

U.S. Department of Energy

Oakland Operations Office, Oakland, California

**FINAL
RADIONUCLIDE AIR EMISSION ANNUAL REPORT
(SUBPART H OF 40 CFR 61)
CALENDAR YEAR 2001**

for the

**LABORATORY FOR ENERGY-RELATED HEALTH RESEARCH
UNIVERSITY OF CALIFORNIA, DAVIS**

prepared for:

United States Department of Energy
Oakland Operations Office
1301 Clay Street
Oakland, California 94612-5208

prepared by:

Weiss Associates
5801 Christie Avenue, Suite 600
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May 3, 2002
Rev. 0

DOE Oakland Operations Contract DE-AC03-96SF20686



Department of Energy
National Nuclear Security Administration
1301 Clay Street
Oakland, California 94612-5208

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JUN 20 2002

Mr. Jack Broadbent
Director, Air Division, A-1-1
U. S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105

SUBJECT: Radionuclide Air Emission Annual Reports for Calendar Year 2001

Dear Mr. Broadbent:

Enclosed are copies of U. S. Department of Energy, Oakland Operations Office (OAK),
Radionuclide Air Emission Reports (Under Subpart H of 40 CFR 61) for Calendar Year
2001 for the following facilities:

Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Laboratory for Energy-Related Health Research
Santa Susana Field Laboratory
Stanford Linear Accelerator Center

Should you have any questions, please contact Steve Black on (510) 637-1595.

Sincerely,

A handwritten signature in cursive script that reads "Ralph Kopenhaver".

Ralph Kopenhaver, Director
Environment, Safety, and Health
Division

Enclosure

cc: Eleanor D. Thornton, EPA Headquarters, Office of Radiation and Indoor Air, w/encl
Harold Peterson, DOE/EH-412 w/encl (3 copies)
Mike Bandrowski, EPA Region IX, A-1-1 w/o encl

bcc w/o encl:

Gus Vasquez, EH-412

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David Osugi, SSO

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Approvals Page

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Approved by:



Michael Zimmerman, P.E., R.E.A.
Task Manager
Weiss Associates

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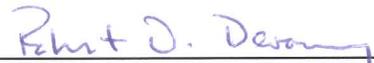


Dolores Loll
Project Quality Assurance Manager
Weiss Associates

Date:

5/3/02

Approved by:



Robert O. Devany, R.G., C.H.G.
Project Manager
Weiss Associates

Date:

5/3/02

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Appendix A CAP88-PC Output Results

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ACRONYMS AND ABBREVIATIONS

#/km ²	number per square kilometer
°C	degrees Celsius
°F	degrees Fahrenheit
Ac-228	actinium-228
AM	Air Monitoring Station
Bi-212	bismuth-212
Bi-214	bismuth-214
C-14	carbon-14
CFR	Code of Federal Regulations
Ci/yr	curies per year
cm/s	centimeters per second
cm/yr	centimeter(s) per year
Co-60	cobalt-60
Cs-137	cesium-137
cu yd	cubic yard(s)
DOE	United States Department of Energy
EDE	effective dose equivalent
EDPs	Eastern Dog Pens
Emis.	emission
ER/WM	Environmental Restoration/Waste Management
g/m ²	grams per square meter
g/m ² -sec	grams per square meter-seconds
hr	hour
ID	identification (number)
K-0	potassium-0
km	kilometers

LEHR	Laboratory for Energy-Related Health Research
m	meter(s)
m/s	meters per second
m ²	square meter(s)
m ³	cubic meter
Max.	maximum
mCi	milliCuries
MEI	maximally exposed individual
MOU	Memorandum of Understanding
mph	miles per hour
mrem/yr	millirem per year
mSv/yr	milliSievert per year
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Pb-210	lead-210
Pb-212	lead-212
Pb-214	lead-214
pCi/g	picoCurie per gram
PM ₁₀	particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
RA	removal action
Ra/Sr	radium/strontium
Ra-226	radium-226
Sr-90	strontium-90
Th-234	thorium-234
Tl-208	thallium-208
U-235	uranium-235
U-238	uranium-238
UC Davis	University of California, Davis
UCL	upper confidence limit
US EPA	United States Environmental Protection Agency
WDPs	Western Dog Pens

μg	microgram(s)
$\mu\text{g}/\text{m}^3$	micrograms per cubic meter
μm	micrometer

US Department of Energy
Radionuclide Air Emission Annual Report
(Subpart H of 40 CFR 61)
Calendar Year 2001

Site Name: Laboratory for Energy-Related Health Research (LEHR)

Field Office Information

Office: Oakland Operations Office
Address: 1301 Clay Street, Room 700 N
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1. FACILITY INFORMATION

The Laboratory for Energy-Related Health Research (LEHR) is in compliance with the requirements of 40 Code of Federal Regulations (CFR) Part 61 Subpart H - National Emissions Standards for Hazardous Air Pollutants (NESHAP) for Emissions of Radionuclides from United States Department of Energy (DOE) Facilities. The NESHAP regulations require that radionuclide emissions not exceed levels that would result in an effective dose equivalent (EDE) of 10 millirem per year (mrem/yr).

This Radionuclide Air Emission Annual Report applies only to the DOE areas at the LEHR facility on the University of California, Davis (UC Davis) campus. For the purposes of this report, the DOE areas will be referred to as "the Site" and references to the LEHR facility are inclusive of the entire 15-acre property where both DOE and UC Davis conduct activities. There are currently no point sources of radionuclide emission at the Site. Potential fugitive/area sources of radionuclide emissions were modeled using the United States Environmental Protection Agency (US EPA) atmospheric dispersion/radiation dose calculation computer code, CAP88-PC Version 1.0. Based on results from this model, the total estimated contribution to the maximum EDE from non-point source emissions for reporting year 2001 is estimated to be $1.0E \times 10^{-3}$ mrem/yr (less than 0.01% of the 10 mrem/yr standard).

