made using EPA-mandated computer dispersion models, are well below the EPA standard, which limits the whole-body EDE to members of the public from DOE activities to 10 mrem/y (100 μ Sv/y). This indicates LLNL is in compliance with 40 CFR 61 Subpart H, (NESHAP) dose standards for DOE facilities.

SECTION IV. Additional Information

Construction and Modifications

No construction projects or modifications were completed for which approval to construct or modify was waived under 40 CFR 61.96. Only maintenance, repair, and replacement activities, as well as those considered normal or routine, were conducted during 1993. Proposed facilities and significantly modified operations are assessed for NESHAPs requirements during the National Environmental Policy Act (NEPA) process. Under NEPA, all proposed projects or actions that might involve NESHAPs issues or concerns—not just pertaining to radionuclides but to air toxics as well—are reviewed and evaluated. If the proposal includes operations that require a NESHAPs assessment, necessary modeling is conducted. If insufficient information is available for modeling at the time the NEPA documents are prepared, LLNL includes in the NEPA documents a statement that NESHAPs review, modeling, and monitoring requirements will be met. It is the responsibility

of the individual project proponent to supply the specific information required for any NESHAPs modeling, analysis, and review that must be completed before operations described in the document are initiated.

Unplanned Releases

There was one unplanned atmospheric radionuclide release at the Livermore site in 1993, and none from Site 300.

In September 1993, an analysis of gross alpha data from a continuous sampler for particulates located in a stack on the unhardened portion of Building 251 revealed a release to the atmosphere of ^{220}Rn (radon-daughters were detected). Subsequent investigation revealed that the release commenced in early June 1993, gradually rising to the trigger level at which it was discovered some three months later. The source of the release was a ^{228}Th experiment occurring in a glovebox connected to the atmosphere by the HEPA-filtered stack. Data and calculations evaluated the total release during the entire period to be 16 Ci (5.9×10^{11} Bq), with a resultant annual dose to the SW-MEI of 3×10^{-4} mrem (3×10^{-3} μSv). This unplanned release was the subject of a DOE Off-Normal Occurrence Report in September 1993. Corrective actions included clean-up and decontamination of the glove box and installation of a charcoal filter.

Diffuse Source Dose Assessments

Diffuse, or non-point, sources (EDE Category 5) are difficult to quantify. There are no EPA-mandated methods for measurement, although LLNL did review proposed future guidance received from the EPA during 1993. At this time, however, dose calculations associated with this type of source are left to the discretion of the DOE facility. We describe Livermore site and Site 300 diffuse sources separately below.

Livermore Site Diffuse Sources

The dose calculations from 1993 diffuse sources at the Livermore site required four different modeling approaches. Building 292 required a calculation of source term and the use of CAP88-PC; Building 331 and the Building 612 Yard needed facility personnel knowledge and environmental surveillance data to estimate emissions; Building 514 required inventory data and standard CAP88-PC modeling techniques; and in the Southeast Quadrant we used direct ambient air monitoring data to calculate the dose.

Building 292: Elevated tritium concentrations in soil moisture near Building 292 resulted from an historic leak in an underground retention tank. This contamination has resulted in diffuse tritium emissions from evaporation of soil moisture and transpiration from vegetation. Measurements and calculations determined that the transpiration of several pine trees accounted for the largest amount of tritium released to the atmosphere. The total annual emissions from

these pine trees were calculated based on estimated total leaf area (573 m²) and collective transpiration rate (1,380 liter/day), together with average measured concentrations of tritium in transpired water (annual mean of 15,000 pCi/liter or 556 Bq/liter), producing a 1993 emission of 7.5×10^{-3} Ci (2.8×10^8 Bq). The annual tritium release to the atmosphere stemming from other nearby local vegetation and evaporation of soil moisture as represented by generous upper-bound estimates. A high value for the measured tritium flux from the ground and vegetation near the tank is 0.26 μ Ci/m²/y (9.6×10^3 Bq/m²/y). Assuming 400 m² effective area, based on isoactivity contours, this gives an annual release of 1.0×10^{-4} Ci (3.7×10^6 Bq). The total tritium emissions from the Building 292 diffuse source were, therefore, determined to be 7.6×10^{-3} Ci (2.8×10^8 Bq) during 1993. The resultant 1993 EDE to the SW-MEI based on CAP88-PC modeling was 2.5×10^{-6} mrem (2.5×10^{-5} μ Sv).

Building 331: As the Tritium Facility (Building 331) undergoes decommissioning and decontamination, tritium-contaminated equipment slated for disposal is removed from the building, packaged in a waste accumulation area, and sent to Hazardous Waste Management Division (HWM) facilities. During 1993, outgassing from such waste processing released an estimated 3 Ci (1.1×10^{11} Bq) of tritium to the atmosphere outside of Building 331. The estimated releases were derived from measurements of surface contamination on the material, process and facility knowledge, and environmental surveillance measurements. It was further estimated that approximately half of the annual total was released during a six-week period in February and March of 1993, when elevated tritium levels were detected in both rain and air samples taken near the facility. These unexpected environmental tritium results were the subject of a DOE Off-Normal Occurrence Report in March 1994. The estimated 3 Ci (1.1×10^{11} Bq) release was modeled in CAP88-PC as a 1 m² area source dispersed by winds determined from actual meteorological data for the time period concerned, leading to a calculated 1993 dose to the SW-MEI of 3.8×10^{-3} mrem (3.8×10^{-2} μ Sv).

Building 514: Another potential source of diffuse emissions of a variety of radionuclides was HWM waste storage and treatment operations. Building 514 houses the HWM "tank farm," consisting of six 7,170-liter tanks with ancillary equipment such as pumps, mixers, probes, and a bulking station. The tanks are used to store and treat liquid and solid radioactive and/or mixed wastes. Treatment is performed on a batch basis. Chemicals and waste are added to the tanks to achieve the desired treatment objectives. A 1993 radionuclide inventory was conducted for the facility to determine the diffuse source term. CAP88-PC modeling gave a 1993 EDE to the SW-MEI of 8.2×10^{-4} mrem (8.2×10^{-3} μ Sv).

Building 612 Yard: The Building 612 Yard is a potential source of diffuse emissions of tritium. This area is dedicated to hazardous-waste, radioactive-waste, and mixed-waste management activities. The yard consists of several areas where waste containers are stacked outdoors. Many of these containers are not air tight and may outgas tritium. A surveillance air monitor has been placed in the Building 612 Yard to provide continuous measurements of tritium near this source. The mean annual

concentration of tritium in air for 1993 was 0.028 pCi/L (1.04×10^{-3} Bq/L). These data were used to calculate the total tritium emissions from the area, using a conservative approach that assumed the source to be concentrated 120 m south-southwest of the air sampler. With this assumption, CAP88-PC requires a diffuse source emission of 2.2 Ci/y (8.1×10^{10} Bq/y) to produce the concentrations measured at the air sampler. This source term produced a 1993 dose to the SW-MEI from the Building 612 Yard of 2.0×10^{-2} mrem (2.0×10^{-1} μ Sv).

Southeast Quadrant: The Southeast Quadrant of the Livermore site has elevated levels of ^{239}Pu in the surface soil and air (presumably from resuspension). A high-volume air-particulate sampler is located adjacent to the U.N.C.L.E. Credit Union (the location of the SW-MEI) to monitor the ^{239}Pu levels in this area. Monitoring data from this air sampler were used as a direct measurement of potential dose via the air pathway. A mean annual concentration of ^{239}Pu in air of 5.4×10^{-19} $\mu\text{Ci/mL}$ (2.0×10^{-14} Bq/mL) was used with the dose conversion factor for ^{239}Pu (0.342 mrem/pCi or 92.3 $\mu\text{Sv/Bq}$) and standard-man breathing rates to calculate the estimated 1993 dose of 1.5×10^{-3} mrem (1.5×10^{-2} μSv).

Site 300 Diffuse Sources

Diffuse sources at Site 300 involve tritium and uranium. In the course of 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. We have used information provided in the Final Site Wide Remedial Investigation Report (Webster-Scholten, Ed., 1994, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-AR-108131) in our diffuse source evaluations. In the course of the remedial investigation, the rate of intermediate 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. We discuss five diffuse tritium sources individually. Uranium, on the other hand, is not as well characterized, and data are confounded by the naturally occurring high concentrations of uranium in Site 300 soils (Gallegos *et al.*, Environmental Report for 1992, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-50027-92). We have treated diffuse uranium sources 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 rinsewater 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 of 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 incorporated into water molecules in subsurface moisture can evaporate to the atmosphere. The affected area is estimated at 18,000 m². 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 1.1 Ci (4.1×10^{10} Bq) for 1993. 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 prior to ground water sampling) in this area often contains elevated levels of tritium. The evaporation of this water to the atmosphere represents another component of the Pit 7 diffuse emission source term; it was estimated to contribute 4.2×10^{-4} Ci (1.6×10^7 Bq) during 1993. The 1993 calculated EDE to the SW-MEI from the combined tritium emissions at the Pit 7 Complex was 9.9×10^{-5} mrem (9.9×10^{-4} μ Sv).

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 limitless source of tritiated water for the time period in question. The affected area of the spring was estimated at 9.3 m², and the 1993 source term was estimated to be 2.4×10^{-3} Ci (8.9×10^7 Bq). The 1993 calculated EDE to the SW-MEI from tritium emissions at the Well 8 Spring was 2.5×10^{-7} mrem (2.5×10^{-6} μ Sv).

Building 802: Tritium in the subsurface soils in the vicinity of the Building 802 firing table may evaporate to the atmosphere. The affected area was estimated to be 900 m². 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 1993 tritium emissions from this source were estimated to be 6.9×10^{-4} Ci (2.6×10^7 Bq). The 1993 calculated EDE to the SW-MEI from tritium emissions at Building 802 was 1.1×10^{-7} mrem (1.1×10^{-6} μ Sv).

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 major 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 m². The tritium flux and tritium emission rate from subsurface soils to air were calculated as in the Building 802 case above. The 1993 tritium emissions from this source were estimated to be 1.4×10^{-1} Ci (5.2×10^9 Bq). The 1993 calculated EDE to the SW-MEI from tritium emissions at Building 850 was 1.5×10^{-5} mrem (1.5×10^{-4} μ Sv).

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 m². The tritium flux and tritium emission rate from subsurface soils to air were calculated as in the Building 802 case above. The 1993 tritium emissions from this source were estimated to be 4.0×10^{-4} Ci (1.5×10^7 Bq). The 1993 calculated EDE to the SW-MEI from tritium emissions at Building 850 was 4.5×10^{-8} mrem (4.5×10^{-7} μ Sv).

Resuspension of Depleted Uranium at Site 300: Like tritium, depleted uranium has been used as a component of explosive 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, we have evaluated the collective effects of surface soil uranium residuals on off-site doses.

Airborne particulate sampling of uranium isotopes was done near the firing tables (Buildings 801, 850 and 851) and other facilities. Samples were taken weekly from all eight on-site sampler locations and combined for analysis. The site-wide annual average airborne concentration of ²³⁸U (the principal radioisotope found in the air samples) was 7.15×10^{-11} g/m³. This included contributions from both naturally occurring uranium and uranium from the Site 300 tests; therefore, use of this concentration gives an upper-bound limit for airborne concentration due to resuspension of surface contamination from historic tests. Depleted uranium includes small fractions of ²³⁵U (0.2%) and ²³⁴U (0.0005%) and these isotopes are included in the dose calculation. The average concentration of uranium in air for the eight samplers was used to represent the concentration at the location of the SW-MEI. The resultant 1993 dose to the SW-MEI from inhalation of resuspended depleted uranium was thereby estimated to be 0.026 mrem (0.26 μ Sv).

Total Dose Estimate and Comparison with Previous Year's Data

For the Livermore site, the dose calculated for the SW-MEI from diffuse emissions in 1993 was 0.026 mrem (0.26 μ Sv). When point and diffuse sources were combined, the total annual dose was 0.066 mrem (0.66 μ Sv). Therefore, the relative contributions to the total were 39% from diffuse sources and 61% from point source emissions. Compared to data from previous years, the 1993 total EDE of 0.066 mrem (0.66 μ Sv) is slightly below the 1992 value of 0.079 mrem (0.79 μ Sv), and is well below the previously reported EDE values of 0.234 mrem (2.34 μ Sv) and 0.240 mrem (2.40 μ Sv) for 1991 and 1990, respectively.

