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**Environmental Protection Department
Environmental Monitoring and Analysis Division**

**LLNL NESHAPs Project
1992 Annual Report**

**Lawrence Livermore National Laboratory
University of California Livermore, California 94550**

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LLNL NESHAPs Project 1992 Annual Report

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**U.S. Department of Energy
Radionuclide Air Emission Annual Report
(under Subpart H of 40 CFR Part 61)
Calendar Year 1992**

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LAWRENCE LIVERMORE LABORATORY 1992 NESHAPs REPORT

SECTION I. Facilities Information

Site Description

Lawrence Livermore National Laboratory (LLNL) is operated by the University of California for the United States Department of Energy (DOE). The Laboratory was established in 1952 to conduct weapons research and development. Since then, other major programs have been added. These include magnetic fusion energy, inertial confinement fusion, laser isotope separation, biomedical and environmental sciences, and applied energy technology. These programs require research in such basic scientific disciplines as chemistry, engineering, physics, and biology. LLNL also carries out a variety of projects for other Federal agencies.

Livermore site: The LLNL Livermore site occupies an area of 3.3 km² and is located about 64 km east of San Francisco, California, in the Livermore Valley of eastern Alameda County, adjacent to the City of Livermore. Nearly 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 15.6 °C. The normal seasonal temperature range is defined by nighttime winter lows in the vicinity of 0 °C and summer daytime highs approximately 38 °C. Prevailing winds for approximately half of the year are from the west and southwest. During the remainder of the year, the wind is calm or wind directions are variable.

Rainfall exhibits a strong seasonal pattern. Most of the precipitation occurs between October and April, with very little rainfall during the warmer months. During 1992 the precipitation measured 366 mm. The highest and lowest annual rainfalls on record are 782 mm and 138 mm.

Site 300: Site 300, LLNL's non-nuclear high explosives (HE) testing 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 in close proximity to two other HE 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 that are oriented along a generally northwest/southeast trend and which are separated by intervening ravines. The elevation ranges from approximately 538 m in the northwestern portion of the site to 150 m at the southeast corner.

The climate at Site 300, while generally similar to that of the Livermore site, is modified by higher elevation and more pronounced relief. The temperature range is somewhat more extreme than that at the Livermore site, with an average temperature of 16.6 °C, and the local topography significantly influences surface wind patterns. Prevailing winds are generally 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. During 1992, 303 mm of precipitation were measured.

Source Description

A wide variety of radioisotopes are used at LLNL, including transuranics, biomedical tracers, tritium, mixed fission products, and other radioisotopes for general research and nuclear weapons research. 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 filtered stacks, to direct small hood roof vents, to direct dispersal of depleted uranium during non-nuclear high-explosives testing at Site 300.

The potential emitted radioisotopes from LLNL facilities include: H-3, N-13, C-14, O-15, Na-22, P-32, S-35, Cl-36, Ca-45, Mn-54, Fe-55, Co-57, Co-58, Co-60, Ni-63, Kr-85, Sr-85, Sr-89, Sr-90, Y-90, Y-91, Nb-94, Nb-95, Zr-95, Mo-99, Tc-99m, Ru-103, Ru-106, Ag-110m, Ag-111, Sb-125, I-125, Sb-126, Sb-127, Sc-127, I-129, I-131, I-132, Te-132, Ba-133, Xe-133, Xe-133m, Xe-135, Cs-136, Cs-137, Ba-140, La-140, Ce-141, Ce-144, Nd-147, Gd-148, Eu-152, Eu-155, Eu-154, Eu-156, Ho-166, Tm-168, Ta-182, Tl-204, Bi-207, Po-210, Bi-214, Ra-226, Th-232, U-235, U-234, U-235, Np-237, U-238, Pu-239, Pu-240, Am-241, Am-242m, Pu-242, and Cf-252.

SECTION II. Air Emission Data

Sources

Information regarding radionuclide air emissions for each of 56 buildings at LLNL where radionuclides are used or activation products occur is given in the enclosed spreadsheet (Attachment 1).

Detailed information is given for all point source emissions from 43 Livermore site buildings. Three Livermore site facilities (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. Two Livermore site facilities (Buildings 514 and 612) are treated as area sources with detailed information found in the Diffuse Sources Section. Detailed information regarding three other diffuse sources also can be found in that section.

Detailed information is given for three Site 300 explosive testing facilities (Buildings 801, 850, and 851 and their associated firing tables). Five other Site 300 facilities are included by reference because radionuclides are not in use in those buildings, are encapsulated, or are sealed.

Estimated Dose Equivalent Calculations: LLNL has prepared seven quarterly reports to the EPA to document the evaluation of all facilities having a potential to discharge radionuclides to the atmosphere for compliance with the National Emissions Standards for Hazardous Air Pollutants standards (40 CFR 61 Subpart H). In general, 1990 wind data were used in the calculations to ensure consistency. The best available inventory data at the time of the model runs, typically 1991, were used. Although 1992 inventory data were not used, most inventories decreased below those used in 1991, making calculations that used the 1991 data conservative. Furthermore, 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.

Based on guidance from DOE, recalculation of the effective dose equivalent (EDE) from each non-continuously monitored stack using 1992 wind data was not performed if it could be demonstrated that the change from the EDE based on the 1990 wind data to the EDE based on the 1992 wind data was small compared with 0.01 mrem/y (0.1 μ Sv/y). Such a screening was consistent with the stated DOE intention to report EDEs to two significant figures.

The annually-averaged distribution of wind speeds with direction at LLNL varies only slightly from year to year. Doses calculated using data sets that are identical save for this meteorological data are typically found to differ little in any given direction and distance to the site boundary. Figure 1 displays this effect for doses resulting from tritium emissions from one of the two stacks on Building 331 (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 windroses from 1990 and 1992. The maximum EDE value occurred in the same direction—the northeast sector—for this example, with magnitudes that differ by 12.5%. Other examples gave nearly this same difference in EDE.

To avoid laborious recalculation of all non-continuously monitored emission points, many of which do not contribute significantly to the cumulative EDE derived for the entire site, a screening value was used, below which no recalculations were performed. New dose calculations were made, however, on all continuously monitored facilities based on direct 1992 monitoring data. The screening value used was 0.01 mrem/y (0.1 μ Sv/y) [0.1% of the 10 mrem/y (100 μ Sv/y) EDE standard as stated in 40 CFR 61 Subpart H] modified by the expected difference between the two comparison years. Specifically, since the comparison showed 1992 doses were larger by 12.5 % than those for 1990 based on wind data differences only, calculations were repeated using 1992 wind data for all cases having maximum receptor doses larger than $0.01/1.125 = 0.009$ mrem/y (0.09 μ Sv/y). Any EDEs that likely would exceed the 0.01 mrem/y (0.1 μ Sv/y) level with 1992 windrose data were therefore recalculated.

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), the EDE, and an "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 that occur in the respective facilities. For Building 231, Room 1128 (a Materials Management vault that is used for the receipt, shipment and storage of sealed radioactive sources), the variety and turnover of radionuclides contained in this storage area makes a listing of individual radionuclides impractical. This area is continuously monitored, and emissions are therefore directly calculated.

Reported annual releases are based on inventory data and unabated EPA potential release fractions for unmonitored sources, and on actual emission measurements for continuously monitored facilities. The continuously monitored facilities at LLNL are Buildings 175, 231, 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. It is our intent to implement the DOE/EH-0173T guidance (where actual values, both positive and negative, are used in calculations of means) for data of this type in the future, but it was impractical to do so for this report. 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 determined isotopic analyses of selected filters which demonstrate that measured activity on filters comes from naturally-occurring radionuclides such as radon-daughters and polonium. In any case, 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.

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. No stack emission control systems are implemented for tritium. 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.

Some LLNL facilities have intermittent monitoring systems which function when operations are taking place. Other facilities have no effluent monitoring systems. All EDEs for unmonitored and non-continuously monitored facilities are based on radionuclide inventories and unabated emissions using EPA methodology. Such reported EDEs overestimate the actual LLNL impact. EDEs associated with

continuously monitored facilities are based on the actual air emission monitoring data and are therefore more realistic estimators of potential dose.

The SW-MEI is defined as the hypothetical member of the public (individual receptor) that receives the greatest LLNL-induced EDE from all sources at a single location. 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 Attachment 2. This location lies 948 m from the principal radionuclide source, the Tritium Facility (Building 331), in an east-northeast 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 Attachment 3. This bunker is 2.38 km southeast of the principal firing table, Building 801. In Attachment 1, the distance to the respective SW-MEI is shown for each facility at each site. Depending on the EDE category (see below), the distance from the facility to the SW-MEI may not be that associated with the presented EDE for a given emission point. If, based on the screening criteria presented above, recalculation of the EDE was not warranted, the EDE shown is that calculated to the MEI for that individual source, 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 (as the stated value is the maximum to any member of the public, in any direction).

The number and variety of EDE calculations require categorization. The first two EDE categories were from non-continuously monitored facilities that were screened using the criteria presented above and their EDEs were less than 0.009 mrem/y (0.09 μ Sv/y). These EDEs were calculated using 1990 wind data. Category 1 EDEs were calculated with AIRDOS-PC; Category 2 EDEs were calculated with CAP88-PC. The change from AIRDOS-PC to CAP88-PC was made to take advantage of the significant improvements made in the model. Category 3 EDEs were those from non-continuously monitored facilities that had an initial EDE calculation greater than 0.009 mrem/y (0.09 μ Sv/y). Category 3 EDEs were therefore recalculated using 1992 wind data and inventories. The only emission point in this category is in Building 177. Category 4 EDEs were those calculated using 1992 monitoring data from continuously monitored facilities. Category 5 EDEs were those calculated for Site 300 explosives tests (using 1992 data), and Category 6 EDEs were those calculated from estimated 1992 diffuse emissions. The EDE Category 5 and 6 emission sources presented significant modeling challenges, as detailed below in their respective dose assessment input parameter sections. All current calculations were performed with CAP88-PC.

SECTION III. Dose Assessment

Description of Dose Model

The estimated EDE to the SW-MEI was calculated using the EPA approved AIRDOS-PC or CAP88-PC models, as noted above in the EDE category column. Dose is expressed in units of mrem/y (1 mrem = 10 μ Sv), effective dose equivalent (EDE), as required by the NESHAPs regulations. Separate doses were calculated for the Livermore site and Site 300.

Summary of Input Parameters

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

Meteorological input for all model runs was actual Livermore site or Site 300 annual average data, as pertinent, acquired from the respective on-site meteorological towers. No EPA meteorological default files were used. Copies of each individual model run, input parameters, and resultant dose calculations are on file in the Environmental Protection Department of LLNL.

Because the EPA-mandated models (AIRDOS-PC and CAP88-PC) do not contain all the radionuclides present at LLNL, surrogate radionuclides were used to estimate EDEs. Attachment 4 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 Annual Limits of Intake via inhalation and Derived Air Concentration. CAP88-PC contains a library of more nuclides than AIRDOS-PC. By rerunning calculations in CAP88-PC previously modeled with AIRDOS-PC, we have found that the use of surrogates in the calculations result in conservative estimates of EDEs.

EDE Categories 1, 2, and 3: In accordance with 40 CFR Part 61 Appendix D, calculations were based on assumptions concerning the fraction of the annual inventory that potentially could be released. These assumptions generally were predicated on the differences in allowable possession quantities based on physical state, i.e., gaseous, liquid/powder, or solid, as outlined in Table 1, Appendix E to 40 CFR 61. If the material was a sealed gas, then the fraction 0.01 generally was used; for liquids and powders, 0.001 was used; and for solids, 0.000001 was used. In addition, no credit was taken for radionuclide emission control devices; emission inputs into the models were assumed to be unabated. Hence, when control devices were in use, actual emissions and exposures were much lower than reported.

EDE Category 4: Actual measured emissions from monitored facilities were used as input variables into CAP88-PC. The use of actual monitoring data is much more direct, and presumably more accurate, than using assumptions based on inventory and release fractions.

EDE Category 5: High-explosive tests using depleted uranium at Site 300 required special attention. During experiments, the explosive device being tested 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, however, be used to define the cloud using the radionuclide and high-explosive inventories. Isotopic ratios of uranium are used, 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 masses of the isotopes are multiplied by their respective specific activities to get the total number of curies for each isotope in the cloud. CAP88-PC then simulates each shot as a low-level, steady-state, stack-type emission occurring over one year. EPA directed LLNL to use the CAP88-PC code for these calculations, despite the recognized difficulties in modeling explosive events.

EDE Category 6: EDE Category 6 is reserved for diffuse emissions, both area sources and fugitive emissions. Refer to Section 4 below.

Compliance Assessment

The 1992 calculated EDE to the site-wide maximally exposed member of the public, individual receptor (U.N.C.L.E. Credit Union, east of the Livermore site), from Livermore site measured and calculated radionuclide air emissions, using the EPA AIRDOS-PC and CAP88-PC models and actual LLNL meteorology was 0.069 mrem (0.69 μSv). The main contributor, 0.037 mrem (0.37 μSv), was from LLNL Tritium Facility (Building 331) emissions. These emissions contributed to 54% of the Livermore site EDE. The only other emission point contributing to greater than 10% of the EDE was Room 1020 in Building 177, whose emissions resulted in 15% of the EDE. Refer to the "Point Source Radionuclide Section" near the end of Attachment 1.

Dose to the site-wide maximally exposed member of the public, individual receptor, at Site 300 was calculated to be 0.021 mrem (0.21 μSv) EDE. Virtually all the EDE resulted from Building 801 firing table emissions. Other Site 300 emissions did not result in significant dose contributions. Refer to the "Point Source Radionuclide Section" near the end of Attachment 1.

All EDE data, produced using EPA-mandated computer dispersion models, are well below 10 mrem/y (100 $\mu\text{Sv}/\text{y}$), indicating that Lawrence Livermore National Laboratory is in compliance with 40 CFR 61 Subpart H, U.S. Environmental Protection Agency, National Emission Standards for Hazardous Air Pollutants (NESHAPs) dose standards for Department of Energy 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. Proposed facilities such as the Mixed Waste Management Facility (MWMF) and the Contained Firing Facility (CFF) are assessed for NESHAPs requirements during the National Environmental Policy Act process. These facilities were still in the planning stage at the end of 1992.