1.1 Site Description

The LEHR facility is located in Solano County, California, in the southeast quadrant of Section 21, Township 8 North, Range 2 East, Mount Diablo Base and Meridian. It is approximately 1.5 miles south of the town of Davis (Figure 1), and occupies about 15 acres on the southeast portion of the UC Davis campus. The LEHR facility is bounded by UC Davis research facilities, private farmland and the South Fork of Putah Creek. The southern boundary of the LEHR facility is the northern levee of the South Fork of Putah Creek.

The local climate is Mediterranean with mild winters and long summers. Based on the site meteorological station data collected in 2001, the average winter (October through April) temperature was 52 degrees Fahrenheit (°F), and the average summer (May through September) temperature was 72°F. Precipitation data were also collected from the UC Davis climatological data center, located approximately one mile northwest of the LEHR facility. Based on the UC Davis data, the total precipitation for 2001 was 21.66 inches (with totals of 16.07, 10.53 and 24.1 inches recorded in 2000, 1999 and 1998, respectively). The sun shines approximately 95% of the time during daylight hours in the summer and about 45% of the time during daylight hours in the winter.

The prevailing wind direction is from the south, reflecting frequent incursions of marine air through the Carquinez Strait into the Sacramento Valley. Changes in wind direction are common, with winds from the northwest occurring diurnally. Several times a year, strong winds blow from the north, generally following the passage of Pacific storm systems (DOE, 1994a). The average 2001 wind speed recorded at the Site three-meter tower on the meteorological station was approximately 1.72 meters per second (m/s) or 3.84 miles per hour (mph), the maximum wind speed was 9.79 m/s (21.9 mph) and the median wind speed was 1.48 m/s (3.3 mph).

The land within a one-mile radius of the LEHR facility is owned both privately and by UC Davis, and is used for animal research, agriculture and recreation. Immediately to the north, east and west of the LEHR facility are UC Davis research facilities. Privately-owned lands within one mile to the south and east of the LEHR Facility include permanent residences and some crop land. Approximately 75% of the surrounding land in the general vicinity of the LEHR facility is used for agriculture. Major crops include fruits, nuts and grains. Approximately 40% of the agricultural land in the vicinity is irrigated, and some of the nearby lands are used for cattle grazing (DOE, 1988).

The LEHR facility encompasses approximately 15 acres and contains laboratory buildings and former animal-handling facilities (Figure 2). Of the 15 acres, approximately 45% are paved or covered by structures. Approximately 30% are unpaved and relatively free of vegetation. Five percent are covered by large, deep-rooted vegetation. Outdoor dog pens consisting of asphalt, gravel and soil occupy the remaining 20%, or 3 acres, of the LEHR facility. The land is owned by the Regents of the University of California and DOE owns the buildings on site.

In the early 1950s, the Atomic Energy Commission (now DOE) began conducting radiological studies at UC Davis on laboratory animals, particularly beagles. Initial studies were carried out on the main campus and involved the irradiation of beagles. DOE began operating in its present location in 1958 when full-scale experimental use of radioactive materials began. Research at the Site through the mid-1980s focused on the health effects from chronic exposure to radionuclides, primarily strontium-90 (Sr-90) and radium-226 (Ra-226). In the early 1970s, a cobalt-60 irradiator facility was constructed at the Site to study the effects of chronic exposure to gamma rays on bone marrow cells of beagles. In 1975, DOE initiated a program at the Site to study the potential health effects of combustion products from fossil fuel power plants. In 1983, the Toxic Pollutant Health Research Laboratory was established at the site. DOE-funded research at the LEHR facility ended in 1989. The LEHR facility is presently occupied by the UC Davis Center for Health and the Environment and the LEHR environmental restoration/waste management (ER/WM) project. UC Davis radionuclide emissions are not included in this report.

1.2 Source Description

The NESHAP requirements primarily target point source/stack emissions. However, a Memorandum of Understanding (MOU) between DOE and US EPA (DOE, 1995) applies the same point source criteria to potential non-point diffuse area sources.

1.2.1 Point Sources

An evaluation of potential point sources of radionuclide emissions determined there were none at the Site in 2001.

1.2.2 Non-Point Sources

Non-point diffuse sources were limited to wind-blown fugitive dust from the following areas (Table 1):

- Western Dog Pens (WDPs) area; and,
- Eastern Dog Pens (EDPs) area.

A removal action (RA) at the WDPs area was conducted during the summer of 2001. Radium/Strontium (Ra/Sr) Area II is not included in this report because all contaminated structures and waste were removed in 2000.

1.2.3 Western and Eastern Dog Pens Areas

The WDPs and EDPs areas, located near the center of the LEHR facility (Figure 2), are a potential non-point diffuse source of radiological emissions. The dog pens were used to house dogs involved in the Ra-226 and Sr-90 research activities at the Site. Excreta from dogs housed in outdoor pens contained low levels of radiological constituents. Solids were removed from the pens on a daily basis. Urine evaporated and/or infiltrated the gravel fill in the pens. An estimated 2 milliCuries (mCi) of Sr-90 and 0.5 mCi of Ra-226 were potentially excreted in dog urine in these areas over the life of the project (WA, 1997).

The WDPs area originally contained 320 pens. In 1975, 64 pens were removed to allow for construction of the Cellular Biology Lab (Building H-294, Figure 2). The EDPs area contained 96 pens and overlies UC Davis Landfill No. 2.

In 1996, the barrels, interior chain-link fencing and concrete pedestals were removed from the EDPs and existing 256 WDPs. The barrels and concrete pedestals were properly packaged and shipped to the DOE Hanford site for disposal. In 1999, the interior chain-link fencing was released according to DOE Order 5400.5 and recycled off site (EMS, 1999).

Between May and August 1 2001, the concrete curbing, gravel, metal grating and fence posts were removed from the existing 256 WDPs. Approximately 1,725 cubic yards (cu yd) of gravel, 650 cu yd of asphalt, 800 cu yd of concrete curbing, and 45 cu yd of metal grating and fence posts were removed. This material was removed using an excavator, segregated into one of four waste streams and transported to the appropriate stockpile on site using a wheel loader.