The total dose to the Site 300 SW-MEI from Site 300 operations in 1993 was 0.037 mrem (0.37 μ Sv). "Point" source emissions from firing table explosive experiments accounted for 0.011 mrem (0.11 μ Sv), or 30%, of this total, while 0.026 mrem (0.26 μ Sv), or 70%, was contributed by a diffuse source representing resuspension of naturally occurring and LLNL-contributed uranium in surface soils throughout the site. Diffuse-source contributions to dose from tritium emissions were negligible. No diffuse emissions were reported at Site 300 for years prior to 1993, so comparisons with previous years can only be made for point source calculations. Comparing point source levels to calculations in previous years, the point source dose values for 1992, 1991, and 1990 were 0.021 mrem (0.21 μ Sv), 0.044 mrem (0.44 μ Sv), and 0.057 mrem (0.57 μ Sv), respectively. Apart from the diffuse source contribution, we see a monotonic decline from one year to the next.

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.

Name: W. E. Keheley
U.S. Department of Energy
Oakland Operations Office
1301 Clay Street, Room 700N
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Signature: _____ Date: _____
W. E. Keheley

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.

Name: Dennis K. Fisher
Associate Director
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Signature: Dennis K. Fisher Date: 6/10/99
Dennis K. Fisher

SECTION VI. Supplemental Information

Collective Effective Dose Equivalent

Population doses, or collective EDEs, for both LLNL sites were calculated out to a distance of 80 km in all directions from the site-centers using CAP88-PC with 1990 census population data. CAP88-PC evaluates the four principal exposure pathways: ingestion through food and water consumption, inhalation, air immersion, and irradiation by contaminated ground surface.

The collective effective dose equivalent (collective EDE) due to 1993 Livermore site operations was 0.98 person-rem (0.0098 person-Sv), of which 0.78 person-rem (0.0078 person-Sv), or 80%, was from point source emissions, and the remaining 20% from diffuse sources. This value is down from 1.7 person-rem (0.017 person-Sv) in 1992.

The corresponding collective EDE from Site 300 operations in 1993 was 6.9 person-rem (0.069 person-Sv), comprised of 4.6 person-rem (0.046 person-Sv), or 67%, due to point source emissions, and 2.3 person-rem (0.023 person-Sv) from diffuse source emissions. This total is down slightly from 7.1 person-rem (0.071 person-Sv) in 1992, despite the fact that diffuse emissions were not evaluated for 1992 and earlier years.

The larger value for Site 300 relative to the Livermore site in both years is traceable primarily to our highly conservative assumptions about the explosive experiments, especially regarding the fraction of radioactive material that is aerosolized and the height and trajectory of the explosive debris cloud. This conservative modeling methodology over-predicts the long-range dispersal of material in these experiments.

We note that the diffuse sources influence the dose to the SW-MEI more than they impact the population dose. The reason is their relatively less dynamic nature, originating low to the ground at low initial velocity. Stacks forcefully expel the effluent at considerable speed high above the ground, and the explosive experiments throw the effluent high into the air, allowing contaminants to more readily reach population centers downwind.

Compliance with 40 CFR 61 Subpart H (61.93)

Calculations of effective dose equivalents for all Livermore site and Site 300 facilities having the potential to release radionuclides to the atmosphere have been completed. Annual doses for actual total emissions (after abatement devices) of all facilities were found to be well below the 10 mrem (100 μ Sv) NESHAPs dose standard. Tritium accounted for almost 93% of the Livermore site calculated dose, while at Site 300 practically the entire calculated dose was due to the isotopes ^{238}U , ^{235}U , and ^{234}U , in depleted uranium.

Based on potential emissions without control devices, three facilities at the Livermore site (Buildings 331, 332, and the hardened portion of Building 251) will maintain continuous monitoring systems in compliance with NESHAPs requirements. Several other Livermore site facilities also have continuous monitoring systems; however, calculations using unabated potential emissions resulted in EDEs of less than 0.1 mrem/y ($1 \mu\text{Sv/y}$) for the emissions from each of these facilities. While this monitoring also will be continued, it is not required under NESHAPs. No other facilities at either LLNL site were found to require continuous monitoring systems.

In August 1993, EPA and DOE signed a Federal Facility Compliance Agreement (FFCA), the terms of which were under negotiation from 1991 to 1993. Quarterly reporting while LLNL was demonstrating its NESHAPs compliance was required. During 1993, LLNL produced two quarterly reports for EPA Region IX. However, at mid-year, LLNL stated it had completed its NESHAPs evaluation and concluded it had demonstrated NESHAPs compliance. EPA Region IX then rescinded the draft FFCA quarterly reporting requirement, pending its evaluation of LLNL's compliance status. EPA asked for, and received, additional data regarding stack monitoring systems. The EPA notified DOE and LLNL in April 1994 that all requirements of the FFCA had been met and that LLNL was now in compliance with the NESHAPs regulations.

Status of compliance with 40 CFR 61 Subpart O - 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

The majority of radon sources at LLNL occur naturally by emanation from the earth. Small emissions of ^{220}Rn from LLNL operations during 1993 were determined to be 16 Ci (5.9×10^{11} Bq) from a single unplanned release (see Section IV), resulting in a maximum EDE to the SW-MEI of 3×10^{-4} mrem ($3 \times 10^{-3} \mu\text{Sv}$). ^{222}Rn emissions from research experiments were estimated to be 59 μCi (2.2×10^6 Bq) with a corresponding EDE of 2×10^{-7} mrem ($2 \times 10^{-6} \mu\text{Sv}$) for 1993. These ^{222}Rn emissions constitute approximately one-millionth of that expected for naturally occurring ^{222}Rn emanation from the soil of the LLNL site. The doses from ^{220}Rn and ^{222}Rn from LLNL operations during 1993 did not exceed 0.1 mrem ($1 \mu\text{Sv}$) to the public.

NESHAPs Continuous-Monitoring Requirements

In past reporting we identified 17 emission points in three facilities (Buildings 251, 331, and 332) that will maintain continuous monitoring in accordance with 40 CFR 61.93(b). Continuous monitoring is maintained in Building 332 and the hardened area of Building 251 in lieu of a modeling or measurement effort to demonstrate the actual need for monitoring. The measured emissions in Building 331, where no emission control systems exist, result in annual EDEs less than 0.1 mrem for 1993; consequently, monitoring is no longer required, but will be maintained.

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 locations were identified that require continuous monitoring.

Upgrades to Existing Sampling Systems

We have made progress on upgrading existing sampling systems located in facilities that have been identified as requiring continuous monitoring of discharge points. These facilities are the hardened portion of the Heavy Element Facility (Building 251), the Tritium Facility (Building 331), and the Plutonium Facility (Building 332). The sampling systems in these facilities have been previously described in the NESHAPs June 1992 quarterly progress report to EPA Region IX. In our March 1993 quarterly progress report to EPA Region IX, we reported on operational changes made to the existing monitoring systems to ensure the extraction of representative samples. Although LLNL and EPA Region IX have concurred that the existing systems satisfy or exceed the NESHAPs requirements regarding air sampling of radionuclide effluents, further upgrades being implemented in 1994 will improve these sampling systems to meet specific American National Standards Institute standards (ANSI).

Requirements that are being addressed in these upgrades are continuous measurement of stack velocity, installation of multi-port aerosol extraction probes, minimization of sample transport line length, and relocation or installation of samplers to meet location requirements for extraction of samples. The upgraded particulate sampling systems will ensure the continued extraction of representative samples as specified by the ANSI N13.1-1969 guidelines.

In total, the upgrades to the sampling systems will involve the installation of 23 aerosol sampling probes and 25 velocity probes at 17 discharge locations. Costs of these upgrades is estimated to be \$800,000 to \$900,000.

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 proposes 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: In addition to the continuous monitoring performed for Buildings 331, 332, and 251, five additional facilities have continuous effluent monitoring systems (Buildings 175, 231, 419, 490, and 491). LLNL maintains these monitoring systems and, the data from filter analyses are reviewed by both a Hazards Control Health Physicist responsible for the area and an Environmental Protection Department Environmental Analyst. Analysis of air sampler data identified the unplanned release of ^{220}Rn from Building 251 during 1993.

Annual Effluent Sampling: For sources where the EDE is between 0.1% and 1% of the NESHAPs emission standard of 10 mrem/y (100 $\mu\text{Sv/y}$) (between 0.01 and 0.1 mrem/y or 0.1 and 1.0 $\mu\text{Sv/y}$), and no existing monitoring system is in place, LLNL plans to institute annual sampling of the effluent downstream of any emission control systems. No facilities had emissions in this category in 1993.

General Surveillance Monitoring: Surveillance air monitoring for tritium and for radioactive particles has been in place since the 1970s and will continue. 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 this network are presented in the Site Annual Environmental Report (Gallegos *et al.*, Environmental Report for 1992, Lawrence Livermore National Laboratory, Livermore, CA, UCRL-50027-92). General surveillance monitoring helped us interpret the high levels of tritium in rain and air samplers that occurred in February and March of 1993 (see Building 331 discussion in Section IV).

Site-Specific Surveillance Monitoring: Surveillance air monitors are placed in the vicinity of diffuse emission sources, such as those associated with Buildings 292, 331, 514, and 612, as well as in and around the Southeast Quadrant of the Livermore site. The data from these monitoring networks provide continuous measurements of the concentrations of specific radionuclides present in the air near these sources and allow a direct and accurate determination of their environmental impact. This practice will continue at these locations. The use of site-specific surveillance monitoring for Site 300 diffuse sources of tritium is being evaluated.

Status of the NESHAPs QA Program

The LLNL NESHAPs Quality Assurance (QA) Program is a multi-organizational effort that relies on the Quality Assurance/Quality Control programs that are in place at the LLNL facilities with continuous air monitoring systems, the Radiological Measurements Laboratory (RML) of the Hazards Control Department, and the Environmental Monitoring Section (EMS) in the Environmental Protection Department (EPD).

Facility Safety Procedures (FSPs), Safety Analysis Reports (SARs) and QA Manuals for each monitored facility describe its organizational structure, responsibilities for sampling locations used for continuous air monitoring, and the procedures to be followed in the case of unplanned radionuclide releases. For example, the FSP for the Plutonium Facility (Building 332) describes in detail the procedure for responding to detection of radioactive materials in a release from the stacks. These documents also describe the sampling collection systems for both continuous and passive (i.e., not alarmed) air monitoring systems (CAM and PAM, respectively), including sampling probes and procedures to be used on measuring flow rates, sampling, and calibration. Similarly, the FSP for the Tritium Facility (Building 331) describes its stack monitoring system, which includes molecular sieve detectors for tritiated water (HTO) and elemental tritium gas (HT).

The RML Quality Assurance Program describes laboratory analysis procedures, precision, accuracy and completeness objectives, sample tracking procedures, quality-control (QC) sampling, sample handling, and data reporting. For example, the Gross Alpha-Beta Procedures Manual of the RML describes operational procedures for analyzing the CAM and PAM filters for radioactivity.

EPD, which is responsible for NESHAPs modeling and reporting, also operates under a Quality Assurance Management Plan and associated procedures. Detailed records are kept of all measurements, model runs, and calculations, and selected model runs are validated. The Terrestrial and Atmospheric Monitoring and Modeling Group (TAMM) of EMS is responsible for modeling and reporting radionuclide emissions for the purpose of NESHAPs compliance. TAMM is refining mechanisms to ensure that it is informed whenever new operations are proposed, significant changes in radionuclide inventories occur, or existing operations are modified so that NESHAPs modeling can be performed and appropriate action taken. All NESHAPs calculations are archived with the supporting information used to make the calculations.

LLNL is continuing to upgrade its NESHAPs QA program. This process involves an assessment of LLNL's compliance with requirements of 40 CFR Part 61, Appendix B, Method 114, Section 4. In this regard, we have collected FSPs, SARs and QA Manuals for the three continuously monitored facilities. In addition, we have collected the QA Plan, Health and Safety Manual, Laboratory Procedures Manual,

and Calibration Procedures Manual for RML, as well as the Quality Assurance Plan and Quality Implementing Procedures of the Environmental Protection Department.