Unplanned Releases

There were no accidental atmospheric radionuclide releases at either the Livermore site or Site 300 during 1992.

Diffuse Source Dose Assessments

EDE Category 6: Diffuse, or non-point, sources are difficult to quantify. There are no EPA-mandated methods for measurement; dose calculations associated with these types of sources are left to the discretion of the DOE facility. The dose calculations from 1992 diffuse sources at LLNL required four different modeling approaches. Building 292 required a calculation of source term and the use of CAP88-PC; Building 331 needed facility personnel knowledge to estimate emissions; Buildings 514 and 612 required standard CAP88-PC modeling techniques; and in the Southeast Quadrant we used direct ambient air monitoring data on which to base dose calculations. The calculated EDEs are listed in Attachment 1. Below is a discussion of each source and the assumptions made regarding the emissions.

Building 292: Elevated tritium concentrations in soil moisture near Building 292 resulted from an historical leak in an underground retention tank. This contamination has resulted in diffuse tritium emissions from evaporation of soil moisture and transpiration from vegetation. Based on measurements to determine the level of diffuse tritium emission in the area, the amount of tritium released to the atmosphere was seen to be greatly affected by the transpiration of a single pine tree. The total annual emissions from this pine tree were calculated based on estimated leaf area (250 m²) and transpiration rates (120 L/day), together with measured concentrations of tritium in transpired water (annual mean of 13,000 pCi/L or 480 Bq/L), producing an emission rate of 5.8×10^{-4} Ci/y (2.2×10^7 Bq/y). The annual tritium release to the atmosphere stemming from other vegetation (notably neighboring pine trees) and evaporation of soil moisture are represented by generous upper-bound estimates. A high value for the measured flux from the ground near the tank is $0.26 \mu\text{Ci}/\text{m}^2 \text{ y}$ (9.6×10^3 Bq/m²y). Assuming 400 m² effective area, based on isoactivity contours, this gives 1.0×10^{-4} Ci/y (3.9×10^6 Bq/y). The integrated contributions of neighboring pine trees and other vegetation are

estimated from portable air sampler data to contribute another 1.7×10^{-3} Ci/y (6.3×10^7 Bq/y). The total diffuse tritium emissions from this area are therefore determined to be 2.4×10^{-3} Ci/y (8.8×10^7 Bq/y).

Building 331: A small amount of tritium-contaminated equipment exists outside the facility. Items include glove-box shells, pumps, a molecular sieve, and miscellaneous brackets, shelves and other debris. Several of these items have been packed into a metal box for transport to Hazardous Waste Management. A semi-quantitative estimate of total outgassing has been derived by Building 331 personnel based on measurements from similar boxes previously shipped and process knowledge. The result is 0.8 Ci/y (3.0×10^{10} Bq/y) for the diffuse source emissions around Building 331. This source term was used in CAP88-PC with a stack height of 3 m, an area source of 1 m², and an exit velocity of 0.5 m/s.

Buildings 514 and 612: Another potential source of diffuse emissions of a variety of radionuclides is Hazardous Waste Management operations. Building 514 houses the HWM "tank farm" and Building 612 is adjacent to waste processing and storage yards. These facilities were modeled as part of our quarterly reporting activities using AIRDOS and CAP88-PC. We subjected them to the screening criteria mentioned above to determine if recalculations were warranted. Both facilities had calculated EDEs less than 0.009 mrem/y (0.09 μ Sv/y). Therefore, existing calculations were used, and they could be classified as EDE Category 1 or 2.

Southeast Quadrant:

In June 1991, a high-volume air-particulate sampler was placed adjacent to the U.N.C.L.E. Credit Union as part of a special study investigating elevated levels of Pu in southeast quadrant surface soil and air (presumably from resuspension). Monitoring data from this air sampler were used as a direct measurement of potential dose via the air pathway. A mean annual air concentration of 7.0×10^{-19} μ Ci/mL (2.6×10^{-14} Bq/mL) was used with the dose conversion factor of Pu-239 (0.342 mrem/pCi or 92.3 μ Sv/Bq) and standard man breathing rates to calculate the estimated dose.

Total Dose Estimate and Comparison with Previous Year's Data

For the Livermore site, the total dose calculated for the SW-MEI from diffuse emissions is 0.010 mrem/y (0.1 μ Sv/y). When both point and diffuse sources are considered, the total dose is 0.079 mrem/y (0.79 μ Sv/y). For comparison with data of previous years, the 1992 EDE for the Livermore site of 0.079 mrem (0.79 μ Sv/y) is much reduced from the previously reported EDE values of 0.240 mrem (2.40 μ Sv) and 0.234 mrem (2.34 μ Sv) for 1990 and 1991, respectively. Much of the reduction results from reduced tritium emissions from Building 331. The location of the maximally exposed member of the public, individual receptor, remains at the eastern side of LLNL, at the U.N.C.L.E. Credit Union, near the LLNL Visitor's Center (reported as the location of the SW-MEI for 1991).

Calculations were not previously made for Site 300, so no previous-year comparisons can be made. Similarly, no diffuse emissions occurred at Site 300, so comparisons with point-source calculations cannot be made.

SECTION V. Certification

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

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Signature: R. H. Nolan Date: 6/14/93
W. E. Keheley *for*

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
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Signature: Dennis K. Fisher Date: 6-8-93
Dennis K. Fisher

SECTION VI. Supplemental Information

Collective Effective Dose Equivalent

The collective effective dose equivalent for LLNL 1992 operations was 1.7 person-rem (0.017 person-Sv; based on the ingestion, immersion, and inhalation pathways). The dose was calculated out to a distance of 80 kilometers in all directions using 1990-census population data.

Compliance with 40 CFR 61 Subpart H (61.93)

Calculations of effective dose equivalent for all Livermore site and Site 300 facilities having the potential to release radionuclides to the atmosphere have been completed. Annual dose from actual total emissions (after control devices) of all facilities was found to be well below the 10 mrem/y (100 μ Sv/y) NESHAPs standard. 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 existing monitoring systems; however calculations resulted in EDEs less than 0.1 mrem/y (1 μ Sv/y); thus continuous monitoring is not required. No other facilities at either LLNL site were found to require continuous monitoring systems. Descriptions of, and testing conducted on, the existing monitoring systems indicate representative sampling is being performed (LLNL NESHAPs Project Quarterly Progress Report, March 31, 1993, UCRL-AR-108419-93-1). Therefore, LLNL has demonstrated compliance with the 40 CFR 61.93 NESHAPs regulations.

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

Lawrence Livermore National Laboratory 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

Lawrence Livermore National Laboratory does not have or store any uranium mill tailings.

Information on Radon-220 and Radon-222 Emissions

Radon sources at Lawrence Livermore National Laboratory are from natural earth emissions, which result in typical outdoor air concentrations of 0.1 to 0.5 pCi (4×10^{-3} to 2×10^{-2} Bq) per liter of air. The EPA radon screening level is 4 pCi (0.1 Bq) per liter of air. The doses from Radon-220 and Radon-222 from LLNL operations do not exceed 0.1 mrem (1 μ Sv) per year to the public.

NESHAPs Continuous Monitoring Requirements

We have 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). In our March, 1993, quarterly progress report to EPA Region IX, we reported on recent changes in operation made to the existing monitoring systems. These changes were made to ensure the extraction of representative samples. Upgrades to these sampling systems are also in progress and will allow the specifics of the NESHAPs regulatory requirements and ANSI guidelines to be rigorously met. Although exact estimates of the costs of these upgrades are not yet known, we estimate that the associated costs will be approximately \$800,000.

Site Periodic Confirmatory Measurements

Lawrence Livermore National Laboratory 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 five tier approach: (1) continuous monitoring at selected facilities, (2) quarterly effluent sampling, (3) annual effluent sampling, (4) general surveillance monitoring, and (5) site-specific surveillance monitoring, as described below.

Continuous Monitoring: In addition to the continuous monitoring required for Buildings 331, 332, and 251, five additional facilities have continuous effluent monitoring systems (Buildings 175, 231, 419, 490, and 491). LLNL will maintain these monitoring systems and the data from filter analyses will be reviewed by both a Hazards Control Health Physicist responsible for the area and an Environmental Protection Department Environmental Analyst.

Quarterly Effluent Sampling: For sources where the EDE is greater than or equal to 0.1% of the NESHAPs emission standard of 10 mrem/y (100 μ Sv/y), and no existing monitoring system is in place, LLNL plans to institute quarterly sampling of the effluent downstream of any emission control systems. This program is not currently in place.

Annual Effluent Sampling: For sources where the EDE is between 0.01% and 0.1% of the NESHAPs emission standard of 10 mrem/y (100 μ Sv/y) (between 0.001 and 0.01 mrem/y or 0.01 and 0.1 μ 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. This program is not currently in place.

General Surveillance Monitoring: Surveillance air monitoring for tritium and for radioactive particulates 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-wide Annual Environmental Report.

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 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 and will be instituted for any newly identified diffuse sources.

Status of the NESHAPs QA Program

The LLNL NESHAPs Quality Assurance (QA) Program is a multidisciplinary effort. Each LLNL facility with an effluent monitoring system maintains its own quality assurance/quality control program. A major part of these programs is the aspect of quality assurance required for documentation of the facility's emissions. In addition the Hazards Control Department's Radiological Measurements Laboratory's quality assurance program encompasses the sample tracking, analysis, and data reporting functions. Another major part of each of these quality assurance plans is the implementation of procedures which govern the sampling and analysis. The Environmental Protection Department, under whose auspices NESHAPs modeling and reporting is conducted, also operates under a Quality Assurance Management Plan and associated procedures. Detailed records are kept of all measurements, model runs, and calculations. Model runs are frequently validated and rerun. When new operations are proposed, significant changes in inventories occur, or existing operations are modified, NESHAPs calculations are performed and archived.

LLNL was the subject of a Radionuclide NESHAPs, Subpart H audit by EPA Region IX on December 14-15, 1992. Mr. Shelly Rosenblum of EPA Region IX Office of Radiation and Indoor Air stated that he "did not have findings in addition to those previously identified by LLNL in the Quarterly Compliance Reports and that those items should be addressed in the context of the over-all compliance schedule." He concluded "not recommending any actions by EPA."

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
NOTE: The AIRDOS and CAP88-PC codes require activity rates of curies/year and give doses in mrem/year. To convert curies to becquerels use $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$ and to convert millirem to sieverts use $1 \text{ mrem} = 1.0 \times 10^{-5} \text{ Sv}$.									
LIVERMORE SITE SECTION									
Building 131 complex is a large off-laboratory facility housing both Mechanical Engineering and Electrical Engineering. The high-bay facility houses Mechanical Engineering, Weapons Engineering, and the Nuclear Explosive 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	3.0×10^{-10} 9.0×10^{-7}	HEPA	99.97	None	10.6
131	Hi-Bay Rooms 1345, 1345A, 1331, 1349, 1339, 1341, 1350, 1350A, 1350C	131-HiBay-FEV	Machining classified parts	Th-232 U-234 U-235 U-238	1.7×10^{-11} 5.1×10^{-11} 6.9×10^{-14} 5.0×10^{-11}	HEPA	99.97	None	10.6
Building 151 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 drillback cores. Due to the nature of the nuclear weapons tests, it is not possible to report absolute values for the various nuclides, because they vary according to test and sampling conditions. Estimates taken over a one year period of time can be considered reliable. Samples are initially processed in the dissolving facility in room 1043. This facility is completely enclosed, and exhaust either passes through HEPA filters or through a caustic "scrubber solution" to collect condensed gases and to remove acid fumes. Volatile samples are handled in room 1143, where gaseous debris samples are chemically separated. The bulk of the initial radionuclide content is caused by short-lived Xe isotopes. In addition to inert Xe and Kr gases, there is a small amount of iodine and hydrogen in gaseous forms collected by the sampling systems. Gas sample collections are quite variable, but conservative estimates of average samples were made. The values used for modeling assume four events per year. Building 151 contains the Radiation Analytical Sciences laboratory (room 2117) where samples of waste 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 sealed and generally are of the microcurie level. A summary of the data input and modeling results for this building follow. Each stack has a unique identification number. A brief description of the operation is also given.									
151	1033	151-1033-FHE-02	Initial Chemical Separation	Co-60, Ag-111 Sr-89,90 Y-91, Zr-95 Mo-99, Nb-94, Nb-95 Xe-133, Xe-133m Cs-136, Cs-137 Ba-140 U-235 U-238 Pu-239 Pu-240 Am-241 Tc-99m Sb-125, Sb-126, Sb-127 Ce-141, Ce-144, Nd-147 Eu-155, Eu-156 Te-132	1.1×10^{-5} 4.0×10^{-6} 5.4×10^{-5} 9.3×10^{-6} 1.2×10^{-5} 8.8×10^{-6} 1.4×10^{-5} 2.4×10^{-10} 2.1×10^{-13} 3.8×10^{-9} 1.4×10^{-9} 9.9×10^{-10} 4.1×10^{-12} 1.9×10^{-6} 1.4×10^{-5} 9.1×10^{-6}	Scrubber-Precipitator	Varies with Nuclide	None	6.88
151	1039	151-1039-FHE-04	Storage and aliquot preparation	Co-60, Ag-111 Sr-89, Sr-90 Y-91, Zr-95 Cs-136, Cs-137 Mo-99 Tc-99m Ba-140 Sb-125, Sb-126, Sb-127 Xe-133m, Xe-133 Ce-141, Ce-144, Nd-147, Eu-155, Eu-156 U-235 U-238 Pu-239 Pu-240 Am-241 Te-132	1.0×10^{-5} 5.4×10^{-6} 7.7×10^{-5} 9.3×10^{-6} 8.4×10^{-6} 3.3×10^{-11} 1.3×10^{-5} 2.3×10^{-6} 1.0×10^{-5} 3.5×10^{-4} 1.9×10^{-9} 1.7×10^{-12} 3.1×10^{-8} 1.1×10^{-8} 8.0×10^{-9} 8.2×10^{-6}	Scrubber-Precipitator	Varies with Nuclide	None	6.88