The WDPs area emissions are based on the maximum detected radionuclide concentrations that exceed background in soil samples collected from the upper two feet of soil in the WDPs. To be conservative, the data from all the WDPs Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) investigations (Table 2) were included in the data set. The EDPs area emissions were based on the maximum detected radionuclide concentrations (Table 3) that exceed background in soil samples collected during the 1999 EDPs investigation, the only CERCLA investigation in this area. There were no soil-disturbing activities performed in the EDPs in 2001.

Ambient air samples were collected during the entire RA at the WDPs area from three stations around the perimeter of the LEHR facility and one distant station serving as a background station (Air Monitoring Station [AM]-3, Figure 2). Details of the air monitoring results are presented in the *Draft DOE Areas Remedial Investigation Report* (WA, 2002). Statistical analysis of on-site air monitoring data collected during the WDPs RA indicated that radionuclide concentrations in ambient air were either below background or the Derived Concentration Guide (WA, 2002). Particulate matter emissions with an aerodynamic diameter less than or equal to 10 micrometers (PM₁₀) from the excavation activities were closely monitored. During the RA, PM₁₀ concentrations did not exceed the US EPA air quality standard of 150 micrograms per cubic meter (µg/m³). The maximum PM₁₀ concentration detected on site during the RA was 60.81 µg/m³, collected from AM-5 located west of the WDPs area (Figure 2).

2. AIR EMISSION DATA

2.1 Point Sources

As discussed in Section 1, there are currently no point sources of radionuclide emissions at the Site.

2.2 Non-Point Sources

As discussed in Section 1, two potential non-point diffuse sources of radionuclide emissions were present at the Site in 2001. These included wind-blown, fugitive dust emission of radionuclides from the WDPs and EDPs areas. Based on the surface and shallow soil sampling results from the WDPs and EDPs, surface contamination is conservatively assumed to exist across the entire area of each potential radionuclide non-point emissions source. The 2001 WDPs RA was a significant change to site conditions that could have resulted in emissions different from those estimated in the *Radionuclide Air Emission Annual Report for Calendar Year 2000* (WA, 2001). Since the emissions from the WDPs RA were assumed to come from the upper two feet of soil in the WDPs, emissions from this area were not significantly different than from prior years before the RA was completed.

To calculate air emissions for this report, the surface area of each non-point source area was determined, using a scaled map of the Site, as follows:

- WDPs surface area = 9,500 square meters (m²) and
- EDPs surface area = 3,900 m².

The particulate re-suspension rate model was used to calculate the fugitive dust emission rate based on the US EPA's guidance document *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites* (Cowherd, 1985). Cowherd provides a methodology for the rapid, worst-case assessment of inhalation exposure to respirable particulate emissions, defined as airborne particles equal to or smaller than PM₁₀. PM₁₀ emission rates from site fugitive non-point sources were estimated using the equation developed by Cowherd for estimating respirable particle emissions from wind erosion of surfaces with an "unlimited reservoir" of erodible particles, adjusted for site-specific data using the following formula:

$$E_{10} = 0.036 \times (1 - V) \times \left(\frac{[u]}{u_t} \right)^3 \times F(x) \quad (\text{Eq. 1})$$

where

- E_{10} = annual average PM_{10} emission rate per unit contaminated surface, grams per square meter-hour [$g/(m^2\text{-hr})$];
- V = fraction of contaminated surface vegetative cover (assumed zero for worst-case bare soil);
- $[u]$ = mean annual wind speed at 7 meters height = $[u]_{\text{site}} \times \ln(700/z_0)/\ln(300/z_0) = 2.03$ meters per second (m/s);
- $[u]_{\text{site}}$ = 95% upper confidence limit (UCL) of LEHR site meteorological tower mean annual wind speed at a height of three meters (= 1.74 m/s);
- z_0 = emission source area roughness height (= two centimeters [cm]);
- u_t = threshold value of wind speed at 7 meters high = $u_{\text{friction}} / 0.4 \times \ln(700/z_0) = 7.3$ m/s;
- u_{friction} = threshold friction velocity (= 50 cm per second [cm/s]);
- x = $0.866 u_t/[u]$ = dimensionless ratio; and,
- $F(x)$ = function plotted in Figure 4-3 (= 5.6×10^{-2}) of *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites* (Cowherd, 1985).

The fraction of contaminated surface vegetative cover was conservatively assumed to be zero (i.e., bare soil) to calculate a worst-case value. The roughness height of two centimeters represents a value between the ranges for a plowed field and grasslands (Cowherd, 1985). Cowherd recommends a procedure for determining the threshold friction velocity based upon surface soil sieve analysis data. Because no surface soil sieve analysis data were available for the Site, a conservative threshold friction velocity of 50 cm/s was selected, following Cowherd's example (Application No. 1), for a rural emergency response application (Cowherd, 1985).

Cowherd recommends using the mean annual wind speed data tabulated in Table 4-1 of the particulate emission rate guidance document (Cowherd, 1985). However, since the tabulated values are based on 1977 meteorological data from Sacramento, and because site-specific data were available for 2001 from the LEHR on-site meteorological tower, the on-site data were selected as more representative of local site conditions. Therefore, the 95% UCL of the mean annual wind speed data was calculated using meteorological data collected during 2001 from the site meteorological tower.

The 95% UCL was calculated using equations for characterizing confidence limits of the mean for lognormal populations (Gilbert, 1987), as recommended by US EPA guidance (US EPA, 1992a). The resulting 95% UCL of the LEHR site meteorological tower mean annual wind speed for 2001 was 1.74 m/s. Because the height of the on-site meteorological tower is three meters, the wind speed must be converted to the equivalent wind speed at a height of seven meters using a variation of Cowherd's Equation (see parameter $[u]$ above), which assumes a logarithmic velocity profile near the Earth's surface.