Quality Control (QC) on 1993 Inventory and Modeling

Approximately 15% of the Livermore-site facilities re-inventoried in 1993 were randomly selected for validation. For this QC check, two emission points were selected in Building 151, one in Buildings 175 and 177 respectively, two in Building 222, three in Building 231, and one in Building 251. An EPD Environmental Analyst contacted the responsible party who signed the NESHAPs Inventory Forms and physically visited and inspected the facilities to verify inventory data. The responsible party was asked to demonstrate how he/she arrived at the data submitted on the original inventory form. Stack parameters were also verified. The QC data were compared to the original data. The accuracy of the inventory data was confirmed.

Approximately 15% of the CAP88-PC modeling effort was verified by a second analyst using a different computer and copy of CAP88-PC. The modeling runs included those inventories that were randomly selected as discussed above and those that had a significant contribution to the total EDE. The latter group included two emission points in Building 177, one in Building 194, two in Building 331, one from Building 514, and one firing table from Site 300. The analyst performing this QC effort independently gathered radionuclide inventories and stack data from the NESHAPs Inventory Forms and pertinent distances from site maps. The resulting EDEs at the SW-MEI were verified with values from the original CAP88-PC modeling runs. In all cases, the validation process demonstrated that quality objectives are being met.

Attachment 2: Surrogate Radionuclides List

Available in CAP88-PC	Radionuclide	Half-life	Lung Class ^a	ALI (inh), μCi	DAC, $\mu\text{Ci}/\text{m}^3$	Surrogate	Correction Factor ^b
	^{108m} Ag	127 y	Y	20	1×10^{-7}	⁶⁰ Co	
y	^{110m} Ag	250 d	Y	90	4×10^{-8}	⁶⁰ Co	
v	¹¹¹ Ag	7.45 d	Y	900	4×10^{-7}	⁶⁰ Co	
v	²⁴³ Am	7380 y	W	0.006	3×10^{-12}	²⁴¹ Am	
	²⁰⁷ Bi	38 y	W	400	1×10^{-7}	²¹⁴ Bi	
v	¹³³ Ba	10.7 y	D	700	3×10^{-7}	¹⁴⁰ Ba	
	⁴⁵ Ca	163 d	W	800	4×10^{-7}	⁹⁰ Sr	
	¹⁰⁹ Cd	464 d	D	40	1×10^{-8}	⁶⁰ Co	
y	¹⁴¹ Ce	32.5 d	Y	600	2×10^{-7}	¹⁴⁰ La	
v	¹⁴⁴ Ce	284 d	Y	10	6×10^{-9}	¹⁴⁰ La	100
	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	
y	²⁴⁴ Cm	18.1 y	W	0.01	5×10^{-12}	²⁴¹ Am	
y	⁵⁷ Co	271 d	Y	700	3×10^{-7}	⁶⁰ Co	
y	⁵⁸ Co	70.8 d	Y	700	3×10^{-7}	⁶⁰ Co	
y	¹³⁴ Cs	2.06 y	D	100	4×10^{-8}	¹³⁷ Cs	
y	¹³⁶ Cs	13.1 d	D	700	3×10^{-7}	¹³⁷ Cs	
	²⁵⁴ Es	276 d	W	0.07	3×10^{-11}	²³⁹ Pu	
y	¹⁵² Eu	13.33 y	W	20	1×10^{-8}	¹⁴⁰ La	50
v	¹⁵⁴ Eu	8.8 y	W	20	8×10^{-9}	¹⁴⁰ La	50
y	¹⁵⁵ Eu	4.96 y	W	90	4×10^{-11}	¹⁴⁰ La	10
y	¹⁵⁶ Eu	15.2 d	W	500	2×10^{-7}	¹⁴⁰ La	
v	⁵⁵ Fe	2.7 y	D	2000	8×10^{-7}	⁶⁰ Co	
	¹⁴⁸ Gd	93 y	D	0.008	3×10^{-12}	¹⁴⁰ La	1×10^5
y	¹⁶⁶ Ho	26.80 h	W	2000	7×10^{-7}	¹⁴⁰ La	
y	¹⁹² Ir	74.02 d	Y	200	9×10^{-8}	⁶⁰ Co	
y	⁵⁴ Mn	313 d	W	800	3×10^{-7}	⁹⁰ Y	
y	²² Na	2.60 y	D	600	3×10^{-7}	¹³⁷ Cs	
y	⁹⁴ Nb	2.03×10^4 y	Y	20	6×10^{-9}	⁹⁹ Mo	50
v	⁹⁵ Nb	35.2 d	Y	1000	5×10^{-7}	⁹⁹ Mo	
y	¹⁴⁷ Nd	11 d	Y	800	4×10^{-7}	¹⁴⁰ La	

(See next page for footnotes.)

Attachment 2: (continued)

Available in CAP88- PC	Radio- nuclide	Half-life	Lung Class ^a	ALI (inh), μCi	DAC, μCi/m ³	Surrogate	Correction Factor ^b
v	⁶³ Ni	96 y	W	3000	1 × 10 ⁻⁶	⁶⁰ Co	
y	²³⁷ Np	2.14 × 10 ⁶ y	W	0.004	2 × 10 ⁻¹²	²⁴¹ Am	
	¹⁸⁵ Os	94 d	D	500	2 × 10 ⁻⁷	⁹⁹ Mo	
v	²³¹ Pa	3.28 × 10 ⁴ y	W	0.002	6 × 10 ⁻¹³	²³⁹ Pu	
v	¹⁴⁷ Pm	2.62 y	W	100	6 × 10 ⁻⁸	¹⁴⁰ La	10
v	²³⁸ Pu	87.7 y	W	0.007	3 × 10 ⁻¹²	²³⁹ Pu	
v	²⁴² Pu	3.76 × 10 ⁵ y	W	0.007	3 × 10 ⁻¹²	²³⁹ Pu	
v	²⁴⁴ Pu	8.26 × 10 ⁷ y	W	0.007	3 × 10 ⁻¹²	²³⁹ Pu	
	¹⁸⁴ Re	38.0 d	W	1000	6 × 10 ⁻⁷	⁹⁹ Mo	
v	¹⁰³ Ru	39.3 d	Y	600	3 × 10 ⁻⁷	⁶⁰ Co	
y	¹⁰⁵ Ru	4.44 h	Y	10000	5 × 10 ⁻⁶	⁶⁰ Co	
v	¹⁰⁶ Ru	368 d	Y	10	5 × 10 ⁻⁹	⁶⁰ Co	10
v	³⁵ S	87.4 d	W	2000	9 × 10 ⁻⁷	³² P	
v	¹²⁵ Sb	2.77 y	W	500	2 × 10 ⁻⁷	²¹⁴ Bi	
v	¹²⁶ Sb	12.4 d	W	500	2 × 10 ⁻⁷	²¹⁴ Bi	
v	¹²⁷ Sb	3.85 d	W	900	4 × 10 ⁻⁷	²¹⁴ Bi	
	⁷⁵ Se	120 d	W	600	3 × 10 ⁻⁷	³² P	
	⁸⁵ Sr	64.8 d	Y	2000	6 × 10 ⁻⁷	⁹⁰ Sr	
v	⁸⁹ Sr	50.5 d	Y	100	6 × 10 ⁻⁸	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
y	¹⁶⁰ Tb	72.3 d	W	200	9 × 10 ⁻⁸	¹⁴⁰ La	5
y	⁹⁹ Tc	2.13 × 10 ⁵ y	W	700	3 × 10 ⁻⁷	^{99m} Tc	1000
y	¹³² Te	78.2 h	D	200	9 × 10 ⁻⁸	¹²⁵ I	
	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
y	²³² U	72 y	Y	0.008	3 × 10 ⁻¹²	²³⁸ U	10
v	²³³ U	1.59 × 10 ⁵ y	Y	0.04	2 × 10 ⁻¹¹	²³⁸ U	
y	²³⁶ U	2.34 × 10 ⁷ y	Y	0.04	2 × 10 ⁻¹¹	²³⁸ U	
v	^{133m} Xe	2.19 d	None		1 × 10 ⁻⁴	¹³³ Xe	
y	¹³⁵ Xe	9.09 h	None		1 × 10 ⁻⁵	¹³³ Xe	10
v	⁹¹ Y	58.5 d	Y	100	5 × 10 ⁻⁸	⁹⁰ Y	6
y	⁶⁵ Zn	244 d	Y	300	1 × 10 ⁻⁷	⁶⁰ Co	
y	⁹⁵ Zr	64.0 d	D	100	5 × 10 ⁻⁸	⁹⁰ Y	6

^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.

^c Data on lung class and ALIs for ¹⁶⁷Tm were used. The nuclides have similar decay and energy characteristics.

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.