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Unit	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
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Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
151	1043	151-1043-FGBE-19/20	Dissolving of weapon test cores	Co-60	5.4×10^{-8}	Scrubber-Precipitator	Varies with Nuclide	None	8
				Ag-111	4.5×10^{-5}				
				Ru-103	2.9×10^{-4}				
				Ru-106	2.5×10^{-5}				
				Kr-85	6.8×10^{-7}				
				Sr-89	1.6×10^{-5}				
				Sr-90	1.1×10^{-7}				
				Y-91	1.7×10^{-5}				
				Zr-95	1.9×10^{-5}				
				Mo-99	3.7×10^{-5}				
				Tc-99m	1.6×10^{-11}				
				I-129	7.1×10^{-13}				
				I-131	4.7×10^{-4}				
				Xe-133	2.7×10^{-5}				
				Xe-133m	1.9×10^{-5}				
				Ce-136	1.4×10^{-4}				
				U-234	8.3×10^{-13}				
				U-235	9.6×10^{-10}				
				U-238	8.3×10^{-13}				
				Pu-239	1.5×10^{-8}				
				Pu-240	5.7×10^{-9}				
				Ce-141	2.9×10^{-5}				
				Ce-144	3.5×10^{-6}				
				Nd-147	2.2×10^{-5}				
				Eu-155	2.3×10^{-8}				
				Eu-156	1.2×10^{-6}				
				Am-241	4.0×10^{-9}				
				Sb-125	3.9×10^{-7}				
				Sb-126	7.2×10^{-8}				
				Sb-127	7.1×10^{-6}				
				Te-132	3.7×10^{-5}				
				Ba-140	5.7×10^{-5}				
				Ce-137	3.4×10^{-5}				
151	1133	151-1133-FHE-48	Chemistry of samples	U-235	3.0×10^{-14}	None	0	None	11.1
				U-238	3.0×10^{-13}				
				Pa-231, Pu-239	6.3×10^{-12}				
				Pu-240	6.0×10^{-13}				
				Np-237	1.0×10^{-13}				
151	1143	151-1143-FHE-64	Gaseous debris analysis	H-3	4.9×10^{-5}	None	0	None	11.1
				C-14	2.4×10^{-9}				
				Fe-55	5.0×10^{-9}				
				Kr-85	7.0×10^{-8}				
				I-129	4.0×10^{-12}				
				I-131	9.6×10^{-6}				
				Xe-133m, Xe-133, Xe-135	9.6×10^{-6}				
				Ta-182	1.3×10^{-10}				
				Ra-226	6.0×10^{-9}				
				Na-22	1.0×10^{-12}				

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
5.4×10^{-8}	Scrubber-Precipitator	Varies with Nuclide	None	8.41	0.21	13.10	1260	6.7×10^{-4}	2
4.5×10^{-5}									
2.9×10^{-4}									
2.5×10^{-5}									
6.8×10^{-7}									
1.6×10^{-5}									
1.1×10^{-7}									
1.7×10^{-5}									
1.9×10^{-5}									
3.7×10^{-5}									
1.6×10^{-11}									
7.1×10^{-13}									
4.7×10^{-4}									
2.7×10^{-5}									
1.9×10^{-5}									
1.4×10^{-4}									
8.3×10^{-13}									
9.6×10^{-10}									
8.3×10^{-13}									
1.5×10^{-8}									
5.7×10^{-9}									
2.9×10^{-5}									
3.5×10^{-6}									
2.2×10^{-5}									
2.2×10^{-8}									
1.2×10^{-6}									
4.0×10^{-9}									
3.9×10^{-7}									
7.2×10^{-8}									
7.1×10^{-6}									
3.7×10^{-5}									
5.7×10^{-5}									
3.4×10^{-5}									
3.0×10^{-14}	None	0	None	11.89	0.61	2.40	1260	5.8×10^{-9}	1
3.0×10^{-13}									
6.3×10^{-12}									
6.0×10^{-13}									
1.0×10^{-13}									
4.9×10^{-5}	None	0	None	11.89	0.61	2.80	1260	3.3×10^{-5}	1
2.4×10^{-9}									
5.0×10^{-9}									
7.0×10^{-8}									
4.0×10^{-12}									
9.8×10^{-6}									
9.6×10^{-6}									
1.3×10^{-10}									
8.0×10^{-9}									
1.0×10^{-12}									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (ft)	Estimated Annual Release (Ci/yr)
151	1318	151-1318-FHE-25	Core sample chemistry	Co-60, Ag-111	2.2×10^{-6}	None	0	None	11.89	2.2
				Sr-89, Sr-90	8.0×10^{-7}					8.0
				Y-91, Zr-95	1.1×10^{-5}					1.1
				Mo-99	1.9×10^{-6}					1.9
				Tc-99m	8.2×10^{-13}					8.2
				Xe-133m, Xe-133	2.3×10^{-6}					2.3
				Na-22, Cs-136, Cs-137, Cs-138	1.8×10^{-6}					1.8
				Ba-140	2.9×10^{-6}					2.9
				U-235	4.8×10^{-11}					4.8
				Pu-239	7.7×10^{-10}					7.7
				Pu-240	2.8×10^{-10}					2.8
				Am-241, Cm-244	2.0×10^{-10}					2.0
				Sb-125, Sb-126, Sb-127	3.8×10^{-7}					3.8
				Te-132	1.8×10^{-6}					1.8
				Ce-141, Ce-144, Nd-147	2.0×10^{-5}					2.0
				Eu-155, Eu-156						
				U-233, U-238	8.2×10^{-14}					8.2
151	1322	151-1322-FHE-34	Core sample chemistry	Co-60, Ag-110m, Ag-111	4.8×10^{-6}	None	0	None	11.89	4.8
				Ce-145, Sr-89, Sr-90	5.8×10^{-6}					5.8
				Y-91, Zr-95	6.5×10^{-6}					6.5
				Mo-99	1.9×10^{-6}					1.9
				Tc-99m	8.2×10^{-13}					8.2
				Xe-133m, Xe-133, Xe-135	2.6×10^{-6}					2.6
				Ce-136, Cs-137	1.8×10^{-6}					1.8
				Ba-133, Ba-140	7.5×10^{-6}					7.5
				Th-204, Pb-210	1.2×10^{-5}					1.2
				Th-232	7.0×10^{-11}					7.0
				U-235	4.0×10^{-11}					4.0
				U-232, U-238	1.0×10^{-8}					1.0
				Pu-239, Pu-240, Pu-242, Pu-244, Es-254	1.4×10^{-9}					1.4
				Am-241, Cf-249	3.3×10^{-9}					3.3
				Sb-125, Sb-126, Sb-127	3.8×10^{-7}					3.8
				Te-132	1.8×10^{-6}					1.8
				Ce-141, Ce-144, Nd-147, Gd-148	1.1×10^{-2}					1.1
				Eu-155, Eu-156, Ho-166						

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
2.2×10^{-6}	None	0	None	11.89	0.61	2.40	1260	9.1×10^{-6}	1
8.0×10^{-7}									
1.1×10^{-5}									
1.9×10^{-6}									
8.2×10^{-13}									
2.3×10^{-6}									
1.8×10^{-6}									
2.9×10^{-6}									
4.8×10^{-11}									
7.7×10^{-10}									
2.8×10^{-10}									
2.0×10^{-10}									
3.8×10^{-7}									
1.8×10^{-6}									
2.0×10^{-5}									
8.2×10^{-14}									
4.8×10^{-6}	None	0	None	11.89	0.61	2.40	1260	2.1×10^{-3}	1
5.8×10^{-6}									
6.5×10^{-6}									
1.9×10^{-6}									
8.2×10^{-13}									
2.6×10^{-6}									
1.8×10^{-6}									
7.5×10^{-6}									
1.2×10^{-5}									
7.0×10^{-11}									
4.0×10^{-11}									
1.0×10^{-8}									
1.4×10^{-9}									
3.3×10^{-9}									
3.8×10^{-7}									
1.8×10^{-6}									
1.1×10^{-2}									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	St. Height	Annual (C)
151	1326	151-1326-FHE-43	Core sample chemistry	Co-60, Ag-111	2.2 x 10-6	None	0	None	11	2.2 x
				Sr-89, Sr-90	8.0 x 10-7					8.0 x
				Y-91, Zr-95	1.1 x 10-5					1.1 x
				Mo-99	1.9 x 10-6					8.2 x
				Tc-99m	8.2 x 10-13					2.3 x
				Xe-133m, Xe-133	2.3 x 10-6					1.8 x
				Cs-136, Cs-137	1.8 x 10-6					2.9 x
				Ba-140	2.9 x 10-6					4.8 x
				U-235	4.8 x 10-11					4.1 x
				U-238	4.1 x 10-14					7.7 x
				Pu-239	7.7 x 10-10					2.8 x
				Pu-240	2.8 x 10-10					2.0 x
				Am-241	2.0 x 10-10					4.0 x
				Sb-125, Sb-126,	4.0 x 10-6					
				Sb-127						1.8 x
				Te-132	1.8 x 10-6					2.0 x
				Ce-141, Ce-144,	2.0 x 10-5					
				Nd-147, Eu-155,						
				Eu-156						
151	1330	151-1330-FHE-52	Core sample chemistry	Co-60, Ag-111	2.2 x 10-6	None	0	None	11	2.2 x
				Sr-89, Sr-90	8.0 x 10-7					8.0 x
				Mo-99	1.9 x 10-6					1.9 x
				Tc-99m	8.2 x 10-13					8.2 x
				Xe-133m, Xe-133	2.3 x 10-6					2.3 x
				Cs-136, Cs-137	1.8 x 10-6					1.8 x
				Ba-140	2.9 x 10-6					2.9 x
				U-235	4.8 x 10-11					4.8 x
				U-238	4.1 x 10-14					4.1 x
				Pu-239	7.7 x 10-10					7.7 x
				Pu-240	2.8 x 10-10					2.8 x
				Am-241	2.0 x 10-10					2.0 x
				Y-91, Zr-95	1.1 x 10-5					1.1 x
				Sb-125, Sb-126,	3.8 x 10-7					3.8 x
				Sb-127						
				Te-132	1.8 x 10-6					1.8 x
				Ce-141, Ce-144,	2.0 x 10-5					2.0 x
				Nd-147, Eu-155, Eu-156						
151	1334	151-1334-FHE-61	Core sample chemistry	Co-60, Ag-111	2.2 x 10-6	None	0	None	11	2.2 x
				Sr-89, Sr-90	8.0 x 10-7					8.0 x
				Y-91, Zr-95	1.1 x 10-5					1.1 x
				Mo-99	1.9 x 10-6					1.9 x
				Tc-99m	8.2 x 10-13					8.2 x
				Xe-133m, Xe-133	2.3 x 10-6					2.3 x
				Cs-136, Cs-137	1.8 x 10-6					1.8 x
				Ba-140	2.9 x 10-6					2.9 x
				U-235	5.2 x 10-11					5.2 x
				U-236, U-238	4.0 x 10-10					4.0 x
				Pu-239	7.7 x 10-10					7.7 x
				Pu-240	2.8 x 10-10					2.8 x
				Np-237, Am-241	2.2 x 10-10					2.2 x
				Sb-125, Sb-126,	3.8 x 10-7					3.8 x
				Sb-127						
				Te-132	1.8 x 10-6					1.8 x
				Ce-141, Ce-144,	2.0 x 10-5					2.0 x
				Nd-147, Eu-155,						
				Eu-156						

Attachment 1 - 1992 LLNL NESHAPs Annual Report Spreadsheet

Attachment 1 - 1992 LUNL NESHAP's Annual Report Spreadsheet									
Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
2.2 x 10-6	None	0	None	11.89	0.61	2.40	1260	9.1 x 10-6	1
8.0 x 10-7									
1.1 x 10-5									
1.9 x 10-6									
8.2 x 10-13									
2.3 x 10-6									
1.8 x 10-6									
2.9 x 10-6									
4.8 x 10-11									
4.1 x 10-14									
7.7 x 10-10									
2.8 x 10-10									
2.0 x 10-10									
4.0 x 10-6									
1.8 x 10-6	None	0	None	11.89	0.61	2.40	1260	9.1 x 10-5	1
2.0 x 10-5									
2.2 x 10-6									
8.0 x 10-7									
1.9 x 10-6									
8.2 x 10-13									
2.3 x 10-6									
1.8 x 10-6									
2.9 x 10-6									
4.8 x 10-11									
4.1 x 10-14									
7.7 x 10-10									
2.8 x 10-10									
2.0 x 10-10									
1.1 x 10-5	None	0	None	11.89	0.61	2.40	1260	9.1 x 10-5	1
3.8 x 10-7									
1.8 x 10-6									
2.0 x 10-5									
2.2 x 10-6									
8.0 x 10-7									
1.1 x 10-5									
1.9 x 10-6									
8.2 x 10-13									
2.3 x 10-6									
1.8 x 10-6									
2.9 x 10-6									
5.2 x 10-11									
4.0 x 10-10									
7.7 x 10-10	None	0	None	11.89	0.61	2.40	1260	9.1 x 10-5	1
2.8 x 10-10									
2.2 x 10-10									
3.8 x 10-7									
1.8 x 10-6									
2.0 x 10-5									
2.2 x 10-6									
8.0 x 10-7									
1.1 x 10-5									
1.9 x 10-6									
8.2 x 10-13									
2.3 x 10-6									
1.8 x 10-6									
2.9 x 10-6									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	St. Helens
151	2109	151-2109-FHE-19	Initial chemical separation of nuclides	Co-60, Ag-111	4.5×10^{-6}	None	0	None	1
				Sr-90, Sr-90	1.6×10^{-6}				
				Y-91, Zr-95	2.2×10^{-5}				
				Mo-99	3.7×10^{-6}				
				Tc-99m	1.6×10^{-12}				
				Xe-133m, Xe-133	4.6×10^{-6}				
				Ce-136, Ce-137	3.5×10^{-6}				
				Ba-140	5.7×10^{-6}				
				U-235	9.6×10^{-11}				
				U-238	8.3×10^{-14}				
				Pu-239	1.5×10^{-9}				
				Pu-240	5.6×10^{-10}				
				Am-241	4.0×10^{-10}				
				Sb-125, Sb-126,	7.6×10^{-7}				
				Sb-127					
				Te-132	3.7×10^{-6}				
				Ce-141, Ce-144,	4.0×10^{-5}				
				Nd-147, Eu-155,					
				Eu-156					
151	2117	151-2117-FHE-28	Chemistry of samples	H-3	1.6×10^{-6}	None	0	None	1
				C-14	2.0×10^{-10}				
				Co-58, Co-60,	5.9×10^{-11}				
				Ru-106					
				Na-22, Cs-134,	8.0×10^{-11}				
				Ce-137					
				U-235	1.7×10^{-11}				
				U-238	4.9×10^{-10}				
				Pu-239	1.0×10^{-8}				
				Am-241	5.8×10^{-10}				
				Mn-54, Zr-95	9.1×10^{-9}				
				Nb-95	3.9×10^{-10}				
				Sb-125	2.0×10^{-11}				
				Ce-141, Ce-144,	8.3×10^{-8}				
				Eu-152, Eu-154,					
				Eu-155, Tm-168					
151	2125	151-2125-FHE-46	Chemistry of samples	Bi-207	7.7×10^{-9}	None	0	None	1
				Pu-239, Pu-244	6.3×10^{-13}				
151	2143	151-2143-FHE-63	Chemistry of samples	H-3	2.2×10^{-8}	None	0	None	1
				C-14	5.0×10^{-10}				
151	2131	151-2131-FHE-56	Chemistry of samples	Co-60	9.6×10^{-7}	None	0	None	1
				Tc-99m	2.1×10^{-8}				
				Na-22, Cs-136,	2.9×10^{-8}				
				Ce-137					
				Ra-226	1.0×10^{-9}				
				Am-241	6.1×10^{-10}				
				Sb-125	6.2×10^{-7}				
				Sr-85	2.9×10^{-9}				
				Eu-155	6.4×10^{-13}				
				Pu-242	3.0×10^{-11}				
151	2149	151-2149-FHE-78	Chemistry of samples	Pu-240	1.5×10^{-8}	None	0	None	1
				Pu-238	1.0×10^{-8}				
				Hp-237	1.1×10^{-8}				
				Ce-136	2.6×10^{-7}				