Using Equation 1 and the data discussed above, the annual average PM₁₀ emission rate per unit contaminated surface was calculated as $E_{10} = 4.34 \times 10^{-5} \text{ g/m}^2\text{-hr}$. This emission rate is combined with the maximum radionuclide activity measured above background in surface soil activities for each potential emission source to calculate a particulate emission rate based on the following equation:

$$E_{\text{area}} = E_{10} \times A_{\text{area}} \times (24\text{-hr/day} \times 365 \text{ days/yr}) \times C_{\text{Rad}} \times (10^{-12} \text{ Curies per pCi})(\text{Eq. 2})$$

where,

- E_{area} = annual average PM₁₀ emission rate for the potential radionuclide emission non-point source, Curies per year (Ci/yr)
- E_{10} = annual average PM₁₀ emission rate per unit contaminated surface, g/(m²-hr)
- A_{area} = surface area of potential radionuclide emission non-point source, m² and
- C_{Rad} = maximum value of the measured surface soil radionuclide activities, pCi/g

Equations 1 and 2 and the methodology discussed above were used to estimate the non-point source fugitive dust radionuclide emission rate for each of the two potential radionuclide emission sources, as presented in Tables 2 and 3.

2.3 Particulate Matter-10

PM₁₀ data were calculated based on a volumetric flow rate. Glass fiber filters prepared by a US EPA-approved commercial laboratory were used to collect particulates greater than 10 micrometers at an average flow rate of 1.1 cubic meters per minute for approximately 24 hours. The total air volumes, V, ranged from 1,573 to 1,815 cubic meters (m³) based on the exposure time. The concentration of PM₁₀ was calculated with the equation below:

$$C_{PM-10} = \frac{M_{ff} - M_{fi}}{V} \quad (\text{Eq. 3})$$

where,

- C_{PM-10} = concentration of PM₁₀; $\mu\text{g/m}^3$
- M_{ff} = weight of the glass fiber filter after approximately 24 hours of exposure time reported by the laboratory; micrograms (μg)
- M_{fi} = weight of the glass fiber filter before sampling reported by the laboratory; μg and
- V = total air volume, m³

3. DOSE ASSESSMENTS

3.1 Description of Dose Model

Compliance with the NESHAP requirements for diffuse, non-point source emissions was assessed using the US EPA atmospheric dispersion/radiation dose calculation computer code, CAP88-PC Version 1.0. This code was used to calculate the EDE to individual receptors at various distances from the two potential site radionuclide emission non-point sources. A total of two "individual receptor" CAP88-PC runs were executed to model the fugitive dust emission sources described in Section 2. For each of the two potential radionuclide emission non-point sources, a human receptor was identified in each of the north, south, east and west quadrants in relationship to the source.

The area source algorithm employed by CAP88-PC, Version 1.0, assumes the distance from an area source to a receptor is measured as the distance from the centroid of the area source to the receptor (US EPA, 1992b). For the site CAP88-PC modeling, the distance from an area source to a receptor is measured as the approximate distance from the centroid of the area source to the building assumed to house the receptor. Each CAP88-PC run included receptor distances to the respective source's maximally exposed individual (MEI), as well as the distances to MEIs identified for the other potential radionuclide emission sources ("Location" column for each source in Table 4).

The reported EDE to an MEI at the LEHR facility includes contributions from the two potential site radionuclide emission non-point sources based on the CAP88-PC model output. Based on the combined non-point source exposures, the MEI at the LEHR facility is located in Reproductive Biology Laboratory (Building H-215) (Table 4).

The collective population dose is calculated as the average radiation dose to an individual in a specified area, multiplied by the number of individuals in that area. Two "population" CAP88-PC runs were executed to model the three fugitive dust emission non-point sources. The CAP88-PC model output for each run is included in Appendix A. For each of two potential radionuclide emission non-point sources, the CAP88-PC model was run with an updated population data file used in the *Radionuclide Air Emission Annual Report for Calendar Year 1998* (WA, 1999a), which includes the residential population in Davis and the student population at the UC Davis campus. The method used over the last four years to estimate population has been to take the 1997 data and add 2.4% per year (the average annual population growth for the City of Davis) (City of Davis Website).

The population file includes receptors within a distance of 10 kilometers (km) from the Site, rather than 80 km as specified in DOE guidance. This modification was necessary to avoid including

the large number of receptors in the Sacramento area whose exposure to radionuclides resulting from the Site would be negligible, but whose population numbers would have a large effect on the collective population dose results. This approach is appropriate for calculating the collective population dose for the primarily rural LEHR facility surroundings. The results of the CAP88-PC population runs based upon the combined source exposures are presented in Table 5 and Appendix A.

Supplemental information required by DOE (DOE, 1994b) is included in Appendix B.

3.2 Summary of Input Parameters

The input parameters for the CAP88-PC runs are summarized for the WDPs and EDPs areas in Tables 6, and 7, respectively. As noted above, the areal extent of each non-point source was conservatively calculated assuming that the maximum concentration (not corrected for background) of the observed radiological surface and shallow soil contamination for the WDPs and EDPs areas were present across the entire potential radionuclide emission non-point source area. Conservative radionuclide emissions were calculated using the maximum of the soil radionuclide concentrations measured for each potential area non-point source and applying the US EPA-recommended particulate re-suspension rate model to calculate the fugitive dust emission rates.

The Sacramento area wind file included with the CAP88-PC computer code was used for the modeling. Site meteorological data were not utilized for the CAP88-PC modeling due to incompatible formats between on-site data (MET144) and the CAP88-PC requirement (CD144). Use of the Sacramento wind file is appropriate because of the Site's proximity (approximately 15 miles) to Sacramento, the similar geography of the two areas, the lack of intervening geographical anomalies, and the absence of a compatible meteorological data file from a closer air station.

4. COMPLIANCE ASSESSMENT

Point Source Effective Dose Equivalent: None

Non-Point Source Maximum Effective Dose Equivalent: 1.0×10^{-3} millirem per year [mrem/yr]
 (1.0×10^{-5}) milliSievert [mSv]/yr

Location of On-Site Maximally Exposed Individual: Specimen Storage Building (H-216), 48 m west of the WDPs (Figure 2)

4.1 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 (See 18 U. S. C. 1001).