Building	Room/Area	Stock ID	Operation	Radionuclides	Estimated Annual Release	Control Device	Efficiency	Type of monitoring at release point	
NOTE: The AIRDOCS and CAPMO-PC codes require activity rates of Ci/year and gms decay in Ci/year. To convert curies to becquerels use 1 Ci=3.7 x 10 ¹⁰ Bq and to convert becquerels to curies use 1 Bq=2.7 x 10 ⁻¹¹ Ci.									
LIVERMORE SITE POINT SOURCES									
Building 131 complex is a large office/lab facility housing both Mechanical Engineering and Electrical Engineering. The high-bay facility houses Mechanical Engineering, Weapons Engineering, and the Nuclear Explosives Division. The Electrical Engineering Department and the Nuclear Engineering Support Services Division are also located in the high-bay. Work in the high-bay area includes machining and handling classified parts, some containing depleted uranium.									
131	Vault Room	131-Vault-RA	Temporary storage vault	Th-232 U-238	3.0 x 10 ⁻¹⁰ 9.0 x 10 ⁻⁷	HEPA	99.97	None	
131	High-Bay Rooms 134A, 134B, 134C, 134D, 134E, 134F, 134G, 134H, 134I, 134J, 134K, 134L, 134M, 134N, 134O, 134P, 134Q, 134R, 134S, 134T, 134U, 134V, 134W, 134X, 134Y, 134Z, 134AA, 134AB, 134AC, 134AD, 134AE, 134AF, 134AG, 134AH, 134AI, 134AJ, 134AK, 134AL, 134AM, 134AN, 134AO, 134AP, 134AQ, 134AR, 134AS, 134AT, 134AU, 134AV, 134AW, 134AX, 134AY, 134AZ, 134BA, 134BB, 134BC, 134BD, 134BE, 134BF, 134BG, 134BH, 134BI, 134BJ, 134BK, 134BL, 134BM, 134BN, 134BO, 134BP, 134BQ, 134BR, 134BS, 134BT, 134BU, 134BV, 134BW, 134BX, 134BY, 134BZ, 134CA, 134CB, 134CC, 134CD, 134CE, 134CF, 134CG, 134CH, 134CI, 134CJ, 134CK, 134CL, 134CM, 134CN, 134CO, 134CP, 134CQ, 134CR, 134CS, 134CT, 134CU, 134CV, 134CW, 134CX, 134CY, 134CZ, 134DA, 134DB, 134DC, 134DD, 134DE, 134DF, 134DG, 134DH, 134DI, 134DJ, 134DK, 134DL, 134DM, 134DN, 134DO, 134DP, 134DQ, 134DR, 134DS, 134DT, 134DU, 134DV, 134DW, 134DX, 134DY, 134DZ, 134EA, 134EB, 134EC, 134ED, 134EE, 134EF, 134EG, 134EH, 134EI, 134EJ, 134EK, 134EL, 134EM, 134EN, 134EO, 134EP, 134EQ, 134ER, 134ES, 134ET, 134EU, 134EV, 134EW, 134EX, 134EY, 134EZ, 134FA, 134FB, 134FC, 134FD, 134FE, 134FF, 134FG, 134FH, 134FI, 134FJ, 134FK, 134FL, 134FM, 134FN, 134FO, 134FP, 134FQ, 134FR, 134FS, 134FT, 134FU, 134FV, 134FW, 134FX, 134FY, 134FZ, 134GA, 134GB, 134GC, 134GD, 134GE, 134GF, 134GG, 134GH, 134GI, 134GJ, 134GK, 134GL, 134GM, 134GN, 134GO, 134GP, 134GQ, 134GR, 134GS, 134GT, 134GU, 134GV, 134GW, 134GX, 134GY, 134GZ, 134HA, 134HB, 134HC, 134HD, 134HE, 134HF, 134HG, 134HH, 134HI, 134HJ, 134HK, 134HL, 134HM, 134HN, 134HO, 134HP, 134HQ, 134HR, 134HS, 134HT, 134HU, 134HV, 134HW, 134HX, 134HY, 134HZ, 134IA, 134IB, 134IC, 134ID, 134IE, 134IF, 134IG, 134IH, 134II, 134IJ, 134IK, 134IL, 134IM, 134IN, 134IO, 134IP, 134IQ, 134IR, 134IS, 134IT, 134IU, 134IV, 134IW, 134IX, 134IY, 134IZ, 134JA, 134JB, 134JC, 134JD, 134JE, 134JF, 134JG, 134JH, 134JI, 134JJ, 134JK, 134JL, 134JM, 134JN, 134JO, 134JP, 134JQ, 134JR, 134JS, 134JT, 134JU, 134JV, 134JW, 134JX, 134JY, 134JZ, 134KA, 134KB, 134KC, 134KD, 134KE, 134KF, 134KG, 134KH, 134KI, 134KJ, 134KK, 134KL, 134KM, 134KN, 134KO, 134KP, 134KQ, 134KR, 134KS, 134KT, 134KU, 134KV, 134KW, 134KX, 134KY, 134KZ, 134LA, 134LB, 134LC, 134LD, 134LE, 134LF, 134LG, 134LH, 134LI, 134LJ, 134LK, 134LL, 134LM, 134LN, 134LO, 134LP, 134LQ, 134LR, 134LS, 134LT, 134LU, 134LV, 134LW, 134LX, 134LY, 134LZ, 134MA, 134MB, 134MC, 134MD, 134ME, 134MF, 134MG, 134MH, 134MI, 134MJ, 134MK, 134ML, 134MM, 134MN, 134MO, 134MP, 134MQ, 134MR, 134MS, 134MT, 134MU, 134MV, 134MW, 134MX, 134MY, 134MZ, 134NA, 134NB, 134NC, 134ND, 134NE, 134NF, 134NG, 134NH, 134NI, 134NJ, 134NK, 134NL, 134NM, 134NN, 134NO, 134NP, 134NQ, 134NR, 134NS, 134NT, 134NU, 134NV, 134NW, 134NX, 134NY, 134NZ, 134OA, 134OB, 134OC, 134OD, 134OE, 134OF, 134OG, 134OH, 134OI, 134OJ, 134OK, 134OL, 134OM, 134ON, 134OO, 134OP, 134OQ, 134OR, 134OS, 134OT, 134OU, 134OV, 134OW, 134OX, 134OY, 134OZ, 134PA, 134PB, 134PC, 134PD, 134PE, 134PF, 134PG, 134PH, 134PI, 134PJ, 134PK, 134PL, 134PM, 134PN, 134PO, 134PP, 134PQ, 134PR, 134PS, 134PT, 134PU, 134PV, 134PW, 134PX, 134PY, 134PZ, 134QA, 134QB, 134QC, 134QD, 134QE, 134QF, 134QG, 134QH, 134QI, 134QJ, 134QK, 134QL, 134QM, 134QN, 134QO, 134QP, 134QQ, 134QR, 134QS, 134QT, 134QU, 134QV, 134QW, 134QX, 134QY, 134QZ, 134RA, 134RB, 134RC, 134RD, 134RE, 134RF, 134RG, 134RH, 134RI, 134RJ, 134RK, 134RL, 134RM, 134RN, 134RO, 134RP, 134RQ, 134RR, 134RS, 134RT, 134RU, 134RV, 134RW, 134RX, 134RY, 134RZ, 134SA, 134SB, 134SC, 134SD, 134SE, 134SF, 134SG, 134SH, 134SI, 134SJ, 134SK, 134SL, 134SM, 134SN, 134SO, 134SP, 134SQ, 134SR, 134SS, 134ST, 134SU, 134SV, 134SW, 134SX, 134SY, 134SZ, 134TA, 134TB, 134TC, 134TD, 134TE, 134TF, 134TG, 134TH, 134TI, 134TJ, 134TK, 134TL, 134TM, 134TN, 134TO, 134TP, 134TQ, 134TR, 134TS, 134TT, 134TU, 134TV, 134TW, 134TX, 134TY, 134TZ, 134UA, 134UB, 134UC, 134UD, 134UE, 134UF, 134UG, 134UH, 134UI, 134UJ, 134UK, 134UL, 134UM, 134UN, 134UO, 134UP, 134UQ, 134UR, 134US, 134UT, 134UU, 134UV, 134UW, 134UX, 134UY, 134UZ, 134VA, 134VB, 134VC, 134VD, 134VE, 134VF, 134VG, 134VH, 134VI, 134VJ, 134VK, 134VL, 134VM, 134VN, 134VO, 134VP, 134VQ, 134VR, 134VS, 134VT, 134VU, 134VV, 134VW, 134VX, 134VY, 134VZ, 134WA, 134WB, 134WC, 134WD, 134WE, 134WF, 134WG, 134WH, 134WI, 134WJ, 134WK, 134WL, 134WM, 134WN, 134WO, 134WP, 134WQ, 134WR, 134WS, 134WT, 134WU, 134WV, 134WW, 134WX, 134WY, 134WZ, 134XA, 134XB, 134XC, 134XD, 134XE, 134XF, 134XG, 134XH, 134XI, 134XJ, 134XK, 134XL, 134XM, 134XN, 134XO, 134XP, 134XQ, 134XR, 134XS, 134XT, 134XU, 134XV, 134XW, 134XZ, 134YA, 134YB, 134YC, 134YD, 134YE, 134YF, 134YG, 134YH, 134YI, 134YJ, 134YK, 134YL, 134YM, 134YN, 134YO, 134YP, 134YQ, 134YR, 134YS, 134YT, 134YU, 134YV, 134YW, 134YX, 134YY, 134YZ, 134ZA, 134ZB, 134ZC, 134ZD, 134ZE, 134ZF, 134ZG, 134ZH, 134ZI, 134ZJ, 134ZK, 134ZL, 134ZM, 134ZN, 134ZO, 134ZP, 134ZQ, 134ZR, 134ZS, 134ZT, 134ZU, 134ZV, 134ZW, 134ZX, 134ZY, 134ZZ	131-High Bay Room	131-High Bay-FEV	Machining classified parts	Th-232 U-234 U-238 U-235	1.7 x 10 ⁻¹¹ 8.1 x 10 ⁻¹¹ 8.8 x 10 ⁻⁸ 8.0 x 10 ⁻¹¹	HEPA	99.97	None
Building 131 houses the Nuclear Chemistry Division which processes samples generated by the nuclear test program. The radionuclides in these samples are fission products contained in debris from airburst tests. However, no debris-type samples were processed in 1993.									
Building 131 contains the Radiation Analytical Sciences laboratory (room 2117) where samples of various streams and environmental media (air, water, soil, etc.) are analyzed for their radionuclide content. The basement of the building contains a large number of chemically separated samples that are used to make final radioactivity measurements. These samples are heated and generally are of the microscale level.									
131	1033	131-1033-FHE-02	Initial Chemical Separation	None	0	Scrubber-Precipitator	Varies with Nuclide	None	
131	1033V	131-1033-FHE-04	Storage and solvent preparation	None	0	Scrubber-Precipitator	Varies with Nuclide	None	
131	1043	131-1043-FHE-1B20	Decoding of weapon test cores	None	0	Scrubber-Precipitator	Varies with Nuclide	None	
131	1133	131-1133-FHE-48	Chemistry of samples	Am-241 Pu-238 Pu-240 U-238 U-235 Pu-239 Am-241	1.0 x 10 ⁻¹³ 3.1 x 10 ⁻¹² 6.0 x 10 ⁻¹³ 3.0 x 10 ⁻¹⁴ 3.0 x 10 ⁻¹³ 3.1 x 10 ⁻¹²	Scrubber-Precipitator	Varies with Nuclide	None	
131	1143	131-1143-FHE-64	Gaseous debris analysis	None	0	None	0	None	
131	1218	131-1218-FHE-25	Core sample chemistry	None	0	None	0	None	
131	1222	131-1222-FHE-34	Core sample chemistry	None	0	None	0	None	
131	1228	131-1228-FHE-43	Core sample chemistry	None	0	None	0	None	
131	1230	131-1230-FHE-52	Core sample chemistry	None	0	None	0	None	
131	1234	131-1234-FHE-61	Core sample chemistry	None	0	None	0	None	
131	2109	131-2109-FHE-18	Radioactive waste analysis	None	0	None	0	None	
131	2117	131-2117-FHE-28	Chemistry of samples	H-3 C-14 U-235 U-238 Pu-238 Am-241	1.4 x 10 ⁻³ 2.0 x 10 ⁻¹⁰ 1.7 x 10 ⁻¹¹ 4.9 x 10 ⁻¹⁰ 1.0 x 10 ⁻⁹ 5.9 x 10 ⁻¹⁰	None	0	None	
131	2125	131-2125-FHE-48	Chemistry of samples	Bi-214 (Bi-207) Pu-238 Pu-244	7.7 x 10 ⁻⁹ 3.1 x 10 ⁻¹³ 3.1 x 10 ⁻¹³	None	0	None	

Attachment 1 - 1993 LLNL NESHAPs Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Walls MEI (m)	Annual Effluent Data Equivalent (micro)	EDC Category
use use 1 Ch3.7 x 10x10 Bq and to control sulfur to achieve use 1 5m1.2 x 1046 micro.								
chemical Engineering, Weapons Engineering, and the Nuclear Explosive Division.								
includes machinery and handling classified parts, some containing depleted uranium.								
HEPA	99.97	None	10.67	0.80	0.80	1320	4.5 x 10-4	2
HEPA	99.97	None	10.67	1.00	3.00	1320	4.5 x 10-4	2
we are fusion products contained in debris from debris cones.								
all are 3 are analyzed for their radioisotope content								
samples are sealed and generally are of the microscale level								
Scrubber-Preseparator	Varies with Nucleide	None	6.88	0.61	2.80	1320	0.	1
Scrubber-Preseparator	Varies with Nucleide	None	6.88	0.61	2.80	1320	0.	1
Scrubber-Preseparator	Varies with Nucleide	None	6.41	0.21	13.10	1320	0.	1
Scrubber-Preseparator	Varies with Nucleide	None	11.89	0.61	2.40	1320	8.0e10-10	1
None	0	None	11.89	0.61	2.80	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	0.	1
None	0	None	11.89	0.61	2.40	1320	1.5 x 10-4	1
None	0	None	11.89	0.61	2.80	1320	8.0 x 10-11	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release	Control Devices	Efficiency	Type of monitoring at release point
					ICR			
151	2131	151-2131-FHE-56	One of tenor analysis	De-80 Tc-99m Na-22 Cs-137 (Cs-137, Cs-136) Ru-226 Am-241 Sr-90 (Sr-90) Sr-90 (Sr-90) Pu-242	9.8 x 10 ⁻⁷ 2.1 x 10 ⁻⁸ 1.0 x 10 ⁻⁸ 2.0 x 10 ⁻⁸ 1.0 x 10 ⁻⁸ 6.1 x 10 ⁻¹⁰ 6.2 x 10 ⁻⁷ 2.9 x 10 ⁻⁸ 6.4 x 10 ⁻¹³ 3.0 x 10 ⁻⁸	None	0	None
151	2143	151-2143-FHE-63	Chemistry of samples	H-3 C-14	2.2 x 10 ⁻⁵ 5.0 x 10 ⁻⁷	None	0	None
151	2146	151-2146-FHE-78	Chemistry of samples	Pu-240 Pu-238 Pu-239 Pu-241 Pu-242	1.5 x 10 ⁻⁸ 1.0 x 10 ⁻⁸ 1.1 x 10 ⁻⁸ 2.6 x 10 ⁻⁷	None	0	None
151	2302A	151-2302A-FHE-59	Chemical Separation	None	0	None	0	None
151	2306	151-2306-FHE-12	Radiochemical Studies	None	0	None	0	None
151	2312	151-2312-FHE-17	Chemical Separation	None	0	None	0	None
151	2318	151-2318-FHE-30	Chemical Separation	None	0	None	0	None
151	2322	151-2322-FHE-58	Chemical Separation	None	0	None	0	None
151	2326	151-2326-FHE-49	Chemical Separation	None	0	None	0	None
151	2328A	151-2328A-FHE-40	Chemical Separation	None	0	None	0	None
Building 171 is operated for the Laser Program in support of research and development activities for U-AMLS								
171	107	171-107-RA	Making uranium under vacuum	U-238 U-234	0 0	None	0	None
Building 175 is operated for the Laser Program in support of research and development activities for U-AMLS								
Two Stacks were used to determine the EDE								
175	103	175-103-FHE-112	Not Currently in Use	None	0	HEPA	99.97	Filter
175	112	175-112-FHE-112	Assembly of Parts/Storage	None	0	HEPA	99.97	Filter
175	120	175-120-FHE-1000/2000	Cleaning Activities	None	0	HEPA	99.97	Filter
Building 177 is operated for the Laser Program in support of research and development activities for U-AMLS								
Two Stacks were used to determine the EDE								
177	1010	177-1010-FHE-18	Corrosion experiments	None	0	HEPA	99.97	None
177	1014	177-1014-FHE-10	Cleaning and Storage of uranium	U-238 U-235 U-234	1.3 x 10 ⁻⁷ 4.3 x 10 ⁻⁸ 7.8 x 10 ⁻⁷	HEPA	99.97	None
177	1015	177-1015-FHE-27	Sample Preparation	U-238 U-235 U-234	5.0 x 10 ⁻¹¹ 1.4 x 10 ⁻¹² 3.3 x 10 ⁻¹¹	HEPA	99.97	None
177	1020	177-1020-FHE-22	Uranium Vapor Environment	None	0	HEPA	99.97	None