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
4.5 x 10-6	None	0	None	11.89	0.46	2.70	1260	1.8 x 10-4	1
1.6 x 10-6									
2.2 x 10-5									
3.7 x 10-6									
1.6 x 10-12									
4.6 x 10-6									
3.5 x 10-6									
5.7 x 10-6									
9.6 x 10-11									
8.3 x 10-14									
1.5 x 10-9									
5.6 x 10-10									
4.0 x 10-10									
7.6 x 10-7									
3.7 x 10-6									
4.0 x 10-5									
1.8 x 10-6	None	0	None	11.89	0.61	2.80	1260	9.0 x 10-6	1
2.0 x 10-10									
5.9 x 10-11									
8.0 x 10-11									
1.7 x 10-11									
4.9 x 10-10									
1.0 x 10-8									
5.6 x 10-10									
9.1 x 10-9									
3.9 x 10-10									
2.0 x 10-11									
8.3 x 10-8									
7 x 10-9									
6.3 x 10-13									
2.2 x 10-8									
5.0 x 10-10									
9.6 x 10-7	None	0	None	11.89	0.61	2.80	1260	1.4 x 10-7	1
2.1 x 10-8									
2.9 x 10-8									
1.0 x 10-9									
6.1 x 10-10									
6.2 x 10-7									
2.9 x 10-9									
6.4 x 10-13									
3.0 x 10-11									
1.5 x 10-6									
1.0 x 10-8									
1.1 x 10-8									
2.6 x 10-7									
1.5 x 10-6	None	0	None	11.89	0.61	1.60	1260	3.8 x 10-5	1
1.0 x 10-8									
1.1 x 10-8									
2.6 x 10-7									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
151	2302A	151-2302A-FHE-09	Chemical Separation	Na-22, Co-134, Co-137	7.5×10^{-6}	None	0	None	11
				Fe-55, Co-57, Co-60,	9.6×10^{-6}				
				Zn-65, Ag-108m, Cd-109					
				Y-91	3.7×10^{-5}				
				Ba-133	1.5×10^{-6}				
				Ce-141, Ce-144, Nd-147,	3.7×10^{-4}				
				Eu-152, Eu-154, Eu-155,					
				Eu-156, Tb-157, Tb-158,					
				Tb-160, Ho-166, Tm-168					
				Ta-182	5.0×10^{-6}				
				U-234	2.5×10^{-13}				
				U-238	2.5×10^{-13}				
				Pu-239	1.2×10^{-12}				
151	2308	151-2308-FHE-12	Radiochemical Studies	Co-60	6.7×10^{-9}	None	0	None	11
				Sr-89	2.0×10^{-6}				
				Sr-90	1.3×10^{-8}				
				Y-91	2.2×10^{-6}				
				Zr-95	2.3×10^{-6}				
				Mo-99	4.7×10^{-6}				
				Tc-99m	2.0×10^{-12}				
				Ag-111	5.6×10^{-6}				
				Sb-125	4.9×10^{-8}				
				Sb-126	9.0×10^{-9}				
				Sb-127	8.9×10^{-7}				
				Te-132	4.6×10^{-6}				
				Xe-133m	2.4×10^{-6}				
				Xe-133	3.3×10^{-6}				
				Cs-136	1.7×10^{-7}				
				Cs-137	4.2×10^{-6}				
				Ba-140	7.2×10^{-6}				
				Ce-141	3.7×10^{-6}				
				Ce-144	4.4×10^{-7}				
				Nd-147	2.8×10^{-6}				
				Eu-152	2.5×10^{-4}				
				Eu-155	2.7×10^{-9}				
				Eu-156	1.5×10^{-7}				
				Ho-166	6.0×10^{-9}				
				Ir-192	2.0×10^{-6}				
				U-234	1.0×10^{-13}				
				U-235	1.2×10^{-10}				
				U-238	1.0×10^{-13}				
				Pu-239	1.9×10^{-9}				
				Pu-240	7.1×10^{-10}				
				Pu-244	2.0×10^{-6}				
				Am-241	4.9×10^{-10}				

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
7.5 x 10-6	None	0	None	11.89	0.61	2.80	1260	2.5 x 10-4	1
9.6 x 10-6									
3.7 x 10-5									
1.5 x 10-8									
3.7 x 10-4									
5.0 x 10-6									
2.5 x 10-13									
2.5 x 10-13									
1.2 x 10-12									
6.7 x 10-9	None	0	None	11.89	0.61	2.83	1260	1.8 x 10-3	1
2.0 x 10-6									
1.3 x 10-8									
2.2 x 10-6									
2.3 x 10-6									
4.7 x 10-6									
2.0 x 10-12									
5.6 x 10-6									
4.9 x 10-8									
9.0 x 10-9									
8.9 x 10-7									
4.6 x 10-6									
2.4 x 10-6									
3.3 x 10-6									
1.7 x 10-7									
4.2 x 10-6									
7.2 x 10-6									
3.7 x 10-6									
4.4 x 10-7									
2.8 x 10-6									
2.5 x 10-4									
2.7 x 10-9									
1.5 x 10-7									
6.0 x 10-9									
2.0 x 10-6									
1.0 x 10-13									
1.2 x 10-10									
1.0 x 10-13									
1.9 x 10-9									
7.1 x 10-10									
2.0 x 10-6									
4.9 x 10-10									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	St Heig
151	2312	151-2312-FHE-17	Chemical Separation	Ag-111, Co-60	5.6 x 10-6	None	0	None	11
				Sr-89, Sr-90	2.0 x 10-6				
				Mn-54, Y-91, Zr-95	2.7 x 10-5				
				Nb-94, Mo-99	4.7 x 10-6				
				Tc-99m	2.0 x 10-12				
				Sb-125, Sb-126, Sb-127	9.5 x 10-7				
				Te-132	4.6 x 10-6				
				Xe-133m, Xe-133	5.8 x 10-6				
				Ce-136, Ce-137	4.4 x 10-6				
				Ba-140	7.2 x 10-6				
				Ce-141, Ce-144, Nd-147,	5.0 x 10-5				
				Eu-152, Eu-155, Eu-156,					
				Tb-157, Ho-166					
				U-234	1.0 x 10-13				
				U-235	1.2 x 10-10				
				U-238	1.0 x 10-13				
				Pu-239	1.9 x 10-9				
				Pu-240	7.1 x 10-10				
				Am-241	5.0 x 10-10				
151	2318	151-2318-FHE-30	Chemical Separation	Ag-111, Co-60	5.6 x 10-6	None	0	None	11
				Sr-89, Sr-90	2.0 x 10-6				
				Y-91, Zr-95	5.2 x 10-5				
				Mo-99	4.7 x 10-6				
				Tc-99m	2.0 x 10-12				
				Sb-125, Sb-126, Sb-127	9.5 x 10-7				
				Te-132	4.6 x 10-6				
				Xe-133m, Xe-133	5.8 x 10-6				
				Ce-136, Ce-137	4.4 x 10-6				
				Ba-140	7.2 x 10-6				
				Ce-141, Ce-144, Nd-147,	5.0 x 10-5				
				Eu-155, Eu-156					
				U-234	1.0 x 10-13				
				U-235	1.2 x 10-10				
				U-238	1.0 x 10-13				
				Pu-239	1.9 x 10-9				
				Pu-240	7.1 x 10-10				
				Am-241	5.0 x 10-10				
151	2322	151-2322-FHE-38	Chemical Separation	Ag-111, Co-60	5.6 x 10-6	None	0	None	11
				Sr-89, Sr-90	2.0 x 10-6				
				Y-91, Zr-95	2.7 x 10-5				
				Mo-99	4.7 x 10-6				
				Tc-99m	2.0 x 10-12				
				Sb-125, Sb-126, Sb-127	9.5 x 10-7				
				Te-132	4.6 x 10-6				
				Xe-133m, Xe-133	5.8 x 10-6				
				Ce-136, Ce-137	4.4 x 10-6				
				Ba-140	7.2 x 10-6				
				Ce-141, Ce-144, Nd-147,	5.0 x 10-5				
				Eu-155, Eu-156					
				U-234	1.0 x 10-13				
				U-235	1.2 x 10-10				
				U-238	1.0 x 10-13				
				Pu-239	1.9 x 10-9				
				Pu-240	7.1 x 10-10				
				Am-241	5.0 x 10-10				

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
5.6 x 10-6	None	0	None	11.89	0.61	2.80	1260	2.3 x 10-4	1
2.0 x 10-6									
2.7 x 10-5									
4.7 x 10-6									
2.0 x 10-12									
9.5 x 10-7									
4.6 x 10-6									
5.8 x 10-6									
4.4 x 10-6									
7.2 x 10-6									
5.0 x 10-5									
1.0 x 10-13									
1.2 x 10-10									
1.0 x 10-13									
1.9 x 10-9									
7.1 x 10-10									
5.0 x 10-10									
5.6 x 10-6	None	0	None	11.89	0.61	2.80	1260	2.3 x 10-4	1
2.0 x 10-6									
5.2 x 10-5									
4.7 x 10-6									
2.0 x 10-12									
9.5 x 10-7									
4.6 x 10-6									
5.8 x 10-6									
4.4 x 10-6									
7.2 x 10-6									
5.0 x 10-5									
1.0 x 10-13									
1.2 x 10-10									
1.0 x 10-13									
1.9 x 10-9									
7.1 x 10-10									
5.0 x 10-10									
5.6 x 10-6	None	0	None	11.89	0.61	2.80	1260	2.3 x 10-4	1
2.0 x 10-6									
2.7 x 10-5									
4.7 x 10-6									
2.0 x 10-12									
9.5 x 10-7									
4.6 x 10-6									
5.8 x 10-6									
4.4 x 10-6									
7.2 x 10-6									
5.0 x 10-5									
1.0 x 10-13									
1.2 x 10-10									
1.0 x 10-13									
1.9 x 10-9									
7.1 x 10-10									
5.0 x 10-10									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (ft)	Estimated Annual Release (Ci/yr)
151	2326	151-2326-FHE-49	Chemical Separation	Na-22, Cl-36, Ce-136, Ce-137, Fe-55, Co-60, Ru-106, Ag-111, Sr-89, Sr-90, Y-91, Zr-95, Mo-99, Tc-99m, Sb-125, Sb-126, Sb-127, Te-132, Xe-133m, Xe-133, Ba-140, Ce-141, Ce-144, Nd-147, Pm-147, Eu-152, Eu-155, Eu-156, Tl-204, U-234, U-235, U-238, Pu-239, Pu-240, Am-241	6.6×10^{-6} 1.8×10^{-5} 2.0×10^{-6} 5.8×10^{-5} 4.7×10^{-6} 3.4×10^{-6} 9.5×10^{-7} 4.6×10^{-6} 5.8×10^{-6} 7.2×10^{-6} 2.3×10^{-4} 5.0×10^{-7} 1.0×10^{-13} 1.2×10^{-10} 1.0×10^{-13} 1.9×10^{-9} 7.1×10^{-10} 4.9×10^{-10}	None	0	None	11.88	6.6 1.8 2.0 5.8 4.7 3.4 9.5 4.6 5.8 7.2 2.3 5.0 1.0 1.2 1.0 1.9 7.1 4.9 2.0
151	2326A	151-2326A-FHE-40	Chemical Separation	Re-184, Os-185	2.0×10^{-12}	None	0	None	11.89	2.0
Building 171 is operated for the Laser Program in support of research and development activities for U-AVLIS.										
171	107	171-107-RA	Melting uranium under vacuum Not Currently in Use	U-238 U-234	3.3×10^{-12} 3.3×10^{-12}	None	0	None	4.57	3.3 3.3
Building 175 is operated for the Laser Program in support of research and development activities for U-AVLIS.										
*Two Stacks were used to determine the EDE.										
175	103	175-103-FHE-1/2	Not Currently in Use	None	0	HEPA	99.97	Filter	9.14	0
175	112	175-112-FHE-1/2	Assembly of Parts/Storage	U-238 U-235 U-234	0 0 0	HEPA	99.97	Filter	5.80 5.80	0 0 0
175	128	175-128-FHE-1000/2000	Cleaning Activities	U-238 U-235 U-234	0 0 0	HEPA	99.97	Filter	10.67 10.67	0 0 0
Building 177 is operated for the Laser Program in support of research and development activities for U-AVLIS.										
*Two Stacks were used to determine the EDE.										
177	1010	177-1010-FHE-18	Corrosion experiments	U-238 U-235 U-234	6.6×10^{-10} 6.6×10^{-12} 6.6×10^{-10}	HEPA	99.97	None	9.10	6.6 6.6 6.6
177	1014	177-1014-FHE-10	Storage	U-238 U-235 U-234	1.2×10^{-5} 2.1×10^{-6} 1.2×10^{-5}	HEPA	99.97	None	5.80	1.2 2.1 1.2
177	1015	177-1015-FHE-27	Sample Preparation	U-238 U-235 U-234	3.0×10^{-12} 3.8×10^{-14} 3.0×10^{-12}	HEPA	99.97	None	7.90	3.0 3.8 3.0
177	1020	177-1020-FHE-22	Uranium Vapor Experiment	U-238 U-235 U-234	1.2×10^{-4} 1.6×10^{-6} 1.2×10^{-4}	HEPA	99.97	None	6.40	1.2 1.6 1.2