Signature: Robert Devany Date: 5/3/02
Robert Devany
LEHR Site ER/WM Project Manager

Signature: Jay Beaman for Date: 5/3/02
Catherine Luu
DOE-LEHR Project Manager

5. ADDITIONAL INFORMATION

The LEHR facility completed construction or modifications in 2001 in the WDPs area. The facility met the requirements in 40 CFR 61.96(b) and is therefore exempt from filing an application to construct or modify per the MOU (DOE, 1995). The facility is eligible for this exemption because the EDE caused by all emissions from the completed modifications and construction is less than 1% of the standard in 40 CFR 61.92, 10 mrem/yr.

As required in the MOU for facilities that were exempt from having to submit an application to US EPA for construction or modifications, the following information is provided for the Site:

- **Provide a brief description of the construction or modification project and an estimate of potential doses to the public.**

There were construction or modification projects completed within the 2001 calendar year at the LEHR facility for which approval to construct or modify was required or waived under Section 61.96 of Subpart H of 40 CFR 61. In the summer of 2001 (June through November), contaminated gravel and concrete curbing from the WDPs area were excavated and removed for proper storage and disposal. Approximately 1,725 cu yd of gravel, 650 cu yd of asphalt, 800 cu yd of concrete curbing, and 45 cu yd of metal grating and fence posts were removed.

The collective population equivalent dose to Davis residents was 2.19×10^{-4} person-roentgen equivalent man per year, and the EDE for the off-site MEI was 7.20×10^{-5} mrem/yr, as estimated by CAP88-PC (Table 5). The predicted EDE for the off-site MEI is several orders of magnitude below the 10 mrem/yr standard as required by 40 CFR Part 61 Subpart H.

- **Identify any unplanned releases of radionuclides to the atmosphere.**

There were no unplanned releases of radionuclides to the atmosphere during 2001.

- **Results of the dose assessment associated with the diffuse source emissions from the facility.**

As noted in Sections 1 and 2, there are currently no point sources of radionuclide emissions at the Site. The only potential sources of radionuclide emissions remaining at the Site are diffuse sources of fugitive dust, and the results of the dose assessment associated with the diffuse non-point source emissions from the Site are presented in Section 3 and Table 4. The total

contribution to the EDE to the on-site MEI resulting from non-point source emissions was estimated to be 1.0×10^{-3} mrem/yr (1.0×10^{-5} mSv/yr), far below the 10 mrem/yr standard.

Significant remediation of the source non-point sources of potential radiological emissions actions have occurred at the LEHR Site since 1996 and site cleanup is expected to be complete within the next two years. Therefore, DOE expects that submittal of these reports will also conclude since there should be no soil disturbances of radiological-impacted soils and thus no point sources.

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TABLES

Table 1. Summary of LEHR Site Potential Non-Point Diffuse Area Radionuclide Sources

Potential Fugitive Source	Description
Western Dog Pens Area	Formerly housed animals involved in LEHR facility research; area was remediated in 2001.
Eastern Dog Pens Area	Formerly housed animals involved in LEHR facility research

Note

Radium/Strontium Treatment Systems Area II was included as a potential non-point diffuse area radionuclide source in the Calendar Year 2000 Radionuclide Air Emission Annual Report. The Radium/Strontium Treatment Systems Area II was remediated in 2000 and covered with clean fill; therefore, this area is no longer classified as a potential radionuclide source.

Abbreviation

LEHR Laboratory for Energy-Related Health Research

Table 2. Summary of Maximum Surface Soil Concentrations for Radionuclides Exceeding Background and PM₁₀ Emission Rates, LEHR Western Dog Pens Area

Radionuclide	Maximum Concentration ¹ (pCi/g)	Maximum PM ₁₀ Emission Rate (Ci/yr)
Actinium-228	0.719	2.60E-09
Bismuth-212	0.628	2.27E-09
Bismuth-214	1.09	3.94E-09
Carbon-14	11.3	4.08E-08
Cesium-137	0.115	4.15E-10
Cobalt-60	0.028	1.01E-10
Lead-210	4.96	1.79E-08
Lead-212	0.744	2.69E-09
Lead-214	1.41	5.09E-09
Potassium-40	14.3	5.16E-08
Radium-226	1.9	6.86E-09
Strontium-90	0.675	2.44E-09
Thallium-208	0.272	9.82E-10
Thorium-234	1.62	5.85E-09
Uranium-235	0.232	8.38E-10
Uranium-238	1.62	5.85E-09

Notes

¹The maximum surface soil concentrations are gross concentrations that do not include subtraction of the background concentrations.

Abbreviations

Ci/yr Curies per year

pCi/g picoCuries per gram

PM₁₀ Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers

Table 3. Summary of Maximum Surface Soil Concentrations for Radionuclides Exceeding Background and PM₁₀ Emission Rates, LEHR Eastern Dog Pens Area

Radionuclide	Maximum Concentration (pCi/g)	Maximum PM ₁₀ Emission Rate (Ci/yr)
Bismuth-212	0.415	6.15E-10
Bismuth-214	0.572	8.48E-10
Cesium-137	0.191	2.83E-10
Lead-214	0.607	9.00E-10
Strontium-90	0.164	2.43E-10
Thallium-208	0.219	3.25E-10
Thorium-228	1.54	2.28E-09
Thorium-232	1.26	1.87E-09
Thorium-234	0.89	1.32E-09
Tritium	1.21	1.79E-09
Uranium-235	0.0383	5.68E-11

Abbreviations

Ci/yr Curies per year

pCi/g picoCuries per gram

PM₁₀ Particulate matter with an aerodynamic diameter less than or equal to 10 micrometers

Table 4. Summary of On-Site Effective Dose Equivalent to Maximally Exposed Individual Resulting from Radionuclide Emissions from Each Potential Fugitive Dust Emission Non-Point Source