Control Device	Efficiency	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Methanum (t/y)	Distance to Site (m)	Annual Effective Dose Equivalent (mrem)	DOE Category
None	0	None	11.89	0.61	2.80	1320	2.6×10^{-6}	1
None	0	None	11.89	0.61	1.80	1320	1.3×10^{-6}	1
None	0	None	11.89	0.61	1.60	1320	4.0×10^{-6}	1
None	0	None	11.89	0.61	2.80	1320	0	1
None	0	None	11.89	0.61	2.83	1320	0	1
None	0	None	11.89	0.61	2.80	1320	0	1
None	0	None	11.89	0.61	3.80	1320	0	1
None	0	None	11.89	0.61	2.80	1320	0	1
None	0	None	11.89	0.61	2.80	1320	0	1
None	0	None	11.89	0.61	3.80	1320	0	1
None	0	None	9.14	0.50	0.80	1320	0	2
HEPA	99.97	Filter	9.14	0.73	4.03	1335	0	3
HEPA	99.97	Filter	5.80	0.39	10.80	1335	0	3
HEPA	99.97	Filter	10.67	0.61	4.88	1335	0	3
HEPA	99.97	None	9.10	0.58	1.80	1348	0	1
HEPA	99.97	None	5.80	0.41	2.40	1348	2.3×10^{-6}	1
HEPA	99.97	None	7.50	0.58	12.90	1348	7.8×10^{-10}	1
HEPA	99.97	None	6.40	0.30	8.80	1348	0	1

Building	Room/Area	Stock ID	Operation	Radionuclides	Estimated Annual Release	Control Devices	References	Type of monitoring of release point
					ICR			
177	1021	177-1021-FHE-2 V25	Analytical Chemistry	U-238 U-235 U-234	2.7 ± 10-7 1.6 ± 10-8 2.6 ± 10-9	HEPA	99.97	None
177	1024	177-1024-FHE-14	Uranium Vapor Spectroscopy	None	0	HEPA	99.97	None
Building 178 supports research and development activities for LAYLIS								
178	1000	178-1000-RA1	Metal Storage	U-235 U-234	3.3 ± 10-13 3.3 ± 10-13	None	0	None
178	1020	178-1020 (NO ID)	Metal/Powder Storage	U-238 U-235 U-234	1.2 ± 10-7 2.4 ± 10-8 1.2 ± 10-7	None	0	None
Building 184, operated by the Physical Sciences Directorate, is shared by the Center for Accelerator and Mass Spectroscopy (CAAMS) and E-Genium. The complex houses a high energy linear accelerator and research laboratories. The accelerator beam can produce a small number of short lived for activation products. U-15 and B-10. The quantities of all activation products that are produced depend on beam energy, beam current, and the amount of time the accelerators is operating. Air exhaust from this facility is via a 30-m stack.								
184	Target Exhaust	184-TE-FE4	Linear accelerator	D-18 H-15	0.70 0.3	None	0	None
184	1191	184-1191-RA	Puylon experiments	Na-22	2.0 ± 10-8	None	0	None
184	B194A	TE-FE4	Stored Material			None	0	None
Building 212 is administered by 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	212-174-RA	Contaminated	H-3	1.1 ± 10-8	None	0	None
212	184	212-184-RA	Contaminated	H-3	1.1 ± 10-8	None	0	None
Building 222 is part of the Chemistry and Material Sciences Directorate. Many of the laboratories either store or used depleted uranium or thorium. Usually 2 emits as oxide, either metal pieces or chemical reagents such as oxide powders. Though there may be Magnesium amounts in some of the laboratories, the total activity is low because of low specific activity of these radionuclides. The other source of radionuclides in Building 222 is from analysis of hazardous waste samples.								
222	1020B	222-1020B-FHE-4000	Chemical procedures	U-238 Th-232	6.0 ± 10-12 1.0 ± 10-12	None	0	None
222	1020E	222-1020E-FHE-3000	Chemical procedures	Th-232 U-238	6.4 ± 10-15 2.6 ± 10-14	HEPA	99.97	None
222	1108	222-1108-FHE-130	Decontamination of radioactive materials	Th-232 U-238	2.1 ± 10-14 8.4 ± 10-14	HEPA	99.97	None
222	1110B	222-1110B-FHE-6	Chemical procedures	Th-232 U-238	6.3 ± 10-11 1.9 ± 10-10	HEPA	99.97	None
222	1117B	222-1117B-FHE-12	Chemical procedures	None	0	HEPA	99.97	None
222	1118B	222-1118B-FHE-3000	Chemical procedures	None	0	HEPA	99.97	None
222	1161	222-1161-FHE-1000	Chemical Analysis	Gross Alpha, Beta U-234 U-235 U-238	5.0 ± 10-9 1.0 ± 10-10 4.4 ± 10-12 9.4 ± 10-11	None	0	None
222	1169	222-1169-FHE-128	Chemical Analysis	Gross Alpha, Beta U-234 U-235 U-238 Am-241	5.0 ± 10-8 1.0 ± 10-10 4.4 ± 10-12 9.4 ± 10-11 1.4 ± 10-5	None	0	None

Attachment 1 - 1993 LLNL NESHAPs Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MB (m)	Actual Effluent (Dose Equivalent (mrem))	EDC Category
HEPA	99.97	None	11.00	0.41	7.80 *	1348	2.2×10^{-8}	1
			8.10	0.50	8.50 *			
HEPA	99.97	None	5.49	0.38	0.80	1348	0.	1
None	0	None	3.98	0.50	0.80	1268	3.7×10^{-10}	2
None	0	None	3.98	0.50	7.00	1268	1.3×10^{-4}	2
No complex houses a high energy laser accelerator and research laboratories								
2. Air exhaust from this facility is via a 30-m stack								
None	0	None	30.48	1.37	4.50	1548	4.0×10^{-6}	1
None	0	None	8.53	0.50	0.50	1848	1.2×10^{-8}	1
None	0	None	30.48	1.37	4.60	1548	1.6×10^{-6}	1
No contribution from past operations of the rotating								
None	0	None	4.27	0.50	0.50	1320	1.8×10^{-10}	2
None	0	None	4.27	0.50	0.50	1320	1.6×10^{-10}	2
oxide powders								
None	0	None	28.00	0.91	21.20	1240	2.2×10^{-10}	1
HEPA	99.97	None	12.80	1.07	18.60	1240	1.8×10^{-12}	1
HEPA	99.97	None	6.10	0.34	9.40	1240	6.5×10^{-12}	1
HEPA	99.97	None	9.75	0.48	9.20	1240	1.7×10^{-8}	1
HEPA	99.97	None	5.18	0.51	2.30	1240	0	1
HEPA	99.97	None	12.80	1.07	18.60	1240	0	1
None	0	None	10.70	0.87	19.40	1240	5.6×10^{-7}	1
None	0	None	7.60	0.50	4.90	1240	9.4×10^{-7}	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci)	Control Devices	Efficiencies	Type of monitoring at release point
222	1218	222-1218-FHE-1000	Chemical Analysis	Gross Alpha, Beta U-234 U-238 U-235 H-3	8.0 x 10-9 1.0 x 10-10 4.4 x 10-12 8.4 x 10-11 4.6 x 10-11	None	0	None
222	1223A/B	222-1223A/B-FHE-1000	Analysis of waste	Gross Alpha, Beta U-234 U-238 U-235	8.0 x 10-9 1.0 x 10-10 4.4 x 10-12 8.4 x 10-11	None	0	None
222	1228B	222-1228B-FHE-1000	Analysis of waste samples	C-14 H-3 Gross Alpha, Beta U-234 U-238 U-235	8.0 x 10-10 5.0 x 10-9 3.0 x 10-9 1.0 x 10-10 4.4 x 10-12 8.4 x 10-11	HEPA	99.97	None
222	1405	222-1405	Ion Chromatography	Gross Alpha, Beta	2.0 x 10-9	None	0	None
222	1421	222-1421-FHE-2000	Analysis of gases from test program	None	0	HEPA	99.97	None
222	1428	22-1428-FHE-2000	Chemical Analysis	H-3	2.8 x 10-5	None	0	None
222	1506	222-1506-FHE-108	Chemical Analysis	None	0	None	0	None
222	1515B	222-1515B-FHE-73	Atomic Absorption	Gross Alpha, Beta	2.0 x 10-9	None	0	None
222	1520	222-1520-FHE-114	DC Optical Emission Spectroscopy	U-238	3.0 x 10-15	HEPA	99.97	None
222	1520B	222-1520B-FHE-73	Preparation Laboratory	U-238	3.0 x 10-15	HEPA	99.97	None
222	1523C	222-1523C-FHE-84	STLC Extraction	Gross Alpha, Beta	2.0 x 10-9	None	0	None
222	1524B	222-1524B-FHE-38	Chemical Storeroom	None	0	HEPA	99.97	None
Building 226 is operated by the Chemistry and Materials Science Directorate. The facility houses chemistry laboratories that prepare and analyze various metals such as soil, vegetation, and waste samples for toxic chemical and radionuclide. Radioactive material can exist in the facility, either in the samples or in the prepared standards.								
226	109	226-109-FHE-2	Environmental sample preparation and analysis	H-3 U-238	8.0 x 10-7 5.8 x 10-12	HEPA	99.97	None
Building 227 is part of the Chemistry and Materials Science Directorate. In rooms 1036 and 1044, solid glasses of depleted uranium are melt bonded and tested. The rooms are used only occasionally for these purposes and the values are estimated maximum amounts which might be present. In room 1083, liquid samples containing very small amount of depleted uranium are studied to determine the leaching properties of natural waters. All three activities are contained into one stack.								
227	1036, 1044 and 1083	None	Uranium metal bonding	U-238 U-235 U-236	2.0 x 10-9 2.0 x 10-9 1.0 x 10-9	HEPA	99.97	None
The 231 complex houses research and development activities conducted by the Chemistry and Materials Science Directorate, Engineering, Nuclear Test Engineering, Weapons Engineering, and Safeguards and Security Materials Management oversight for Building 231 is provided by the Engineering Directorate through the Engineering Sciences Division.								
231	1128	231-1128-FHE-31-1.2	Storage of Radionuclides	See test	0	HEPA	99.97	Fiber
231	1128	231-1128-FHE-34-1	Resin coating of samples	None	0	HEPA	99.97	None
231	1441	231-1441-RA	Uranium bonding tests	None	0	HEPA	99.97	None
231	1737	231-1737-FHE-84	Electron beam welding	Th-232 U-238	3.2 x 10-8 4.4 x 10-8	HEPA	99.97	None