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	E/E Category
6.6×10^{-6}	None	0	None	11.89	0.61	2.80	1260	4.2×10^{-4}	1
1.8×10^{-5}									
2.0×10^{-6}									
5.6×10^{-5}									
4.7×10^{-6}									
3.4×10^{-6}									
9.5×10^{-7}									
4.6×10^{-6}									
5.6×10^{-6}									
7.2×10^{-6}									
2.3×10^{-4}									
5.0×10^{-7}									
1.0×10^{-13}									
1.2×10^{-10}									
1.0×10^{-13}									
1.9×10^{-9}									
7.1×10^{-10}									
4.9×10^{-10}									
2.0×10^{-12}	None	0	None	11.89	0.61	2.80	1260	2.6×10^{-14}	1
9.3×10^{-12}	None	0	None	4.57	0.50	0.50	1320	3.1×10^{-9}	1
9.3×10^{-12}									
0	HEPA	99.97	Filter	9.14	0.73	4.01	1260	0	4
0	HEPA	99.97	Filter	5.80	0.38	10.80 *	1260	0	4
0				5.80	0.36	5.20 *			
0									
0	HEPA	99.97	Filter	10.67	0.61	4.85 *	1260	0	4
0				10.67	0.61	4.85 *			
0									
1.6×10^{-10}	HEPA	99.97	None	9.10	0.38	1.60	1260	2.0×10^{-7}	2
1.6×10^{-12}									
1.6×10^{-10}									
1.2×10^{-5}	HEPA	99.97	None	5.80	0.41	2.40	1260	4.6×10^{-3}	2
2.1×10^{-6}									
1.2×10^{-5}									
1.0×10^{-12}	HEPA	99.97	None	7.90	0.56	12.90	1260	7.7×10^{-10}	2
1.8×10^{-14}									
1.0×10^{-12}									
1.2×10^{-4}	HEPA	99.97	None	6.40	0.30	8.90	1260	1.2×10^{-2}	3
1.6×10^{-6}									
1.2×10^{-4}									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
177	1021	177-1021-FHE-24/25	Analytical Chemistry	U-238 U-235 U-234	9.8×10^{-10} 9.8×10^{-11} 9.8×10^{-10}	HEPA	99.97	None	11.1
177	1024	177-1024-FHE-14	Uranium Vapor Spectroscopy	U-238 U-235 U-234	4.2×10^{-13} 4.0×10^{-11} 4.2×10^{-13}	HEPA	99.97	None	5.1
Building 179 supports research and development activities for U-AVLIS.									
179	1000	179-1000-RA1	Metal Storage	U-238 U-23	3.3×10^{-13} 3.3×10^{-13}	None	0	None	3.1
179	1020	179-1020-(NO 10)	Metal/Powder Storage	U-238 U-235 U-234	1.2×10^{-7} 3.4×10^{-8} 1.2×10^{-7}	None	0	None	3.1
Building 190 is operated by the Physical Sciences Directorate. This experimental facility houses a 10-MV Tandem Accelerator, support laboratories and shops. The primary experimental work involves accelerator mass spectroscopy and associated There are no unsealed, unencapsulated radioactive sources used in this facility, and no atmospheric discharges of accelerator activation products. There are no radionuclide air releases.									
190	N/A	N/A	10-MV Tandem Accelerator	None	0	None	0	Flow Thru	N/A
Building 194, operated by the Physical Sciences Directorate, is shared by the Center for Accelerator and Mass Spectroscopy (CAMS) and E-Division. The complex houses a high energy linear accelerator and research laboratories. The accelerator beam can produce small quantities of air activation products: O-15 with a half-life of 9.96 minutes, and N-13 with a half-life of 2.05 minutes. The quantities of air activation products that are produced depend on beam energy, beam current, and the amount of time the accelerator is operating. Air exhaust from this facility is via a 30-m stack. The accelerator did not run in 1992. Therefore, there were no stack emissions.									
194	Target Exhaust	194-TE-FE4	Linear accelerator	O-15 N-13	0 0	None	0	Flow Thru	30.1
194	1131	194-1131-RA	Research experiment	Na-22	5×10^{-8}	None	0	None	6.5
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	4.2
212	184	212-184-RA	Contaminated	H-3	1.1×10^{-8}	None	0	None	4.2
Building 222 is part of the Chemistry and Material Sciences Directorate. With the exception of a tritium source, the radionuclide inventory in each laboratory is low. Laboratory 10208 has up to 10 curies of tritium stored in a standard gas cylinder. This cylinder may be opened a few times a year, resulting in a very small fraction being released. Gaseous radionuclides may also be released from room 1421, which processes gases collected for the nuclear test program, about 1/100 the amount of radioactive gas that is handled in room 1143 of Building 151. Many of the laboratories either store or used depleted uranium or thorium. Usually it exists as solids, either metal pieces or chemical reagents such as oxide powders. Though there may be kilogram amounts in some of the laboratories, the total activity is low because of low specific activity of these nuclides. The other source of radionuclides in Building 222 is from analysis of hazardous waste samples.									
222	10208	222-10208-FHE-4000	Use of tritium gas	H-3	1.0×10^{-2}	None	0	None	28.0
222	10288	222-10288-FHE-3000	Chemical procedures	Th-232 U-238	1.5×10^{-10} 5.7×10^{-10}	HEPA	99.97	None	12.0
222	1106	222-1106-FHE-130	Chemical procedures	Th-232 U-238	5.0×10^{-11} 1.7×10^{-10}	HEPA	99.97	None	6.1
222	11108	222-11108-FHE-6	Chemical procedures	Th-232 U-238	1.4×10^{-10} 1.4×10^{-9}	HEPA	99.97	None	9.7
222	11178	222-11178-FHE-13	Chemical procedures	U-238	1.3×10^{-8}	HEPA	99.97	None	5.1
222	11188	222-11188-FHE-3000	Chemical procedures	Th-232 U-238	1.0×10^{-8} 1.4×10^{-10}	HEPA	99.97	None	12.0

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
9.8 x 10-10	HEPA	99.97	None	11.00	0.41	7.80	1260	2.6 x 10-7	2
9.8 x 10-11				8.10	0.30	8.00			
9.8 x 10-10									
4.2 x 10-13	HEPA	99.97	None	5.49	0.36	0.80	1260	9.0 x 10-9	2
4.0 x 10-11									
4.2 x 10-13									
3.3 x 10-13	None	0	None	3.96	0.50	0.50	1268	3.1 x 10-10	1
3.3 x 10-13									
1.2 x 10-7	None	0	None	3.96	0.50	7.00	1268	1.3 x 10-4	1
3.4 x 10-8									
1.2 x 10-7									
Laboratories and shops. The primary experimental work involves accelerator mass spectroscopy and associated studies.									
Products. There are no radionuclide air releases.									
0	None	0	Flow Thru	N/A	N/A	N/A	1433	0	1
E-Division. The complex houses a high energy linear accelerator and research laboratories.									
Half-life of 2.05 minutes.									
Accelerator is operating. Air exhaust from this facility is via a 30-m stack.									
0	None	0	Flow Thru	30.48	1.37	5.70	1320	0	2
0									
5 x 10-8	None	0	None	8.53	0.50	0.50	1320	1.4 x 10-6	1
Emissions are due to contamination from past operations of the rotating									
1.1 x 10-8	None	0	None	4.27	0.50	0.50	1320	1.8 x 10-10	2
1.1 x 10-8	None	0	None	4.27	0.50	0.50	1320	1.8 x 10-10	2
Tritium in each laboratory is low. Laboratory 10208 has up to 10 curies of tritium stored in a standard gas									
Tritium also be released from room 1421, which processes gases collected for the nuclear test program,									
Tritium agents such as oxide powders,									
solides.									
1.0 x 10-2	None	0	None	28.00	0.91	21.20	1260	6.1 x 10-6	1
1.5 x 10-10	HEPA	99.97	None	12.80	1.07	15.60	1260	2.8 x 10-3	1
5.7 x 10-10									
5.0 x 10-11	HEPA	99.97	None	6.10	0.34	9.40	1260	2.5 x 10-7	1
1.7 x 10-10									
1.4 x 10-10	HEPA	99.97	None	9.75	0.46	5.20	1260	1.2 x 10-6	1
1.4 x 10-9									
1.3 x 10-8	HEPA	99.97	None	5.18	0.51	2.30	1260	1.2 x 10-5	1
1.0 x 10-8	HEPA	99.97	None	12.80	1.07	15.60	1260	8.2 x 10-6	1
1.4 x 10-10									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
222	1228B	222-1228B-FHE-1000	Analysis of waste samples	Am-241	3.5×10^{-10}	HEPA	99.97	None	12.8
				C-14	1.2×10^{-10}				
				H-3	1.1×10^{-6}				
				Mn-54, Zr-95	5.4×10^{-6}				
				Nb-95	2.3×10^{-10}				
				Co-58, Co-60	3.5×10^{-11}				
				Ru-106					
				Sb-125	1.2×10^{-11}				
				Na-22, Cs-137, Ce-134	4.8×10^{-11}				
				Pu-240	6.0×10^{-10}				
				U-235	1.0×10^{-11}				
				U-238	2.9×10^{-10}				
				Pu-239	6.0×10^{-9}				
				Ce-141, Ce-144, Eu-152, Eu-154, Eu-155, Tm-168	5.0×10^{-6}				
222	1421	222-1421-FHE-2000	Analysis of gases from test program	H-3	4.9×10^{-7}	HEPA	99.97	None	28.0
				Kr-85	7.0×10^{-10}				
				I-131	9.8×10^{-6}				
				Xe-133, Xe-133m, Xe-135	9.6×10^{-6}				
222	1520	222-1520-FHE-116	Mass Spectrometry Analysis	Th-232	1.1×10^{-9}	HEPA	99.97	None	5.20
				U-238	3.4×10^{-9}				
222	1520B	222-1520B-FHE-75	Sample Dissolution	Th-232	5.5×10^{-15}	HEPA	99.97	None	4.90
				U-234	6.7×10^{-11}				
				U-238	6.7×10^{-11}				
222	1524B	222-1524B-FE-38	Gas Analysis	U-234	7.1×10^{-10}	HEPA	99.97	None	5.20
				U-238	7.1×10^{-10}				
Building 226 is operated by the Chemistry and Materials Science Directorate. The facility houses chemistry laboratories that prepare and analyze various media such as soil, vegetation, and waste samples for toxic chemical and radioactivity analysis. Radioactive material can exist in this facility, either in the samples or in the prepared standards.									
226	109	226-109-FHE-2	Environmental sample preparation and analysis	H-3	6.0×10^{-7}	HEPA	99.97	None	6.40
				U-238	5.8×10^{-12}				
Building 227 is part of the Chemistry and Materials Science Directorate. In rooms 1036 and 1044, solid pieces of depleted uranium are joint 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 amounts of depleted uranium are studied to determine the leaching properties of natural waters. All three sources were combined into one stack.									
227	1036, 1044 and 1083	None	Uranium metal bonding	U-238	2.0×10^{-9}	HEPA	99.97	None	18.3
				U-238	2.0×10^{-9}				
				U-238	1.0×10^{-9}				
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 Division. Management oversight for Building 231 is provided by the Engineering Directorate through the Engineering Sciences Division.									
231	1128	231-1128-FHE-34-1	Resin coating of samples	U-238	3.4×10^{-9}	HEPA	99.97	None	9.14
				Th-232	9.7×10^{-10}				
231	1128	231-1128-FHE-31-1,2	Storage of Radionuclides	See Text	0	HEPA	99.97	Filter	9.10
231	1441	231-1441-RA	Uranium bonding tests	U-238	1.7×10^{-9}	HEPA	99.97	None	12.5
231	1737	231-1737-FHE-54	Electron beam welding	U-238	1.7×10^{-6}	HEPA	99.97	None	10.5
231	1737	231-1737-FGBE-5	Electron beam welding	U-238	1.7×10^{-6}	HEPA	99.97	None	10.5
231	1945B	231-1945B-FHE-40	Metallurgical rolling and wet grinding tests	U-238	3.4×10^{-6}	HEPA	99.97	None	10.7