MEI Receptor Description	<u>Western Dog Pens Area</u>		<u>Eastern Dog Pens Area</u>		Maximum Total Dose (mrem/yr) ³
	(mrem/yr) ¹	Location ²	(mrem/yr) ¹	Location ²	
Specimen Storage Building (Building H-216)	9.8E-04	48 m W	6.5E-05	132 m W	1.0E-03
UC Davis Building E of LEHR Site	5.2E-05	300 m E	4.2E-05	180 m E	9.4E-05
Off-Site Receptor S of Putah Creek	4.7E-05	1,200 m S	9.8E-07	1,000 m S	4.8E-05
Off-Site Receptor W of LEHR Site	5.7E-05	400 m W	4.8E-06	500 m W	6.2E-05
Animal Hospital Building No. 1 (Building H-219)	4.5E-04	65 m W	4.2E-05	165 m W	4.9E-04
Inter-Regional Project No. 4 Building (Building H-217)	7.2E-04	52 m W	5.5E-05	143 m W	7.8E-04
Animal Hospital Building No. 2 (Building H-218)	4.5E-04	65 m W	4.2E-05	165 m W	4.9E-04
Cellular Biology Laboratory (Building H-294)	5.4E-04	65 m N	4.8E-05	150 m NNE	5.9E-04

Notes

- ¹ The EDE to the MEI is taken as the maximum modeled dose within a 22.5° sector in the direction and at the distance indicated in the "location" column. The dose 65 m north of the Western Dog Pens Area, for example, would be the maximum modeled dose at 65 m N, 65 m NNE and 65 m NNW.
- ² The distance from an area source to a receptor is defined by CAP88-PC as distance from the centroid of the area source to the receptor (US EPA, 1992b). For the LEHR facility CAP88-PC modeling, the distance from an area non-point source to a receptor is measured as the approximate distance from the centroid of area non-point source to the centroid of the building assumed to house the receptor.
- ³ The maximum total dose is the sum of EDEs modeled for each MEI receptor from the three potential radionuclide fugitive dust emission non-point sources. Value in boldface is the maximum total dose for the site-wide MEI.

Abbreviations

EDE	effective dose equivalent
E	east
m	meters
MEI	Maximally Exposed Individual
mrem/yr	millirem per year
N	north
NNE	north by northeast
NNW	north by northwest
No.	number
S	south
UC Davis	University of California, Davis
W	west

Table 5. Summary of Estimated Collective Population Dose Resulting from Radionuclide Emissions from Each Fugitive Dust Emission Non-Point Source

Potential Emission Source	Off-Site Maximally Exposed Individual		Collective Population Dose (person-rem/yr)
	(mrem/yr)	Location	
Western Dog Pens Area	4.3E-05	250 m north ¹	1.3E-04
Eastern Dog Pens Area	2.9E-05	250 m north ¹	8.6E-05
Total LEHR Site	7.2E-05		2.2E-04

Notes

Source of data: CAP88-PC Version 1.0 modeling output files.

The collective population dose is for receptors within a 10-km radius.

¹The approximate location of UC Davis agricultural and primate research facilities.

Abbreviations

km kilometer(s)
 m meter(s)
 mrem/yr millirem per year
 N north
 UC Davis University of California, Davis

Table 6. LEHR Facility NESHAP—CAP88-PC Inputs: Western Dog Pens Area

Run type (Dataset ID: OU3aRECP.SCR)	Individual	Receptor distances (m): 48, 52, 65, 300, 400, 1200			
Run type (Dataset ID: OU3aPOP.SCR)	Population	Population file to use: 01LEHR.POP			
Modeling Options	Generate genetic effects?	Yes			
	Create Dose and Risk Factor file?	Yes			
	Create Concentration Table file?	Yes			
	Create Chi/Q Table file?	Yes			
Meteorological Data					
Windfile to use:	SAC0320.WND (CAP88-PC supplied wind file)				
Annual precipitation (cm/yr):	55.02 (2001 Davis total)				
Annual ambient temperature (°C):	15.6 (2001 Davis average)				
Height of lid (m):	1,000 (CAP88-PC default)				
Source Data					
Source type:	AREA				
Number of source:	1				
Height (m):	0				
Area (m ²):	9,500				
Plume rise:	Zero (Plume rise is zero for each Pasquill stability category.)				
Agricultural Data					
	Source: Rural (CAP88-PC defaults)				
	Vegetable	Milk	Beef		
Fraction home produced:	0.7	0.399	0.442		
Fraction from assessment area:	0.3	0.601	0.558		
Fraction imported:	0	0	0		
	Beef cattle density (#/km ²): 8.81E-02 (CAP88-PC default)				
	Milk cattle density (#/km ²): 2.85E-02 (CAP88-PC default)				
Land fraction cultivated for vegetable crops:	0.25 (Site specific parameter per 1995 NESHAP)				
Radionuclide Release Data					
PM ₁₀ Emission rate (g/m ² -sec):	4.34E-05 (Using Cowherd, 1985, unlimited erosion potential.)				
	Nuclide ID	Max. Soil (pCi/g)	Emis. Rate (Ci/yr)	Size ¹ (µm)	Class ¹
	Ac-228	0.719	2.60E-09	1	Y
	Bi-212	0.628	2.27E-09	1	W
	Bi-214	1.09	3.94E-09	1	W
	C-14	11.3	4.08E-08	0	G
	Cs-137	0.115	4.15E-10	1	D
	Co-60	0.028	1.01E-10	1	Y
	Pb-210	4.96	1.79E-08	1	D
	Pb-212	0.744	2.69E-09	1	D
	Pb-214	1.41	5.09E-09	1	D
	K-40	14.3	5.16E-08	1	D
	Ra-226	1.9	6.86E-09	1	W
	Sr-90	0.675	2.44E-09	1	D
	Tl-208	0.272	9.82E-10	1	D
	Th-234	1.62	5.85E-09	1	Y
	U-235	0.232	8.38E-10	1	Y
	U-238	1.62	5.85E-09	1	Y

Table 6. LEHR Facility NESHAP—CAP88-PC Inputs: Western Dog Pens Area (continued)

Note

¹ CAP88-PC default particle size and lung retention class.