Attachment 1 - 1993 LLM, NESHAP's Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site (m)	Annual Effluent (kg/yr)	ECG Category
None	0	None	10.70	0.87	19.40	1248	7.8 ± 10^{-7}	1
None	0	None	10.70	0.87	19.40	1248	8.9 ± 10^{-7}	1
HEPA	99.97	None	12.80	0.81	8.90	1248	5.8 ± 10^{-7}	1
None	0	None	7.00	1 m ^{1/2}	0	1240	4.8 ± 10^{-7}	1
HEPA	99.97	None	28.00	1.67	18.80	1248	0	1
None	0	None	10.70	0.84	26.70	1240	1.3 ± 10^{-7}	1
None	0						0	1
None	0	None	5.20	0.30	7.40	1240	3.6 ± 10^{-7}	1
HEPA	99.97	None	5.20	0.30	7.40	1240	1.9 ± 10^{-13}	1
HEPA	99.97	None	4.80	0.34	8.80	1240	1.8 ± 10^{-13}	1
None	0	None	1.80	0.30	8.50	1240	3.3 ± 10^{-7}	1
HEPA	99.97	None	5.20	0.35	0.84	1240	0	1
Waste such as soil, vegetation, and waste samples for toxic chemical and radioactivity analyses.								
HEPA	99.97	None	6.40	0.37	10.40	1184	8.1 ± 10^{-8}	1
Waste								
If three sources were combined into one stack:								
HEPA	99.97	None	18.30	1.20	11.80	1184	8.2 ± 10^{-8}	1
Engineering, Weapons Engineering, and Safeguards and Security Materials Management Division								
HEPA	99.97	Filter	9.10	0.41	12.50	1200	0	3
HEPA	99.97	None	9.14	0.41	12.00	1170	0	1
HEPA	99.97	None	12.30	0.50	0.60	1200	0	1
HEPA	99.97	None	10.52	0.48	7.00	1200	2.3 ± 10^{-6}	1

Building	Room/Area	Stack ID	Operation	Restrictions	Estimated Annual Release (Ci)	Control Devices	Efficiencies	Type of monitor or release point
231	1845B	231-1845B-FHE-40	Uranium Etching	U-238	6.9 x 10-4	HEPA	99.97	None
231	2834	231-2834-FHE-23	Electron Microscopy	U-238	6.0 x 10-10	None	0	None
Building 235 is part of the Chemistry and Materials Sciences Directorate. Operations in the facility include optimization of material structure, surface, and subsurface; proton curing; ion implantation; and metallurgical studies. Most of the depleted uranium in this building is there for characterization studies; some is used for ion beam implantation experiments. Chemical characterization studies take place in rooms 1100, 1124, and 1226. Up to 500 grams each of depleted uranium and thorium might be present in each of these rooms.								
235	1100	235-1100-FHE-2001	Metall characterization	U-238	3.4 x 10-10	HEPA	99.97	None
235	1121	235-1121-RA	Electron microscopy studies	U-238	1.7 x 10-11	HEPA	99.97	None
235	1123	235-1123-RA	Electron microscopy studies	U-238	1.7 x 10-11	HEPA	99.97	None
235	1125	235-1125-RA	Electron microscopy studies	U-235	1.7 x 10-11	HEPA	99.97	None
231	1131	235-1131-FHE-2	Metallurgy	U-238	8.7 x 10-10	HEPA	99.97	None
235	1224	235-1224-FHE-2001	Chemical characterization studies	U-238	1.9 x 10-10	HEPA	99.97	None
235	1226	235-1226-FHE-2001	Chemical characterization studies	Th-232	4.9 x 10-11			
235	1251	235-1251-FHE-2001	Ion beam implantation	U-238	1.8 x 10-10	HEPA	99.97	None
235	1251	235-1251-FHE-2001	Ion beam implantation	Th-232	4.9 x 10-11	HEPA	99.97	None
Building 241 is administered by the Chemistry and Materials Sciences Directorate for material properties research and testing. Radionuclide emissions result from contamination from past operations that have been discontinued.								
241	1600	241-1600-FGBE-51	Contaminated (Out of Service)	U-238	3.3 x 10-9	HEPA	99.97	None
				U-235	2.1 x 10-9			
				U-234	3.3 x 10-9			
241	1887	241-1887-FGBE-27	Contaminated (Out of Service)	Th-232	8.4 x 10-12	HEPA	99.97	None
Building 251, the Heavy Element Facility, is operated by the Nuclear Test-Experimental Sciences Directorate as a facility for handling radioactive materials, especially transuranic isotopes. One area of the facility has been "hardened" to resist damage from earthquakes. Room exhausts from this 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 sample filter systems.								
251	1117	251-1117-FGBE-21/22	Transuranic Research	Pu-238	0	HEPA	99.97	Filter
251	1117	251-1117-FGBE-23/24	Transuranic Research	None	0	HEPA	99.97	Filter
251	1117	251-1117-FGBE-25/26	Transuranic Research	Cf-252	0	HEPA	99.97	Filter
251	1142	251-1142-FHE-09/10	Transuranic Research	U-235	0	HEPA	99.97	Filter
251	1150	251-1150-FGBE-53/54	Transuranic Research	Cf-252	0	HEPA	99.97	Filter
251	1211	251-1211-FHE-06/07	Transuranic Research	Bk-242	0	HEPA	99.97	Filter
				Cm-244	0			
				Cm-246	0			
251	1232	251-1232-FGBE-38/39	Transuranic Research	U-238	0	HEPA	99.97	Filter
				U-235	0			
				Pu-238	0			
				Th-232	0			
251	1254	251-1254-FGBE-44/45	No operations	0	0	HEPA	99.97	Filter
Building 253 houses the Materials Control Department, and the facility includes laboratories for the chemical analysis and counting of radioactive samples.								
253	1222A	253-1222A-(NO ID)	Passive Sample	H-3	4.5 x 10-12	None	0	None

Attachment 1 - 1993 LLNL NESHAPs Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Aluminum (m/s)	Distance to Site Wide MET (m)	Annual Effective Dose Equivalent (mrem)	EDE Category
HEPA	99.97	None	10.73	0.36	3.80	1200	2.3 ± 10 ⁻⁴	1
None	0	None	12.82	0.35	1.70	1200	2.3 ± 10 ⁻⁴	1
and subareas, precision cutting, ion implanting, and metallurgical studies precipitation studies take place in rooms 1100, 1224, and 1226.								
HEPA	99.97	None	11.13	2.31	0.18	1050	1.3 ± 10 ⁻⁷	2
HEPA	99.97	None	4.57	0.50	0.80	1050	1.0 ± 10 ⁻⁴	2
HEPA	99.97	None	4.57	0.50	0.80	1050	1.0 ± 10 ⁻⁴	2
HEPA	99.97	None	4.57	0.50	0.50	1050	1.0 ± 10 ⁻⁴	2
HEPA	99.97	None	8.96	0.38	7.13	1050	2.7 ± 10 ⁻⁷	2
HEPA	99.97	None	11.13	2.31	0.18	1050	1.3 ± 10 ⁻⁷	2
HEPA	99.97	None	11.13	2.31	0.18	1050	1.3 ± 10 ⁻⁷	2
HEPA	99.97	None	11.13	2.31	0.18	1050	7.3 ± 10 ⁻⁴	2
a result from contamination from past operations that have been discontinued								
HEPA	99.97	None	14.94	0.18	5.30	1122	2.1 ± 10 ⁻⁴	2
HEPA	99.97	None	11.28	0.23	21.70	1122	3.7 ± 10 ⁻⁴	2
oxide, especially transuranic isotopes core box exhausts are triple HEPA filtered are continuously sampled by sample filter systems								
HEPA	99.97	Filter	8.50	0.10	10.20	1148	0.	3
HEPA	99.97	Filter	8.50	0.10	8.10	1148	0.	3
HEPA	99.97	Filter	8.50	0.10	12.80	1148	0.	3
HEPA	99.97	Filter	2.50	0.28	9.10	1148	0.	3
HEPA	99.97	Filter	8.00	0.15	12.80	1148	0.	3
HEPA	99.97	Filter	6.40	0.25	8.00	1148	0.	3
HEPA	99.97	Filter	7.20	0.15	5.10	1148	0.	3
HEPA	99.97	Filter	10.20	0.15	10.20	1148	0.	3
None	0	None	7.62	0.36	6.30	1073	6.3 ± 10 ⁻¹⁵	2

Building	Room/Area	Section ID	Operation	Radionuclides	Estimated Annual Release (Ci)	Control Devices	Efficiencies	Type of monitoring at release point
Building 255 is shared by Hazards Control and L. O'Brien and houses a radiation calibration and standards laboratory. Most operations involve the use of sealed sources.								
255	180	255-180-FHE-2	Tridium Monitoring	H-3	2.8×10^{-4}	None	0	None
Building 281 is part of the Chemistry and Materials Sciences Directorate.								
In rooms 1311 and 1319, there are a number of sources, both as solids and in solution, which are kept and used in glass beakers. There are HEPA filters between the glove boxes and the vent stack. Room 1313 is used for collection of Nuclear Test Site groundwater samples. These samples contain some volatile water.								
281	1311	281-1311-FHE-1820	Analytical sources	H-3 Cs-137 Co-60 Tc-99 Eu-152, Tm-171 Th-232 Am-241, Pu-237 Am-243 U-235, U-238 Pu-242	1.0×10^{-10} 3.0×10^{-10} 1.0×10^{-8} 1.0×10^{-10} 8.8×10^{-11} 1.0×10^{-12} 2.8×10^{-7} 3.8×10^{-9} 1.0×10^{-7}	HEPA	99.97	None
281	1319	281-1319-FHE-24	Chemistry	Mn-54 Co-60 Eu-152 Eu-154, Eu-155 Eu-156	1.0×10^{-8} 1.0×10^{-10} 1.0×10^{-10} 4.3×10^{-8} 1.0×10^{-8}	HEPA	99.97	None
281	1323	281-1323-FHE-1	Groundwater Analysis	H-3	3.0×10^{-7}	None	0	None
Building 282 is operated by the Nuclear Chemistry Division. Experimental work involves neutron particle mass and related studies. Gaseous tritium is absorbed on a "griff" material to which it is tightly bound at room temperature. Because the tritium is tightly held a release fraction of 0.01 is used.								
282	Aree	282	Neutron research	H-3	2.0×10^{-1}	None	0	None
282		282 AREA RA	Neutron spectrometer experiments	H-3 Rb-83	2.0×10^{-1} 5.0×10^{-8}	HEPA	99.97	None
Building 292 is administered by the Physical Sciences Directorate. Residual contamination exists throughout this facility from the past operation of a rotating target neutron source, that is no longer in operation.								
292	1200/1202	292-1200/1202-FHE-1000	Contamination	H-3	2.0×10^{-8}	None	0	None
292	1204	292-1204-RA	Neutron Experiment	H-3	2.8×10^{-5}	None	0	None
292	1402/1404 1406/1407	292-1402/1404/1406/1407-FHE-1000	Contamination	H-3	2.0×10^{-8}	None	0	None
Building 298 is part of the Laser Fusion Program. Small amounts of tritium are used in this facility in conjunction with fusion target research and development.								
298	Various	298-FHE-1	Fusion target research	H-3	1.0×10^{-2}	None	0	None
298	188	298-188-FHE-14	Uranium Coating	U-238 U-234 H-3	4.7×10^{-9} 4.7×10^{-9} 3.0×10^{-2}	HEPA	99.97	None
Metal Fabrication Shop, Buildings 321A, 321B, 321C are part of the Mechanical Engineering Department. Operations in this complex include milling, shaping and machining of depleted uranium. Unwanted pieces may be worked on in a single location, or they may be moved from machine to machine. In addition, depleted uranium parts occasionally undergo heat treatment. The amount of depleted uranium that is handled depends on programmatic demands, and varies greatly from month to month.								
321A	1001	321A-1001-FHE-24	Heat treatment	U-238	5.8×10^{-7}	HEPA	99.97	None
321C	1153	321C-1153-FHE-8	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None
321C	1151	321C-1151-FHE-1000	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None
321C	1437	321C-1437-FHE-15	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None