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
3.5 x 10-10	HEPA	99.97	None	12.80	0.51	6.90	1260	3.2 x 10-6	1
1.2 x 10-10									
1.1 x 10-6									
5.4 x 10-6									
2.3 x 10-10									
3.5 x 10-11									
1.2 x 10-11									
4.8 x 10-11									
6.0 x 10-10									
1.0 x 10-11									
2.9 x 10-10									
6.0 x 10-9									
5.0 x 10-8									
4.9 x 10-7	HEPA	99.97	None	28.00	1.07	15.60	1260	1.2 x 10-7	1
7.0 x 10-10									
9.8 x 10-8									
9.6 x 10-8									
1.1 x 10-9	HEPA	99.97	None	5.20	0.30	7.40	1260	5.7 x 10-6	1
3.4 x 10-9									
5.5 x 10-15	HEPA	99.97	None	4.90	0.34	5.80	1260	1.3 x 10-7	1
6.7 x 10-11									
6.7 x 10-11									
7.1 x 10-10	HEPA	99.97	None	5.20	0.35	0.64	1260	1.4 x 10-6	1
7.1 x 10-10									
analyze various media such as soil, vegetation, and waste samples for toxic chemical and radioactivity analysis									
6.0 x 10-7	HEPA	99.97	None	6.40	0.27	10.40	1164	8.1 x 10-9	1
5.8 x 10-12									
point bonded and tested.									
rural waters. All three sources were combined into one stack.									
2.0 x 10-9	HEPA	99.97	None	18.30	1.20	11.90	1164	8.2 x 10-6	1
2.0 x 10-9									
1.0 x 10-9									
Nuclear Test Engineering, Weapons Engineering, and Safeguards and Security Materials Management Division.									
3.4 x 10-9	HEPA	99.97	None	9.14	0.41	12.00	1170	2.6 x 10-6	1
9.7 x 10-10									
0	HEPA	99.97	Filter	9.10	0.41	12.00	1170	0	4
1.7 x 10-9	HEPA	99.97	None	12.50	0.50	0.50	1170	6.9 x 10-7	1
1.7 x 10-8	HEPA	99.97	None	10.52	0.46	2.00	1170	7.5 x 10-6	1
1.7 x 10-8	HEPA	99.97	None	10.52	0.46	2.00	1170	7.5 x 10-6	1
3.4 x 10-8	HEPA	99.97	None	10.73	0.36	3.80	1170	1.5 x 10-5	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
Building 235 is part of the Chemistry and Materials Sciences Directorate. Operations in the facility include examination of material structure, surface, and subsurface; precision cutting, ion implanting, 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, 1224, 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	Metal characterization	U-238	3.4×10^{-10}	HEPA	99.97	None	11.1
235	1121	235-1121-RA	Electron microscopy studies	U-235	1.7×10^{-11}	HEPA	99.97	None	4.5
235	1123	235-1123-RA	Electron microscopy studies	U-235	1.7×10^{-11}	HEPA	99.97	None	4.5
235	1125	235-1125-RA	Electron microscopy studies	U-235	1.7×10^{-11}	HEPA	99.97	None	4.5
235	1131	235-1131-FHE-2	Metallurgy	U-238	6.7×10^{-10}	HEPA	99.97	None	8.9
235	1224	235-1224-FHE-2001	Chemical characterization studies	U-238 Th-232	1.9×10^{-10} 4.9×10^{-11}	HEPA	99.97	None	11.1
235	1226	235-1226-FHE-2001	Chemical characterization	U-238 Th-232	1.9×10^{-10} 4.9×10^{-11}	HEPA	99.97	None	11.1
235	1251	235-1251-FHE-2001	Ion beam implantation	U-238	1.9×10^{-10}	HEPA	99.97	None	11.1
Building 241 is administered by the Chemistry and Materials Sciences Directorate for material properties research and testing. Current radionuclide emissions result from contamination resulting from past operations that are no longer in service.									
241	1600	241-1600-FGBE-51	Contaminated (Out of Service)	U-238 U-235 U-234	3.3×10^{-9} 2.1×10^{-9} 3.3×10^{-9}	HEPA	99.97	None	14.9
241	1887	241-1887-FGBE-27	Contaminated (Out of Service)	Th-232	5.4×10^{-12}	HEPA	99.97	None	11.2
Building 243 is operated by the Earth Sciences Department. Building activities include various earth-sciences-related activities such as: mineral equation of state work, characterization of DOE Nevada Test Site (NTS) geological samples, nuclear waste site characterization studies, and energy program studies such as oil shale and geothermal energy. Although there are no radionuclide air releases, the model parameters are shown as Building 243 is listed as possible future location for radioisotope use.									
243	2018	243-2018-FHE-2000	Not In Use	None	0	HEPA	99.97	None	17.2
Building 251, the Heavy Elements Facility, is operated by the Nuclear Chemistry Division as a facility for handling highly radioactive materials, especially transuranic isotopes. Exhausts from this building has continuous monitoring.									
251	1117	251-1117-FGBE-21/22	Transuranic Research	U-233 Pu-238 Pu-239 Pu-242 Pu-244 Am-241 Am-242m Am-243m	0 0 0 0 0 0 0 0	HEPA	99.97	Filter	8.50
251	1117	251-1117-FGBE-23/24	Transuranic Research	U-232 U-233 Pu-238 Pu-239 Pu-240 Pu-242 Am-241 Pa-231	0 0 0 0 0 0 0 0	HEPA	99.97	Filter	8.50
251	1117	251-1117-FGBE-25/26	Transuranic Research	Pu-240 Pu-239 Pu-238 Am-241 Cf-252	0 0 0 0 0	HEPA	99.97	Filter	8.50

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
Material structure, surface, and subsurface; precision cutting, ion implanting, and metallurgical studies. Experiments. Chemical characterization studies take place in rooms 1100, 1224, and 1226.									
3.4 x 10-10	HEPA	99.97	None	11.13	2.31	0.19	1050	1.3 x 10-7	1
1.7 x 10-11	HEPA	99.97	None	4.57	0.50	0.50	1050	1.0 x 10-8	1
1.7 x 10-11	HEPA	99.97	None	4.57	0.50	0.50	1050	1.0 x 10-8	1
1.7 x 10-11	HEPA	99.97	None	4.57	0.50	0.50	1050	1.0 x 10-8	1
6.7 x 10-10	HEPA	99.97	None	8.96	0.36	7.13	1050	2.7 x 10-7	1
1.9 x 10-10	HEPA	99.97	None	11.13	2.31	0.19	1050	1.3 x 10-7	1
4.9 x 10-11									
1.9 x 10-10	HEPA	99.97	None	11.13	2.31	0.19	1050	1.3 x 10-7	1
4.9 x 10-11									
1.9 x 10-10	HEPA	99.97	None	11.13	2.31	0.19	1050	7.3 x 10-8	1
Current radionuclide emissions result from contamination resulting from past operations that are no longer in service.									
3.3 x 10-9	HEPA	99.97	None	14.94	0.18	5.30	1122	2.1 x 10-6	1
2.1 x 10-9									
3.3 x 10-9									
5.4 x 10-12	HEPA	99.97	None	11.28	0.23	21.70	1122	3.7 x 10-9	1
Such as: mineral equation of state work, characterization of DOE Nevada Test Site (NTS) geological samples.									
ation for radioisotope use.									
0	HEPA	99.97	None	17.25	0.34	4.40	1164	0	1
ive materials, especially transuranic isotopes. Exhausts from this building has continuous monitoring.									
0	HEPA	99.97	Filter	8.50	0.10	6.70	1148	0	4
0									
0									
0									
0									
0									
0									
0	HEPA	99.97	Filter	8.50	0.10	6.10	1148	0	4
0									
0									
0									
0									
0									
0	HEPA	99.97	Filter	8.50	0.10	6.10	1148	0	4
0									
0									
0									
0									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height	Estimated Annual Release (Ci/yr)
251	1142	251-1142-FHE-09/10	Transuranic Research	Th-230	0	HEPA	99.97	Filter	7.4	0
251	1211	251-1211-FHE-06/07	Transuranic Research	U-235	0	HEPA	99.97	Filter	6.4	0
				Cm-244	0					0
				Cm-246	0					0
				Cm-248	0					0
251	1232	251-1232-FGBE-38/39	Transuranic Research	U-235	0	HEPA	99.97	Filter	7.25	0
251	1354	251-1354-FGBE-44/45	Transuranic Research	Th-228	0	HEPA	99.97	Filter	10.2	0
Building 253 houses the Hazards Control Department, and the facility includes laboratories for the chemical analysis and counting of radioactive samples.										
253	1722A	253-1722A (NO ID)	Radioactive Samples	H-3	4.5 x 10 ⁻¹²	None	0	None	7.62	4.5 x 10 ⁻¹²
Building 254 is administered by the Hazards Control Department and contains the bioassay laboratory.										
254	109,113	254 (No ID)	Analyze bioassay samples	None	0	None	0	None		0
Building 255 is shared by Hazards Control and L-Division and houses a radiation calibration and standards laboratory. Most operations involve the use of sealed sources.										
255	180	255-180-FHE-2	Tritium Monitoring	H-3	2.5 x 10 ⁻⁴	None	0	None	6.0	2.5 x 10 ⁻⁴
Building 281 is part of the Chemistry and Materials Sciences Directorate. Very small amounts of both enriched and depleted uranium are used in room 1305. In rooms 1311 and 1319, there are a number of sources, both as solids and in solution, which are kept and used in glove boxes. There are HEPA filters between the glove boxes and the vent stack. Room 1323 is used for collection of Nuclear Test Site groundwater samples. These samples contain some tritiated water.										
281	1311	281-1311-FHE-19/20	Analytical sources	H-3	1.0 x 10 ⁻¹⁰	HEPA	99.97	None	6.40	1.0 x 10 ⁻¹⁰
				Cl-36	3.0 x 10 ⁻¹⁰					3.0 x 10 ⁻¹⁰
				Co-60	1.0 x 10 ⁻⁸					1.0 x 10 ⁻⁸
				Tc-99	1.0 x 10 ⁻¹⁰					1.0 x 10 ⁻¹⁰
				Eu-152, Tm-171	5.5 x 10 ⁻¹¹					5.5 x 10 ⁻¹¹
				Th-232	1.0 x 10 ⁻¹²					1.0 x 10 ⁻¹²
				Am-241, Np-237, Am-243	2.9 x 10 ⁻⁷					2.9 x 10 ⁻⁷
				U-233, U-238	3.6 x 10 ⁻⁹					3.6 x 10 ⁻⁹
				Pu-242	1.0 x 10 ⁻⁷					1.0 x 10 ⁻⁷
281	1319	281-1319-FHE-24	Chemistry	Mn-54	1.0 x 10 ⁻⁸	HEPA	99.97	None	6.40	1.0 x 10 ⁻⁸
				Co-60	1.0 x 10 ⁻¹⁰					1.0 x 10 ⁻¹⁰
				Sb-125	1.0 x 10 ⁻¹⁰					1.0 x 10 ⁻¹⁰
				Eu-154, Eu-155, Eu-156	4.3 x 10 ⁻⁸					4.3 x 10 ⁻⁸
281	1323	281-1323-FHE-1	Groundwater Analysis	H-3	3.0 x 10 ⁻⁷	None	0	None	6.40	3.0 x 10 ⁻⁷
Building 282 is operated by the Nuclear Chemistry Division. Experimental work involves neutron particle mass and related studies. Gaseous tritium absorbed on a "getter" 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	Area	282	Neutrino research	H-3	2.0 x 10 ⁻¹	None	0	None	Area Source	2.0 x 10 ⁻¹
282		282-AREA-RA	Neutron spectrometer experiments	H-3	2.0 x 10 ⁻¹	HEPA	99.97	None	5.28	2.0 x 10 ⁻¹
				Rb-83	5.0 x 10 ⁻⁹					5.0 x 10 ⁻⁹
Building 292 is administered by the Physical Sciences Directorate. Residual contamination exists throughout the facility from the past operation of a rotating target neutron source, that is no longer in operation. A neutron mass experiment will begin operation in 1993.										
292	1200/1202	292-1200/1202-FHE-1000	Contamination	H-3	2.0 x 10 ⁻⁶	None	0	None	23.47	2.0 x 10 ⁻⁶
292	1204	292-1204-RA	Neutrino Experiment	H-3	2.5 x 10 ⁻⁵	None	0	None	8.23	2.5 x 10 ⁻⁵
292	1402/1404 1406/1407	292-1402/1404/1406/1407-FHE-1000	Contamination	H-3	2.0 x 10 ⁻⁶	None	0	None	23.47	2.0 x 10 ⁻⁶