Abbreviations

#/km ²	number per square kilometer
°C	degrees Celsius
Ac-228	actinium-228
Bi-212	bismuth-212
Bi-214	bismuth-214
C-14	carbon-14
Ci/yr	Curies per year
cm/yr	centimeter(s) per year
Co-60	cobalt-60
Cs-137	cesium-137
Emis.	emission
g/m ² -sec	grams per square meter-seconds
ID	identification (number)
K-0	potassium-0
m	meters
m ²	square meter(s)
Max.	maximum (concentration)
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Pb-210	lead-210
Pb-212	lead-212
Pb-214	lead-214
pCi/g	picoCurie per gram
PM ₁₀	particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
Ra-226	radium-226
Sr-90	strontium-90
Th-234	thorium-234
Tl-208	thallium-208
U-235	uranium-235
U-238	uranium-238
µm	micrometer

Table 7. LEHR Facility NESHAP—CAP88-PC Inputs: Eastern Dog Pens Area

Run type (Dataset ID: OU3bRECP.SCR)	Individual	Receptor distances (m): 132, 143, 150, 165, 180, 500, 1000			
Run type (Dataset ID: OU3bPOP.SCR)	Population	Population file to use: 01LEHR.POP			
Modeling Options	Generate genetic effects?	Yes			
	Create Dose and Risk Factor file?	Yes			
	Create Concentration Table file?	Yes			
	Create Chi/Q Table file?	Yes			
Meteorological Data					
Windfile to use:	SAC0320.WND (CAP88-PC supplied wind file)				
Annual precipitation (cm/yr):	55.02 (2001 Davis total)				
Annual ambient temperature (°C):	15.6 (2001 Davis average)				
Height of lid (m):	1,000 (CAP88-PC default)				
Source Data					
Source type:	AREA				
Number of source:	1				
Height (m):	0				
Area (m ²):	3,900				
Plume rise:	Zero (Plume rise is zero for each Pasquill stability category.)				
Agricultural Data					
	Source: Rural (CAP88-PC defaults)				
	Vegetable	Milk	Beef		
Fraction home produced:	0.7	0.399	0.442		
Fraction from assessment area:	0.3	0.601	0.558		
Fraction imported:	0	0	0		
Beef cattle density (#/km ²):	8.81E-02 (CAP88-PC default)				
Milk cattle density (#/km ²):	2.85E-02 (CAP88-PC default)				
Land fraction cultivated for vegetable crops:	0.25 (Site specific parameter per 1995 NESHAP)				
Radionuclide Release Data					
PM ₁₀ Emission Rate (g/m ² -hr):	4.34E-05 (Using Cowherd, 1985, unlimited erosion potential.)				
	Nuclide ID	Max. Soil (pCi/g)	Emis. Rate (Ci/yr)	Size ¹ (µm)	Class ¹
	Bi-212	0.415	6.15E-10	1	W
	Bi-214	0.572	8.48E-10	1	W
	Cs-137	0.191	2.83E-10	1	D
	Pb-214	0.607	9.00E-10	1	D
	Sr-90	0.164	2.43E-10	1	D
	Tl-208	0.219	3.25E-10	1	D
	Th-228	1.54	2.28E-09	1	Y
	Th-232	1.26	1.87E-09	1	Y
	Th-234	0.89	1.32E-09	1	Y
	H-3	1.21	1.79E-09	0	G
	U-235	0.383	5.68E-11	1	Y

Table 7. LEHR Facility NESHAP—CAP88-PC Inputs: Eastern Dog Pens Area (continued)

Note

¹ CAP88-PC default particle size and lung retention class.

Abbreviations

#/km ²	number per square kilometer
°C	degrees Celsius
Bi-212	bismuth-212
Bi-214	bismuth-214
Ci/yr	Curies per year
cm/yr	centimeter(s) per year
Cs-137	cesium-137
Emis.	emission
g/m ² -sec	grams per square meter-seconds
H-3	hydrogen-3
m	meter(s)
m ²	square meter(s)
Max.	maximum (concentration)
NESHAP	National Emissions Standards for Hazardous Air Pollutants
Pb-214	lead-214
pCi/g	picoCurie per gram
PM10	particulate matter with an aerodynamic diameter less than or equal to 10 micrometers
Sr-90	strontium-90
Th-228	thorium-228
Th-234	thorium-234
Tl-208	thallium-208
U-235	uranium-235
µm	micrometer