Attachment 1 - 1993 LLNL NESHAP's Annual Report Spreadsheet

Control Device	Efficiency	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MBI (m)	Annual Emissions Dose Equivalent (mrem)	EDG Category
ashed sources								
None	0	None	8.08	0.31	8.10	1020	4.1×10^{-7}	2
between the glove boxes and the vent stack								
HEPA	99.97	None	8.40	0.61	2.70	1248	8.1×10^{-4}	2
HEPA	99.97	None	8.40	0.61	2.70	1248	3.1×10^{-9}	2
None	0	None	8.40	0.61	2.70	1248	5.2×10^{-11}	2
2% of 0.01 is used								
None	0	None	Air Source	N/A	0.80	1230	1.0×10^{-3}	2
HEPA	99.97	None	5.28	0.50	0.60	1330	6.0×10^{-4}	2
drying target neutron source that is no longer in operation								
None	0	None	23.97	0.71	18.40	1230	1.9×10^{-8}	2
None	0	None	8.23	0.80	0.80	1230	7.8×10^{-9}	2
None	0	None	23.47	0.71	18.40	1230	1.8×10^{-9}	2
ignition								
None	0	None	6.10	0.50	0.80	1308	1.2×10^{-6}	2
HEPA	99.97	None	8.40	0.63	16.10	1208	1.8×10^{-4}	2
milling, shaping and machining of depleted uranium will go thru treatment. The amount of depleted uranium that is handled depends								
HEPA	99.97	None	8.75	0.48	5.78	1044	4.0×10^{-4}	2
HEPA	99.97	None	8.53	0.31	18.98	1044	4.0×10^{-4}	2
HEPA	99.97	None	12.47	0.60	6.97	1044	3.0×10^{-4}	2
HEPA	99.97	None	11.20	0.23	15.40	1044	3.0×10^{-4}	2

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci)	Control Devices	Efficiencies	Type of monitoring at release point
321C	1437A	321C-1437A-FHE-11	Machining of uranium	U-238	5.6×10^{-7}	HEPA	99.97	None
Building 331 is operated by the Defense Sciences Program. The building houses the Tritium research facility and associated laboratories. The facility is undergoing significant reduction in tritium work and inventory down aging. Tritium HT and HTQ emissions are continuously monitored from the two 30 meter tall stacks in compliance with NESHAPs regulations.								
331	A8	331-FHE-1	Tritium research	H-3 (HTQ) H-3 (HT)	4.1×10^{-1} 1.5×10^{-1}	None	0	Continuous molecular sieve and ion chamber
331	A8	331-FHE-2	Tritium research	H-3 (HTQ) H-3 (HT)	7.3×10^{-1} 1.1×10^{-2}	None	0	Continuous molecular sieve and ion chamber
Building 332 is operated by the Defense Sciences Program for Plutonium research. All operations employ multiple HEPA filtration. Building exhaust air is double HEPA filtered and monitored with both continuous flow sampling (PAMS) and plutonium specific continuous real time air monitors (CAAMS).								
*Facility as installed is double HEPA filtered, and additionally a third HEPA filter is typically associated with each individual operation, for triple HEPA filtration. Because building plutonium inventory and the plutonium inventory associated with specific stacks is classified, the expanded NESHAPs approach, based on inventory, cannot be utilized without classifying this report. Actual monitoring data from both sample flow samplers (PAMS) and alpha chain monitors (CAAMS) without classification concerns. The air monitoring data for all emission points, for all monitoring systems, show no detectable released plutonium activity whatsoever, i.e., at or below the limit of sensitivity of the analytical analysis, <1 X 10-15 microcuries per cubic centimeter of air.								
332	Various	332-FHE-1000/2900 (Plenum)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
332	Various	332-FGBE-1000/2900 (Loff)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
332	Various	332-FHE-4/5 (Downdraft)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
332	Various	332-FHE-4/5 (Loff)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
332	Various	332-FGBE-3000/4000 (Loff)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
332	Various	332-FFE-1000/2900 (Increment 3)	Plutonium research	Pu-238	0*	Multiple HEPA filters	>99.97	PAMS and CAAMS
B341 is a Physical Sciences Directorate research facility. The experimental studies within the facility include the use of high-energy electrical systems, explosives, high-velocity armor impact experiments, and development and testing of laser systems, flash x-ray generation, and hydrodynamic jetting.								
341	1015	341-1015-NO ID	Temporary storage	U-238	1.5×10^{-8}	HEPA	99.97	None
The biomedical research complex includes buildings 361, 363, 365, and 368. Buildings 363 and 368 have discontinued the use of radionuclides. Building 365 contains small amounts of tritium, carbon-14 and sulfur-35 incorporated in animal carcasses stored frozen pending disposal. No chemical operations are done in Building 365, and the building air is filtered through at least two HEPA filters and one charcoal filter before being exhausted. Most of the organs that contained radionuclides have been removed from the animals for examination. The radionuclide sources in building 361 include tritium, carbon-14, phosphorus-32, and sulfur-35, mostly incorporated as contaminant alone (resins) or in organic compounds.								
361	1245	361-1345-FHE-20/21	Radioactive Tracers	P-32	2.0×10^{-8}	None	0	None
361	1242	361-1342-FHE-18	Use of tracers for biomedical research	C-14	2.3×10^{-8}	None	0	None
361	1348	361-1348-FHE-17	Use of tracers for biomedical research	P-32, S-35	4.2×10^{-9}	None	0	None
361	1347	361-1347-FHE-16	Use of tracers for biomedical research	H-3 P-32	1.0×10^{-8} 1.8×10^{-9}	None	0	None
361	1442	361-1442-FHE-31	Use of tracers for biomedical research	H-3 C-14	1.0×10^{-8} 1.0×10^{-9}	None	0	None
361	1445	361-1445-FHE-14	Use of tracers for biomedical research	P-32, S-35	2.0×10^{-9}	None	0	None

Attachment 1 - 1993 LHM NESHAP's Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Massflow (m³)	Distance to Site Wall (m)	Annual Effective Dose Equivalent (mrem)	EDC Category
HEPA	99.97	None	11.50	0.83	8.83	1044	3.0×10^{-4}	2
interlocking significant reduction in sodium work and inventory down sitting.								
None	0	Continuous molecule sieve and ion chamber	30.00	1.22	7.88	848	7.3×10^{-2}	3
None	0	Continuous molecule sieve and ion chamber	30.00	1.22	10.80	848	2.3×10^{-2}	3
Double HEPA Mixed and measured with								
Note: Because building plutonium inventory and the plutonium inventory associated with data from both sample flow samplers (PAMS) and alpha stream monitors (CAMS) can be presented, whichever, i.e. at or below the limit of sensitivity of the analytical analysis.								
Multiple HEPA filters	>99.97	PAMS and CAMS	8.80	1.07	17.70	912	0*	3
Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.30	7.00	912	0*	3
Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.20	14.30	912	0*	3
Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.88	6.80	912	0*	3
Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.30	2.10	912	0*	3
Multiple HEPA filters	>99.97	PAMS and CAMS	10.1	0.81	12.20	912	0*	3
employees; high-velocity armor impact experiments; and development and testing of optics.								
HEPA	99.97	None	10.08	0.40	8.40	852	4.8×10^{-7}	2
Building 365 contains								
Building 365, and the building air is filtered through								
periods for measurement								
in organic compounds.								
None	0	None	7.00	0.40	4.40	855	1.4×10^{-7}	2
None	0	None	7.01	0.41	4.40	855	2.8×10^{-6}	2
None	0	None	7.01	0.41	4.40	855	3.0×10^{-7}	2
None	0	None	7.01	0.41	4.40	855	1.1×10^{-7}	2
None	0	None	7.32	0.26	3.80	855	6.5×10^{-8}	2
None	0	None	7.01	0.41	4.40	855	1.0×10^{-7}	2

Building	Room/Area	Stock ID	Operation	Radionuclides	Estimated Annual Release	Control Device	Efficiency	Type of monitoring or release point
					ICI			
361	1446	361-1446-FHE-15	Use of tracers for biomedical research	P-32	4.6×10^{-9}	None	0	None
361	1542	361-1542-FHE-15	Use of tracers for biomedical research	P-32, S-35	3.8×10^{-9}	None	0	None
361	1564	361-1564-FHE-2000	Use of tracers for biomedical research	H-3 C-14	1.2×10^{-7} 2.1×10^{-8}	None	0	None
361	1625	361-1625-FHE-28	Use of tracers for biomedical research	S-35	1.8×10^{-11}	None	0	None
361	1642	361-1642-FHE-11	Use of tracers for biomedical research	P-32, S-35	3.5×10^{-9}	None	0	None
361	1642	361-1642-FHE-6	Use of tracers for biomedical research	H-3 C-14	5.0×10^{-9} 7.8×10^{-9}	None	0	None
361	1858	361-1858-FHE-1000	Use of tracers for biomedical research	P-32	1.6×10^{-8}	None	0	None
361	1864	361-1864-FHE-2000	Use of tracers for biomedical research	H-3	5.0×10^{-8}	None	0	None
361	1742	361-1742-FHE-8	Use of tracers for biomedical research	P-32, S-35	8.0×10^{-9}	None	0	None
361	1745	361-1745-FHE-7	Use of tracers for biomedical research	S-35	3.8×10^{-10}	None	0	None
Building 377 is operated by the Health and Ecological Assessment Division. The major activities in this facility are associated with chemical and radiological sample preparation for environmental analysis, and analysis of soil, water, vegetation, etc., samples.								
377	1002	377-1002-FHE-6	Environmental sampling	C-14 H-3 H-33	2.8×10^{-3} 8.0×10^{-3} 1.8×10^{-8}	None	0	None
377	1005	377-1005-FHE-1	Environmental sampling	C-14 H-3	2.6×10^{-7} 8.0×10^{-8}	None	0	None
377	1028	377-1028-FHE-1000	Biomedical experiments	P-32	1.3×10^{-4}	None	0	None
Building 378 is operated by the Health and Ecological Assessment Division. The major activities in this facility are associated with chemical and radiological sample preparation for environmental analysis, and analysis of soil, water, vegetation, etc., samples.								
378	120	378-120-FHE-1,2,3,4,5,8,9,10	Environmental analysis	Pu-242 Pu-238 Am-241	1.8×10^{-12} 3.8×10^{-13} 7.2×10^{-13}	None	0	None
378	120	378-120-FHE-6,7	Environmental analysis	Pu-242 Pu-238 Am-241	4.8×10^{-13} 8.0×10^{-14} 1.8×10^{-13}	None	0	None
Building 381 is part of the Laser Fusion Program. Small quantities of tritium are handled in support of laser target research and development.								
381	B156	381-B156-FHE-1	Neutron spectroscopy target storage	H-3	8.0×10^{-3}	None	0	None
Building 391 is part of the Laser Fusion Program. The high energy laser is located in this facility. Small amounts of tritium are handled in support of laser target research and development.								
391	Various	391-FHE-1	High Energy Laser	H-3	2.8×10^{-1}	None	0	None
Building 419 - Decontamination Facility was used until 1999, at which time decontamination was curtailed and the area is no longer in use.								