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
0	HEPA	99.97	Filter	7.40	0.23	6.80	1148	0	4
0	HEPA	99.97	Filter	6.40	0.25	8.00	1148	0	4
0									
0									
0									
0	HEPA	99.97	Filter	7.20	0.15	5.95	1148	0	4
0	HEPA	99.97	Filter	10.20	0.15	4.14	1148	0	4
Effective samples.									
4.5 x 10 ⁻¹²	None	0	None	7.62	0.36	8.30	1073	6.3 x 10 ⁻¹⁵	1
0	None	0	None				996	0	1
Involve the use of sealed sources.									
2.5 x 10 ⁻⁴	None	0	None	8.08	0.31	6.10	1020	4.1 x 10 ⁻⁷	1
are used in room 1305.									
are HEPA filters between the glove boxes and the vent stack.									
1.0 x 10 ⁻¹⁰	HEPA	99.97	None	6.40	0.61	2.70	1248	5.1 x 10 ⁻⁴	1
3.0 x 10 ⁻¹⁰									
1.0 x 10 ⁻⁸									
1.0 x 10 ⁻¹⁰									
5.5 x 10 ⁻¹¹									
1.0 x 10 ⁻¹²									
2.9 x 10 ⁻⁷									
3.6 x 10 ⁻⁹									
1.0 x 10 ⁻⁷									
1.0 x 10 ⁻⁸	HEPA	99.97	None	6.40	0.61	2.70	1248	3.1 x 10 ⁻⁹	1
1.0 x 10 ⁻¹⁰									
1.0 x 10 ⁻¹⁰									
4.3 x 10 ⁻⁸									
3.0 x 10 ⁻⁷	None	0	None	6.40	0.61	2.70	1248	5.2 x 10 ⁻¹¹	2
Release fraction of 0.01 is used.									
2.0 x 10 ⁻¹	None	0	None	Area Source	N/A	0.50	1230	1.0 x 10 ⁻³	1
2.0 x 10 ⁻¹	HEPA	99.97	None	5.28	0.50	0.50	1230	6.0 x 10 ⁻⁴	1
5.0 x 10 ⁻⁸									
operation of a rotating target neutron source, that is no longer in operation.									
2.0 x 10 ⁻⁶	None	0	None	23.47	0.71	15.40	1230	1.9 x 10 ⁻⁹	1
2.5 x 10 ⁻⁵	None	0	None	8.23	0.50	0.50	1230	7.8 x 10 ⁻⁸	1
2.0 x 10 ⁻⁶	None	0	None	23.47	0.71	15.40	1230	1.9 x 10 ⁻⁹	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
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	e	298-FHE-1	Fusion target research	H-3	3.0×10^{-2}	None	0	None	6.1
298	189	298-189-FHE-14	Nova target fabrication	U-238 U-234 H-3	4.7×10^{-9} 4.7×10^{-9} 3.0×10^{-2}	HEPA	99.97	None	6.4
Material Fabrication Shops, Buildings 321, 321A, 321B, 321C, are part of the Mechanical Engineering Department. Operations in this complex include milling, shaping and machining of depleted uranium. Uranium pieces may be worked on in a single location, or 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	9.7
321C	1153	321C-1153-FHE-9	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None	8.5
321C	1351	321C-1351-FHE-1000	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None	12.4
321C	1437	321C-1437-FHE-15	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None	11.2
321C	1437A	321C-1437A-FHE-11	Machining of uranium	U-238	5.8×10^{-7}	HEPA	99.97	None	11.3
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 sizing. Tritium HT and HTO emissions are continuously monitored from the two 30 meter tall stacks in compliance with NESHAPs regulations.									
331	All	331-FHE-1	Tritium research	H-3 (HTO) H-3 (HT)	5.1×10^{-1} 2.0×10^{-1}	None	0	Continuous molecular sieve and ion chamber	30.0
331	All	331-FHE-2	Tritium research	H-3 (HTO) H-3 (HT)	4.9×10^{-1} 5.6×10^{-1}	None	0	Continuous molecular sieve and ion chamber	30.0
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 filter sampling (PAMS), and plutonium specific, continuous real time air monitoring (CAMS).									
Facility air exhaust 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 tasks is classified, the standard NESHAPs approach, based on inventory, cannot be utilized without classifying this report. Actual monitoring data from both the PAMS and CAMS air monitoring systems can be presented 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, $<1 \times 10^{-15}$ microcuries per cubic centimeter of air.									
332	Various	332-FHE-1000/2000 (Plenum)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	8.80
332	Various	332-FGBE-1000/2000 (Loft)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.0
332	Various	332-FHE-4/5 (Downdraft)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.0
332	Various	332-FHE-4/5 (Loft)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.0
332	Various	332-FGBE-3000/4000 (Loft)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.0
332	Various	332-FFE-1000/2000 (Inherent 3)	Plutonium research	Pu-239	0*	Multiple HEPA filters	>99.97	PAMS and CAMS	10.1
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 optics, laser systems, flash x-ray generators, and hydro-diagnostics equipment.									
341	1015	341-1015-NO ID	Temporary storage	U-238	1.5×10^{-9}	HEPA	99.97	None	10.06

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
Research and development.									
3.0×10^{-2}	None	0	None	6.10	0.30	9.90	1308	1.1×10^{-4}	1
4.7×10^{-9}	HEPA	99.97	None	6.40	0.63	15.10	1308	1.8×10^{-4}	1
4.7×10^{-9}									
3.0×10^{-2}									
This complex includes milling, shaping and machining of depleted uranium. Parts occasionally undergo heat treatment. The amount of depleted uranium that is handled depends on the size of the part.									
5.8×10^{-7}	HEPA	99.97	None	9.75	0.46	5.76	1044	4.0×10^{-4}	1
5.8×10^{-7}	HEPA	99.97	None	8.53	0.31	16.06	1044	4.0×10^{-4}	1
5.8×10^{-7}	HEPA	99.97	None	12.47	0.60	5.97	1044	3.0×10^{-4}	1
5.8×10^{-7}	HEPA	99.97	None	11.20	0.23	13.40	1044	3.0×10^{-4}	1
5.8×10^{-7}	HEPA	99.97	None	11.30	0.63	6.53	1044	3.0×10^{-4}	1
The facility is undergoing significant reduction in tritium work and inventory down sizing.									
5.1×10^{-1}	None	0	Continuous molecular sieve and ion chamber	30.00	1.22	7.59	984	1.8×10^{-2}	4
2.0×10^{-1}									
4.9×10^{-1}	None	0	Continuous molecular sieve and ion chamber	30.00	1.22	10.50	984	1.9×10^{-2}	4
5.6×10^{-1}									
Building exhaust air is double HEPA filtered and monitored with a continuous monitor.									
Because building plutonium inventory and the plutonium inventory associated with the building are small, the actual monitoring data from both the PAMS and CAMS air monitoring systems can be presented as a range of values. The actual monitoring data for the building is presented as a range of values. The actual monitoring data for the building is presented as a range of values.									
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	8.80	1.07	17.70	912	0*	4
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.30	7.00	912	0*	4
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.20	14.30	912	0*	4
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.64	4.50	912	0*	4
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	11.00	0.30	2.10	912	0*	4
0*	Multiple HEPA filters	>99.97	PAMS and CAMS	10.1	0.91	12.20	912	0*	4
Electrical systems; explosives; high-velocity armor impact experiments; and development and testing of optics.									
1.5×10^{-9}	HEPA	99.97	None	10.06	0.40	8.40	852	4.2×10^{-7}	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (CU/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (ft)
The biomedical research complex includes buildings 361, 363, 365 and 366. Buildings 363 and 366 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 constituent atoms (tracers) in organic compounds.									
361	1245	361-1245-FHE-20/21	Radioactive Tracers	P-32	2.0×10^{-6}	None	0	None	7.00
361	1342	361-1342-FHE-18	Use of tracers for biomedical research	C-14	2.2×10^{-5}	None	0	None	7.01
361	1346	361-1346-FHE-17	Use of tracers for biomedical research	P-32, S-35	4.2×10^{-9}	None	0	None	7.01
361	1347	361-1347-FHE-16	Use of tracers for biomedical research	H-3 P-32	1.0×10^{-9} 1.6×10^{-9}	None	0	None	7.01
361	1442	361-1442-FHE-31	Use of tracers for biomedical research	H-3 C-14	1.0×10^{-9} 1.0×10^{-9}	None	0	None	7.32
361	1445	361-1445-FHE-14	Use of tracers for biomedical research	P-32, S-35	2.0×10^{-9}	None	0	None	7.01
361	1446	361-1446-FHE-15	Use of tracers for biomedical research	P-32	4.0×10^{-9}	None	0	None	7.01
361	1542	361-1542-FHE-12	Use of tracers for biomedical research	P-32, S-35	3.5×10^{-9}	None	0	None	7.01
361	1564	361-1564-FHE-2000	Use of tracers for biomedical research	H-3 C-14	1.2×10^{-7} 2.1×10^{-9}	None	0	None	7.62
361	1625	361-1625-FHE-29	Use of tracers for biomedical research	S-35	1.5×10^{-11}	None	0	None	5.49
361	1642	361-1642-FHE-11	Use of tracers for biomedical research	P-35, S-35	3.5×10^{-9}	None	0	None	7.01
361	1649	361-1649-FHE-4	Use of tracers for biomedical research	H-3 C-14	5.0×10^{-9} 1.5×10^{-9}	None	0	None	7.01
361	1658	361-1658-FHE-1000	Use of tracers for biomedical research	P-32	1.6×10^{-8}	None	0	None	7.62
361	1664	361-1664-FHE-2000	Use of tracers for biomedical research	H-3	5.0×10^{-6}	None	0	None	7.01
361	1742	361-1742-FHE-8	Use of tracers for biomedical research	P-32, S-35	8.0×10^{-8}	None	0	None	7.01
361	1745	361-1745-FHE-7	Use of tracers for biomedical research	S-35	3.8×10^{-10}	None	0	None	7.01
Building 377 is operated by the Environmental Sciences 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	1003	377-1003-FHE-6	Environmental sampling	C-14 H-3 Ni-63	2.5×10^{-7} 5.0×10^{-8} 1.5×10^{-8}	None	0	None	5.79
377	1005	377-1005-FHE-1	Environmental sampling	C-14 H-3	2.5×10^{-7} 5.0×10^{-8}	None	0	None	5.79
377	1028	377-1028-FHE-1000	Biomedical experiments	P-32	1.3×10^{-4}	None	0	None	8.23

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
of radionuclides. Building 365 contains operations are done in Building 365, and the building air is filtered through been removed from the animals for examination. Effluent atoms (tracers) in organic compounds.									
2.0 x 10-6	None	0	None	7.00	0.40	4.40	855	1.4 x 10-7	1
2.2 x 10-5	None	0	None	7.01	0.41	4.40	855	2.6 x 10-6	1
4.2 x 10-9	None	0	None	7.01	0.41	4.40	855	3.0 x 10-7	1
1.0 x 10-9 1.6 x 10-9	None	0	None	7.01	0.41	4.40	855	1.1 x 10-7	1
1.0 x 10-8 1.0 x 10-9	None	0	None	7.32	0.26	3.60	855	6.9 x 10-8	1
2.0 x 10-9	None	0	None	7.01	0.41	4.40	855	1.0 x 10-7	1
4.0 x 10-9	None	0	None	7.01	0.41	4.40	855	3.0 x 10-7	1
3.5 x 10-9	None	0	None	7.01	0.41	4.40	855	2.0 x 10-7	1
1.2 x 10-7 2.1 x 10-9	None	0	None	7.62	0.65	5.60	855	2.6 x 10-7	1
1.5 x 10-11	None	0	None	5.49	0.10	8.30	855	1.2 x 10-9	1
3.5 x 10-9	None	0	None	7.01	0.41	4.40	855	2.0 x 10-7	1
5.0 x 10-9 1.5 x 10-9	None	0	None	7.01	0.41	4.40	855	1.0 x 10-7	1
1.6 x 10-8	None	0	None	7.62	0.65	2.80	855	1.1 x 10-6	1
5.0 x 10-6	None	0	None	7.01	0.41	4.40	855	3.0 x 10-8	2
6.0 x 10-9	None	0	None	7.01	0.41	4.40	855	5.0 x 10-7	1
3.6 x 10-10	None	0	None	7.01	0.41	4.40	855	2.6 x 10-8	1
and radiological sample preparation for environmental analysis; and analysis of soil.									
2.5 x 10-7 5.0 x 10-8 1.5 x 10-8	None	0	None	5.79	0.10	11.60	936	1.6 x 10-7	1
2.5 x 10-7 5.0 x 10-8	None	0	None	5.79	0.28	5.80	936	2.0 x 10-8	1
1.3 x 10-4	None	0	None	8.23	0.23	20.60	936	8.8 x 10-6	1

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
Building 378 is operated by the Environmental Sciences 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-1,2,3,4,5,6,9,10	Environmental analysis	Pu-242 Pu-236 Am-241	1.8 x 10-12 3.6 x 10-13 7.2 x 10-13	None	0	None	8.
378	120	378-120-FHE-6,7	Environmental analysis	Pu-242 Pu-236 Am-241	4.5 x 10-13 9.0 x 10-14 1.8 x 10-13	None	0	None	8.
Building 381 is part of the Laser Fusion Program. Small quantities of tritium are handled in support of laser target research and development.									
381	8156	381-8156-FHE-1	Neutron spectroscopy/ target storage	H-3	2.0 x 10-2	None	0	None	11.
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	4.2 x 10-2	None	0	None	6.
The major portion of Building 412W, the west wing, is used for environmental research in support of the Environmental Sciences Division. The east wing of the building contains hot cells that are unused and have been inactive for over a decade. These cells and the associated air filtration/scrubber system are contaminated with low-level radionuclides and are in a caretaker condition. A maintenance and radiation safety monitoring program is in place for them. The air exhaust system for the hot cells is shut down and there are no radionuclide air emissions. This NESHAPs report addresses only the environmental studies occurring in the west wing of the building.									
412W	1111	412W-1111-FHE-8	Environmental analysis	None	0	HEPA	99.97	None	11.
412E	1130	412E-1139-FHE-20/21	No current operations	None	0	HEPA	99.97	None	10.
Building 419 - Decontamination Facility was used until 1969, at which time decontamination was curtailed and the area is no longer in use.									
419			No current operations	None	0	HEPA	99.97	Filter	N/A
Building 490 is part of LLNL's Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program. The Separator Demonstration Facility (SDF), which vaporizes uranium for enrichment, is located in this building. There are four manifolded, 7500-CFM (cubic feet per minute) stacks on the roof of this facility. Stack sampling is continuous, using an in-line isokinetic system. Sampling filters are routinely removed and analyzed for any radioactivity. The Building 490 facility always operates with two in-series high efficiency particulate (HEPA) filter banks in place, and there is never an unabated emission. AIRDOS-PC model results for the hypothetical situation with no filtration in place, which indicate that stack monitoring is not required per the NESHAPs 40 CFR 61 regulations. Even though the model results show that stack sampling is not required, Building 490 air emissions are continuously sampled at the post-HEPA-filter atmospheric discharge points.									
490	All Pods	490-AVLIS-1,2,3,4	Uranium atomic vapor laser isotope separation	U-238 U-238 U-238 U-238	0 0 0 0	Double HEPA	>99.97	Filter	13.
Building 491 is part of the complex that houses the Uranium Atomic Vapor Laser Isotope Separation (U-AVLIS) program. The experiment in this facility is being redesigned and has no inventory of radionuclides. There is one 30,000-CFM, 11.6-meter-high stack located on the south side of this building. When the facility is operational, exhaust air will be passed through two in-series HEPA filters before being discharged to the air. When the facility becomes operational, this stack will be sampled continuously using an in-line isokinetic system. Sampling filters will be routinely removed and analyzed for any radioactivity, as is done in Building 490. Although there are no radionuclide air releases, the model parameters are shown. Further NESHAPs evaluation will be performed when radionuclides are used in this building.									
491	Various	491-FHE-1000	Inactive, experiment being redesigned	None	0	Double HEPA	>99.97	Filter	11.
Building 493 is a warehouse used for the storage of materials in support of research in uranium laser separation of uranium isotopes. All materials are in sealed containers, and, under normal operating conditions, there are no operations that have the potential to release radioactive materials to the atmosphere.									
493	Various	None	ISAM (AVLIS) Storage	Various Radionuclides in sealed containers	0	None	0	None	N/A