Attachment 1 - 1993 LLNL NESHAPs Annual Report Spreadsheet

Control Device	Efficacy	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site View (m)	Annual Emissions Other Equivalents (metric tons)	WOC Category
None	0	None	7.01	0.41	4.40	855	3.9×10^{-7}	2
None	0	None	7.01	0.41	4.40	855	3.0×10^{-7}	2
None	0	None	7.82	0.85	5.80	855	2.8×10^{-7}	2
None	0	None	5.49	0.10	8.30	855	1.2×10^{-8}	2
None	0	None	7.01	0.41	4.40	855	3.0×10^{-7}	2
None	0	None	7.01	0.41	4.40	855	1.0×10^{-7}	2
None	0	None	7.82	0.85	2.80	855	1.1×10^{-6}	2
None	0	None	7.01	0.41	4.40	855	3.0×10^{-8}	2
None	0	None	7.01	0.41	4.40	855	5.0×10^{-7}	2
None	0	None	7.01	0.41	4.40	855	2.8×10^{-8}	2
Total sample preparation for environmental analysis, and analysis of soil.								
None	0	None	5.78	0.10	11.80	229	1.6×10^{-7}	2
None	0	None	5.78	0.28	5.80	838	2.0×10^{-8}	2
None	0	None	8.23	0.23	20.80	838	8.8×10^{-4}	2
Total sample preparation for environmental analysis, and analysis of soil.								
None	0	None	8.53	0.30	5.80	816	1.6×10^{-8}	2
None	0	None	8.53	0.30	9.70	816	4.0×10^{-10}	2
None	0	None	11.28	0.36	20.8	888	3.8×10^{-7}	2
Total target research and development								
None	0	None	8.10	0.30	9.8	1050	3.2×10^{-5}	2

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci)	Control Devices	Efficiency	Type of monitoring at release point
410			No current operations	None	0	HEPA	99.97	Filter
Building 410 is part of LLNL's Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program. The Separation Demonstration Facility (SDF), which requires uranium for enrichment, is located in this building. Stack sampling is continuous. The building also always operates with two in-series high efficiency particulates (HEPA) filter banks in place. CAP98-PC model results for the hypothetical situation with no hydrogen in place indicate a rate exceeding the rate required per the MESHAPs 40 CFR 61 regulations. Even though the model results show that stack sampling is not required, Building 410 air emissions are continuously sampled at the post-SCF222 gas atmospheric discharge point.								
480	10B1	480-10B1-STACK	Uranium atomic vapor laser isotope separation	None	0	Double HEPA	>99.97	Filter
Building 491 is part of the complex that houses the Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program. The separator is being redesigned and the facility has no inventory of radionuclides. When the facility is operational, exhaust air will be passed through two in-series HEPA filters before being discharged to the air and the single stack will be sampled continuously. (Although there are no radionuclides released, the model parameters are shown.)								
491	Vapor	491-FHE-1000	Inertial separator being redesigned	None	0	Double HEPA	>99.97	Filter
Building 513 is operated for the Hazardous Waste Management Division. A potential source for release of radionuclides is the mixed waste shredder. A waste solidification unit is not in use. No releases are assumed to occur from waste storage because the wastes are fully contained.								
513	Shredder	Shredder	Shredding of solid waste	None	0	HEPA	99.97	None
Building 514 - See Diffuse Source Section below.								
Building 584 was used in research to assess the translocation of carbon through plant tissues, but this work was terminated in 1993.								
584			No current operations	None	0	None	0	None
Building 612 is operated for the Hazardous Waste Management Division. A drum crusher is used to compact 55-gallon drums and smaller containers that previously contained hazardous chemicals or radioactive materials. The drum crusher is connected to a high-efficiency particulate air filter. The waste compactor/filter is used to reduce the volume of low-level waste prior to shipment to, and disposal at, the Nevada Test Site. The unit, which is not currently in operation, is connected to a HEPA filter. No operations were performed in 1993.								
612	Crusher - Compactor		No current operations	None	0	HEPA	99.97	NONE
Building 614 serves as a storage area for radioactive and mixed wastes which are awaiting disposal.								
614		Storage Area	Encapsulated sources	0	None	0	0	None
Building 625 serves as a storage area for radioactive and mixed wastes which are awaiting disposal.								
625		Storage Area	Encapsulated sources	0	None	0	0	None
Trailer 2581 is administered by L Division.								
2581	AE	2581-AE (NO ID)	Preparation of Fols	U-238 U-234	1.4 x 10 ⁻¹¹ 1.8 x 10 ⁻¹¹	HEPA	99.97	None
SITE 300 POINT SOURCE								
Site 300 Explosives tests are conducted on open-air firing tables located at Bunkers 801, 850 and 851. These tests have depleted uranium material as part of the material inventory. There are multiple tests per year. A total for 1993 is shown here. The radionuclides in Buildings 804, 810A, 810B, 827B and 854E are encapsulated or sealed and are not used.								
801	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	2.0 x 10 ⁻² 4.0 x 10 ⁻⁴ 7.8 x 10 ⁻³	None	0	None
850	Firing Table	N/A	Explosive Tests	None	0	None	0	None
851	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	1.5 x 10 ⁻³ 2.2 x 10 ⁻⁵ 2.2 x 10 ⁻⁴	None	0	None

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Water (m)	Auxiliary Effluent Data Equipment (m/min)	Risk Category
HEPA	99.97	Filter	N/A	N/A	N/A	720	0.	3
process uranium for enrichment, is located in this building								
41 regulations. Even though the model results show that stack								
Double HEPA	>99.97	Filter	13.70	0.89	5.70	849	0.	3
grad and the facility has no inventory of radionuclides								
Double HEPA	>99.97	Filter	11.60	0.94	20.40	900	0.	3
HEPA	99.97	None	8.84	0.59	1.40	880	0.	3
None	0	None	N/A	N/A	N/A	715	0.	2
all previously contained hazardous chemicals or radioactive materials								
It is not currently in operation, is connected to a HEPA filter								
HEPA	99.97	LCME	N/A	N/A	N/A	420	0.	2
None	0	None	N/A	N/A	N/A	510	0.	2
None	0	None	N/A	N/A	N/A	428	0.	2
HEPA	99.97	None	3.05	0.24	5.00	1082	1.0 x 10 ⁻³	2
as part of the material inventory. There are multiple tests per year								
None	0	None	N/A	N/A	N/A	2380	8.5 x 10 ⁻³	4
None	0	None	N/A	N/A	N/A	4000	0	4
None	0	None	N/A	N/A	N/A	3870	1.5 x 10 ⁻³	4

Building	Report Area	Stack ID	Operation	Radionuclides	Estimated Annual Release	Control Devices	Efficiencies	Type of monitoring at release point
OFFGAS SOURCE SECTION								
Building 292 - diffuse emissions result from non-contaminated water which leaked from an underground storage tank. Vegetation in the area transpires water with elevated tritium concentrations.								
292	Soil Area	N/A	Evaporation and Transpiration	H-3	7.8 ± 10-3	None	0	Soil Gas
Building 331 - As part of D&D operations contaminated equipment outside the facility is washed, transport and storage by hazardous waste management.								
331	Outside	N/A	Storage of Contaminated Parts	H-3	3.0	None	0	None
Building 514 is operated for the Hazardous Waste Management Division. The wastewater treatment tank farm and storage tank area processes the liquid waste from facilities on site. The treatment process may involve batch chemical treatment consisting of neutralization, flocculation, oxidation, reduction, precipitation, separation, and dewatering. Areas used for storage are not considered to release radionuclides because the wastes are fully contained.								
514	Tank Farm	Base Source	Radioactive Waste Treatment Tanks	Am-241	8.8 ± 10-8	None	0	None
				Ba-140	1.6 ± 10-9			
				Ce-141	8.2 ± 10-10			
				Ce-144	3.2 ± 10-6			
				Co-57	8.4 ± 10-10			
				Co-58	8.2 ± 10-10			
				Co-60	4.3 ± 10-9			
				Co-134	5.2 ± 10-10			
				Co-137	1.2 ± 10-8			
				U-238	1.9 ± 10-6			
				U-235	1.8 ± 10-6			
				U-234	4.1 ± 10-10			
				Fe-59	5.2 ± 10-10			
				H-3	1.4 ± 10-7			
				Mn-54	1.3 ± 10-8			
				Nb-92	3.8 ± 10-10			
				Nb-95	2.2 ± 10-7			
				Ru-103	4.8 ± 10-10			
				Nb-125	1.3 ± 10-8			
				Sc-46	4.8 ± 10-10			
				Zr-95	5.2 ± 10-10			
				Zr-98	1.0 ± 10-7			
				Nb-99	3.8 ± 10-9			
514	Tank Farm	None--roof vent	Salt production	Am-241	8.8 ± 10-12	None	0	None
				Ba-140	1.6 ± 10-12			
				Ce-141	8.2 ± 10-13			
				Ce-144	3.2 ± 10-12			
				Co-57	8.4 ± 10-13			
				Co-58	8.2 ± 10-13			
				Co-60	4.3 ± 10-12			
				Co-134	8.2 ± 10-13			
				Co-137	1.2 ± 10-11			
				U-238	1.9 ± 10-9			
				U-235	1.8 ± 10-11			
				U-234	4.1 ± 10-13			
				Fe-59	5.2 ± 10-13			
				H-3	1.4 ± 10-10			
				Mn-54	1.3 ± 10-11			
				Nb-92	3.8 ± 10-13			
				Nb-95	2.2 ± 10-10			
				Ru-103	4.8 ± 10-13			
				Nb-125	1.3 ± 10-11			
				Sc-46	4.8 ± 10-13			
				Zr-95	5.2 ± 10-13			
				Zr-98	1.0 ± 10-10			
				Nb-99	3.8 ± 10-12			

Attachment 1 - 1993 LUN, HESHA's Annual Report Spreadsheet

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (ft)	Stack Diameter (ft)	Monitors (m/s)	Distance to Site Wide MET (m)	Annual Emission Data Equivalent (arom)	BOE Category
w/ water with elevated Arsenic concentrations								
None	0	Stack Gas	1.00	400 m ^{1/2}	0.00	1383	2.5 ± 10-6	5
w/ waste from facilities on site								
None	0	None	1.00	1 m ^{1/2}	0.50	884	3.8 ± 10-3	5
w/ waste from facilities on site								
None	0	None	1.00	6 m ^{1/2}	0.20	520	8.2 ± 10-4	5
w/ waste from facilities on site								
None	0	None	1.00	6 m ^{1/2}	0.20	520	8.2 ± 10-7	5

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci)	Control Devices	Emissions	Type of monitoring at release point
The Building 812 Yard is operated by the Hazardous Waste Management Division. The Yard consists of several areas where containers having radioactive wastes are stacked outdoors. The containers, which are not air tight, can outgas tritium.								
412	Area Source		Storage of low level waste	H-3	2.2	None	0	Tritium sampler
Southeast Quadrant	Area Source		Reinspiration	Po-210	N/A	None	0	High volume air filter
Site 300 - Diffuse sources consist of evapotranspiration of treated water and reabsorption of depleted uranium. Treated water appears probably land areas where water dumped from tanks has been dumped, an open stream filling, and evaporation of water from soils due to irrigation from contaminated ground water.								
Pt 7 complex	Area Source		Evaporation from soil and purple water	H-3	1.1	None	0	None
803	Area Source		Evaporation from soil	H-3	2.9×10^{-4}	None	0	None
850	Area Source		Evaporation from soil	H-3	1.4×10^{-1}	None	0	None
851	Area Source		Evaporation from soil	H-3	4.0×10^{-4}	None	0	None
Well 8 Spring	Area Source		Evaporation from spring water	H-3	2.4×10^{-3}	None	0	None
Site 300	AI		Soil Reinspiration	U-238 U-235 U-234	N/A N/A N/A	None	0	High volume air filter
EMISSIONS WHICH CONTRIBUTE TO MORE THAN 1% OF THE POTENTIAL EFFECTIVE DOSE EQUIVALENT AT EACH SITE								
331		331-FHE-1	Tritium research	H-3 RT(O) H-3 (RT)	4.1×10^{-1} 1.5×10^{-1}	None	0	Continuous molecular sieve and ion chamber
331		331-FHE-2	Tritium research	H-3 RT(O) H-3 (RT)	7.5×10^{-1} 1.1×10^{-2}	None	0	Continuous molecular sieve and ion chamber
801	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	3.0×10^{-2} 4.0×10^{-4} 2.8×10^{-3}	None	0	None
851	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	2.5×10^{-3} 3.2×10^{-5} 2.3×10^{-4}	None	0	None

Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Monitors (m/s)	Distance to Site (m)	Annual Monitor Data Equivalent (m/s)	BLU Category
None	0	Tribune sampler	1.00	6000 m ² /2	0.	420	2.0 x 10-3	3
None	0	High volume air filter	N/A	N/A	N/A	0.	1.5 x 10-3	3
1993 Water Meter								
None	0	None	0.0	18,032 m ² /2	0.5	4710	9.9 x 10-4	5
None	0	None	0.0	892 m ² /2	0.5	3000	1.1 x 10-7	5
None	0	None	0.0	20,624 m ² /2	0.5	4110	1.5 x 10-5	5
None	0	None	0.0	467 m ² /2	0.5	4020	4.5 x 10-4	3
None	0	None	0.0	9.3 m ² /2	0.5	3860	2.5 x 10-7	5
None	0	High volume air filter	N/A	N/A	N/A	N/A	2.5 x 10-2	3
None	0	Continuous molecular sieve end on chamber	30.00	1.22	7.58	984	1.3 x 10-3	3
None	0	Continuous molecular sieve end on chamber	30.00	1.22	10.50	984	2.2 x 10-2	3
None	0	None	N/A	N/A	N/A	2380	8.5 x 10-3	4
None	0	None	N/A	N/A	N/A	3870	1.5 x 10-3	4