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Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
chemical and radiological sample preparation for environmental analysis; and analysis of soil,									
1.8 x 10-12 3.6 x 10-13 7.2 x 10-13	None	0	None	8.53	0.30	5.90	816	1.6 x 10-9	1
4.5 x 10-13 9.0 x 10-14 1.8 x 10-13	None	0	None	8.53	0.30	9.70	816	4.0 x 10-10	1
and development.									
2.0 x 10-2	None	0	None	11.28	0.36	20.6	996	3.8 x 10-5	1
are handled in support of laser target research and development.									
4.2 x 10-2	None	0	None	6.10	0.30	9.9	1050	2.0 x 10-4	1
Loss Division.									
The associated air filtration/scrubber system are contaminated with low-level radionuclides and are in a caretaker, units is shut down and there are no radionuclide air emissions									
0	HEPA	99.97	None	11.50	0.254	4.40	702	0	1
0	HEPA	99.97	None	10.70	0.75	5.10	702	0	1
longer in use.									
0	HEPA	99.97	Filter	N/A	N/A	N/A	720	0	4
Enrichment Facility (SDF), which vaporizes uranium for enrichment, is located in this building.									
using an in-line isokinetic system. Sampling filters are routinely removed and analyzed for any radioactivity.									
is never an unlabeled emission.									
required per the NESHAPs 40 CFR 61 regulations. Even though the model results show that stack points.									
0	Double HEPA	>99.97	Filter	13.70	0.89	5.70	642	0	4
0									
0									
Experiment in this facility is being redesigned and has no inventory of radionuclides.									
Exhaust air will be passed through two in-series HEPA filters before being discharged to the air. When the facility									
is removed and analyzed for any radioactivity, as is done in Building 490.									
used when radionuclides are used in this building.									
0	Double HEPA	>99.97	Filter	11.60	0.94	20.40	900	0	4
Isotopes. All materials are in sealed containers, and, under normal operating conditions, there are no operations that have									
0	None	0	None	N/A	N/A	N/A	N/A	0	N/A

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
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.									
**MFP - Mixed Fission Products									
513	Shredder	Shredder	Shredding of solid waste	Am-241, Am-242m Ba-133 Ce-144 Co-60, Ni-63 Cs-137, MFP** C-14 H-3 Po-210 Pu-238 P-32, S-35 Ra-226 Th-232 U-234 U-235 U-238	1.4 x 10-10 1.5 x 10-12 5.0 x 10-17 1.5 x 10-9 1.5 x 10-7 2.2 x 10-14 2.9 x 10-4 9.5 x 10-14 2.4 x 10-9 2.1 x 10-8 1.8 x 10-10 3.0 x 10-9 9.0 x 10-12 3.1 x 10-11 6.0 x 10-8	HEPA	99.97	None	8.1
Building 514 - See Diffuse Sources Section below.									
Building 594 was used in research to assess the translocation of carbon through plant tissues, but this work was terminated in 1989.									
594			No current operations	None	0	None	0	None	N/A
Building 612 - See Diffuse Sources Section below.									
Building 614 serves as a storage area for radioactive and mixed wastes which are awaiting disposal.									
614			Storage Area	Encapsulated sources	0	None	0	None	N/A
Building 625 serves as a storage area for radioactive and mixed wastes which are awaiting disposal.									
625			Storage Area	Encapsulated sources	0	None	0	None	N/A
Trailer 2581 is administered by L-Division.									
2581	All	2581-All (NO ID)	Preparations of Foils	U-238 U-234	1.6 x 10-11 1.6 x 10-11	HEPA	99.97	None	3.6
SITE 300 SECTION									
Site 300- High 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 1992 is shown here. The radionuclides in Buildings 804, 810A, 810B, 822B, and 854F are encapsulated or sealed and are not used.									
801	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	5.1 x 10-2 6.6 x 10-4 4.5 x 10-3	None	0	None	N/A
850	Firing Table	N/A	Explosive Tests	None	0	None	0	None	N/A
851	Firing Table	N/A	Explosive Tests	U-238 U-235 U-234	3.3 x 10-7 4.3 x 10-9 3.1 x 10-8	None	0	None	N/A

Attachment 1 - 1992 LLNL NESHAPs Annual Report Spreadsheet

Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
waste shredder, 3.									
1.4 x 10-10	HEPA	99.97	None	8.84	0.59	1.40	660	6.3 x 10-5	1
1.5 x 10-12									
5.0 x 10-17									
1.5 x 10-9									
1.5 x 10-7									
2.2 x 10-14									
2.9 x 10-4									
9.5 x 10-14									
2.4 x 10-9									
2.1 x 10-8									
1.8 x 10-10									
3.0 x 10-9									
9.0 x 10-12									
3.1 x 10-11									
6.0 x 10-8									
0	None	0	None	N/A	N/A	N/A	713	0	1
0	None	0	None	N/A	N/A	N/A	510	0	1
0	None	0	None	N/A	N/A	N/A	428	0	1
1.6 x 10-11	HEPA	99.97	None	3.05	0.24	5.00	1062	1.0 x 10-8	1
1.6 x 10-11									
Used uranium material as part of the material inventory. There are multiple tests per year.									
not used.									
5.1 x 10-2	None	0	None	N/A	N/A	N/A	2400	2.1 x 10-2	5
6.6 x 10-4									
4.5 x 10-3									
0	None	0	None	N/A	N/A	N/A	4000	0	5
3.3 x 10-7	None	0	None	N/A	N/A	N/A	3900	6.5 x 10-7	5
4.3 x 10-9									
3.1 x 10-8									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
DIFFUSE SOURCE SECTION									
Building 292 - diffuse emissions result from tritium-contaminated water which leaked from an underground storage tank. Vegetation in the area transpires water with elevated tritium concentrations.									
292	Spill Area	N/A	Evaporation and Transpiration	H-3	2.4 x 10-3	None	0	Silica Gel	1.0
Building 331 - small amounts of slightly contaminated equipment are stored in a metal box awaiting transport and storage by Hazardous Waste Management.									
331	Outside	N/A	Storage of Contaminated Parts	H-3	8.0 x 10-1	None	0	None	3.0
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 filtration. Areas used for storage are not considered to release radionuclides because the wastes are fully contained.									
**MFP - Mixed Fission Products									
514	"Tank Farm"	Area Source	Liquid in tanks	H-3	5.1 x 10-4	None	0	None	Area Source
				C-14	1.5 x 10-5				
				P-32, S-35	2.2 x 10-5				
514	"Tank Farm"	Area Source	Bulking of liquid poured from drums	Am-241, Cf-250	4.2 x 10-10	None	0	None	Area Source
				Ce-141, Ce-144	2.2 x 10-9				
				Co-60, Co-57	5.1 x 10-12				
				Ce-137, MFP**	5.6 x 10-7				
				Nb-95	5.0 x 10-8				
				U-235	1.1 x 10-10				
				U-238	7.1 x 10-7				
514	"Tank Farm"	None—roof vent	Sludge production	Am-241, Cf-250	4.2 x 10-9	None	0	None	4.5
				Ce-141, Ce-144	2.2 x 10-8				
				Co-60, Co-57	5.1 x 10-11				
				Ce-137, MFP**	5.6 x 10-7				
				Nb-95	5.0 x 10-7				
				U-235	1.1 x 10-9				
				U-238	7.1 x 10-6				
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/baler 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.									
The AIRDOS calculation predicts the potential emissions as if the unit were in operation.									
**MFP - Mixed Fission Products									
612	Crusher	Crusher	Drum crusher	Am-241, Am-242m	1.4 x 10-10	HEPA	99.97	None	9.14
				Ba-133	1.5 x 10-12				
				Ce-144	5.0 x 10-17				
				Co-60, Ni-63	1.5 x 10-9				
				Ce-137, MFP**	1.5 x 10-7				
				C-14	2.2 x 10-14				
				H-3	2.9 x 10-4				
				Po-210	9.5 x 10-14				
				Pu-239	2.4 x 10-9				
				P-32, S-35	3.1 x 10-8				
				Ra-226	1.8 x 10-10				
				Th-232	3.0 x 10-9				
				U-234	9.0 x 10-12				
				U-235	3.1 x 10-11				
				U-238	6.0 x 10-8				

Attachment 1 - 1992 LLNL NESHAPs Annual Report Spreadsheet

Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
petation in the area transpires water with elevated tritium concentrations.									
2.4 x 10-3	None	0	Silica Gel	1.00	100 m**2	0.00	1221	1.3 x 10-6	6
Hazardous Waste Management.									
8.0 x 10-1	None	0	None	3.00	1 m**2	0.50	984	8.9 x 10-4	6
Tank area processes the liquid waste from facilities on site. precipitation, separation, and filtration. Areas used for storage are not considered to release radionuclides									
5.1 x 10-4	None	0	None	Area Source	1 m**2	N/A	606	3.4 x 10-5	6
1.5 x 10-5									
2.2 x 10-5									
4.2 x 10-10	None	0	None	Area Source	1 m**2	N/A	606	1.9 x 10-3	6
2.2 x 10-9									
5.1 x 10-12									
5.6 x 10-7									
5.0 x 10-8									
1.1 x 10-10									
7.1 x 10-7									
4.2 x 10-9	None	0	None	4.57	0.34	0.30	606	5.0 x 10-3	6
2.2 x 10-6									
5.1 x 10-11									
5.6 x 10-7									
5.0 x 10-7									
1.1 x 10-9									
7.1 x 10-6									
and smaller containers that previously contained hazardous chemicals or radioactive materials.									
Test Site. The unit, which is not currently in operation, is connected to a HEPA filter.									
1.4 X 10-10	HEPA	99.97	None	9.14	0.15	20.70	528	5.6 x 10-5	6
1.5 x 10-12									
5.0 x 10-17									
1.5 x 10-9									
1.5 x 10-7									
2.2 x 10-14									
2.9 x 10-4									
9.5 x 10-14									
2.4 x 10-9									
3.1 x 10-8									
1.8 x 10-10									
3.0 x 10-9									
9.0 x 10-12									
3.1 x 10-11									
6.0 x 10-8									

Building	Room/Area	Stack ID	Operation	Radionuclides	Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height
812	Compactor/Baler	Compactor	Waste baler/compactor	Am-241, Am-242m	1.4×10^{-10}	HEPA	99.97	None	12.0
				Ba-133	1.5×10^{-12}				
				Ce-144	5.0×10^{-17}				
				Co-60, Ni-63	1.5×10^{-9}				
				Cs-137, MFP**	1.5×10^{-7}				
				C-14	2.2×10^{-14}				
				H-3	2.9×10^{-4}				
				Po-210	9.5×10^{-14}				
				Pu-239	2.4×10^{-9}				
				P-32, S-35	3.1×10^{-8}				
				Ra-226	1.8×10^{-10}				
				Th-232	3.0×10^{-9}				
				U-234	9.0×10^{-12}				
				U-235	3.1×10^{-11}				
				U-238	6.0×10^{-8}				
Southeast Quadrant			Resuspension	Pu-239	N/A	None	0	High volume air filter	N/A
POINT SOURCE RADIONUCLIDE SECTION: Emissions contributing 10% or more to the respective site EDEs.									
177	1020	177-1020-FHE-22	Uranium Vapor Experiment	U-238	1.2×10^{-4}	Building 177, Room 1020 emissions contribute to 15% of the EDE for the Livermore site			
				U-235	1.6×10^{-6}				
				U-234	1.2×10^{-4}				
331	All	331-FHE-1 and 331-FHE-2	Tritium research	H-3 (HTO)	1.0×10^{-2}	Building 331 emissions contribute to 54% of the EDE for the Livermore site (47%)			
				H-3 (HT)	7.6×10^{-1}				
801	Firing Table	N/A	Explosive Tests	U-238	5.1×10^{-2}	The Building 801 firing table emissions contribute to 100% of the EDE for Site 30			
				U-235	6.6×10^{-4}				
				U-234	4.5×10^{-3}				

Attachment 1 - 1992 LLNL NESHAPs Annual Report Spreadsheet

Estimated Annual Release (Ci/yr)	Control Devices	Efficiencies	Type of monitoring at release point	Stack Height (m)	Stack Diameter (m)	Momentum (m/s)	Distance to Site Wide MEI (m)	Effective Dose Equivalent (mrem/yr)	EDE Category
1.4 x 10-10	HEPA	99.97	None	12.00	0.46	2.90	528	4.8 x 10-5	6
1.5 x 10-12									
5.0 x 10-17									
1.5 x 10-9									
1.5 x 10-7									
2.2 x 10-14									
2.9 x 10-4									
9.5 x 10-14									
2.4 x 10-9									
3.1 x 10-8									
1.8 x 10-10									
3.0 x 10-9									
9.0 x 10-12									
3.1 x 10-11									
8.0 x 10-8									
N/A	None	0	High volume air filter	N/A	N/A	N/A	0	1.9 x 10-3	6
1.2 x 10-4	Building 177, Room 1020 emissions contribute to 15% of the EDE for the Livermore site (13% when diffuse emissions are included in the total).							1.2 x 10-2	
1.6 x 10-6								Included in the EDE given above	
1.2 x 10-4								Included in the EDE given above	
1.0 x 10-2	Building 331 emissions contribute to 54% of the EDE for the Livermore site (47% when diffuse emissions are included in the total).							3.7 x 10-2	
7.6 x 10-1								Included in the EDE given above	
5.1 x 10-2	The Building 801 firing table emissions contribute to 100% of the EDE for Site 300.							2.1 x 10-2	
6.6 x 10-4								Included in the EDE given above	
4.5 x 10-3								Included in the EDE given above

Attachment 2. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at the Livermore site, 1992.

Attachment 3. Location of Site-Wide Maximally Exposed Individual (SW-MEI) at Site 300, 1992.

Attachment 4. Surrogate radionuclide list.

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

Attachment 4. (continued)

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

^a D = days, W = weeks, Y = years; ALI (inh) = Annual Limits of Intake via inhalation; DAC = Derived Air Concentration.

^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.

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