FIGURES

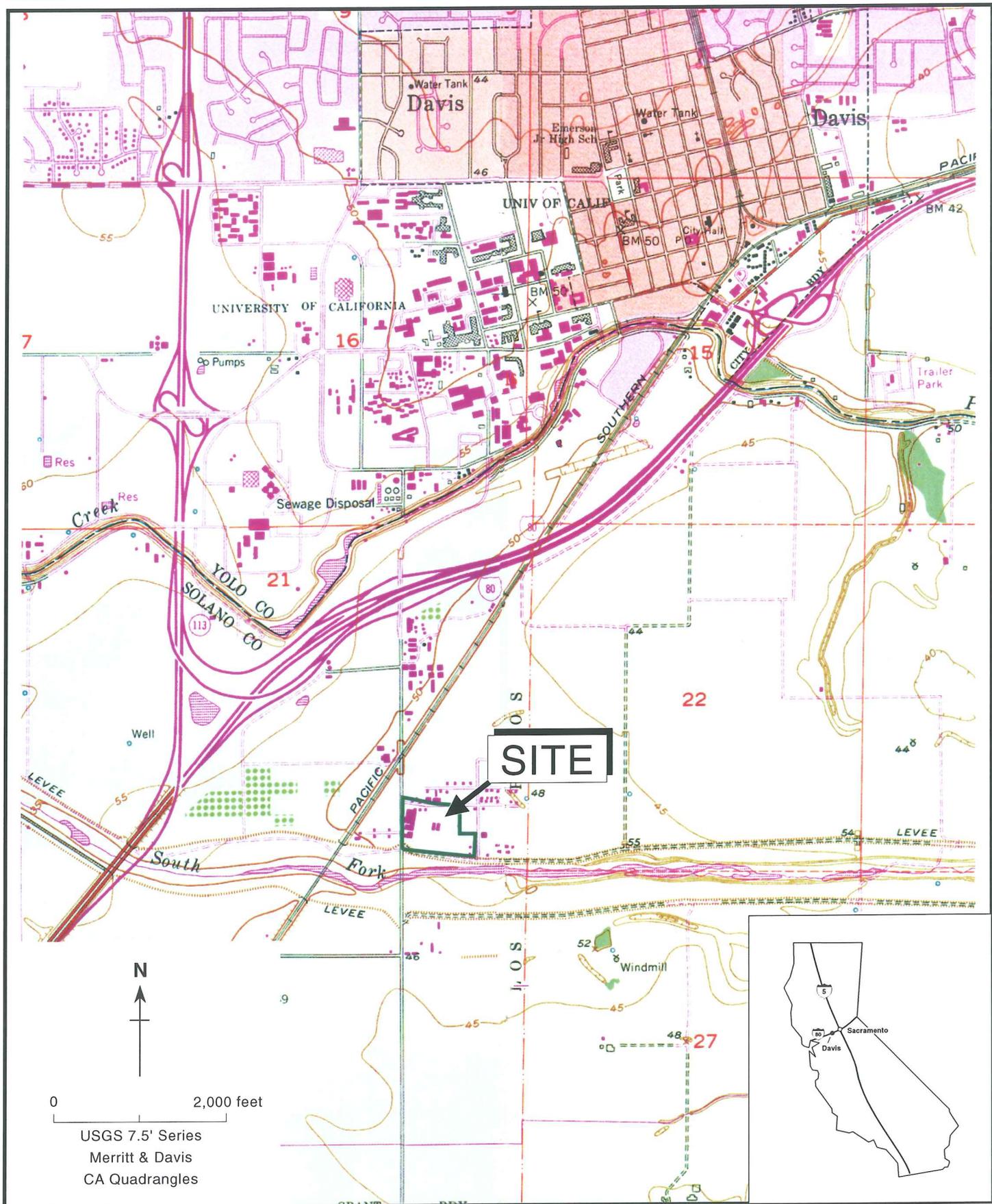


Figure 1. LEHR Facility Location Map

Weiss Associates

APPENDIX A

CAP88-PC OUTPUT RESULTS

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Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Mar 14, 2002 9:43 am

Facility: LEHR
Address: Old Davis Road, MS ITEH
City: Davis
State: CA Zip: 95616

Source Category: Non-point source
Source Type: Area
Emission Year: 2001

Comments:

Dataset Name: WDP-IND-02-tot
Dataset Date: Mar 14, 2002 9:42 am
Wind File: WNDFILES\SAC0320.WND

□

Mar 14, 2002 9:43 am

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	2.38E-04
BREAST	2.29E-04
R MAR	9.60E-04
LUNGS	5.49E-03

	L. sum
THYROID	2.32E-04
ENDOST	1.11E-02
RMNDR	1.02E-03
EFFEC	1.51E-03

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	5.96E-04
INHALATION	8.31E-04
AIR IMMERSION	1.09E-08
GROUND SURFACE	8.42E-05
INTERNAL	1.43E-03
EXTERNAL	8.42E-05
TOTAL	1.51E-03

□ Mar 14, 2002 9:43 am

SUMMARY
Page 2

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
BI-212	5.90E-08
BI-214	4.24E-09
C-14	9.84E-07
CS-137	2.74E-07
CO-60	4.46E-07
PB-210	6.40E-04
PB-212	3.46E-07
RA-226	8.76E-05
SR-90	5.37E-06
TL-208	1.68E-09
TH-234	3.22E-07
U-235	8.30E-05
AC-228	1.72E-07
PB-214	4.26E-09
K-40	1.48E-04
U-238	5.45E-04
TOTAL	1.51E-03

□ Mar 14, 2002 9:43 am

SUMMARY
Page 3

L.sum

CANCER RISK SUMMARY

Cancer	Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	1.40E-09
BONE	6.14E-10
THYROID	8.35E-11
BREAST	7.01E-10
LUNG	9.81E-09
STOMACH	4.42E-10
BOWEL	2.35E-10
LIVER	3.07E-09
PANCREAS	3.71E-10
URINARY	7.05E-10
OTHER	4.53E-10
TOTAL	1.79E-08

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	5.44E-09
INHALATION	1.04E-08
AIR IMMERSION	2.63E-13
GROUND SURFACE	2.04E-09
INTERNAL	1.58E-08
EXTERNAL	2.04E-09
TOTAL	1.79E-08

□

Mar 14, 2002 9:43 am

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
BI-212	7.59E-13
BI-214	4.91E-13
C-14	2.40E-11
CS-137	7.17E-12

	L.sum
CO-60	1.12E-11
PB-210	4.56E-09
PB-212	5.93E-12
RA-226	1.25E-09
SR-90	9.04E-11
TL-208	4.11E-14
TH-234	1.11E-11
U-235	1.09E-09
AC-228	3.47E-12
PB-214	7.28E-13
K-40	3.72E-09
U-238	7.11E-09
TOTAL	1.79E-08

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SUMMARY
Page 5

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Direction	Distance (m)				
	40	65	300	400	1200
N	1.5E-03	5.4E-04	7.8E-05	6.5E-05	4.9E-05
NNW	1.5E-03	5.8E-04	6.9E-05	6.0E-05	4.9E-05
NW	1.4E-03	5.4E-04	7.4E-05	6.2E-05	4.9E-05
WNW	1.3E-03	4.5E-04	6.7E-05	5.8E-05	4.9E-05
W	1.1E-03	3.4E-04	6.1E-05	5.5E-05	4.8E-05
WSW	9.7E-04	2.4E-04	5.3E-05	5.0E-05	4.7E-05
SW	8.4E-04	1.8E-04	5.1E-05	4.9E-05	4.7E-05
SSW	7.0E-04	1.9E-04	5.1E-05	4.9E-05	4.7E-05
S	5.9E-04	2.3E-04	5.8E-05	5.3E-05	4.8E-05
SSE	5.7E-04	2.5E-04	6.1E-05	5.5E-05	4.8E-05
SE	6.1E-04	2.3E-04	5.5E-05	5.2E-05	4.8E-05
ESE	7.3E-04	1.9E-04	5.2E-05	5.0E-05	4.7E-05
E	8.6E-04	1.9E-04	5.2E-05	5.0E-05	4.7E-05
ENE	1.0E-03	2.5E-04	5.3E-05	5.0E-05	4.8E-05
NE	1.1E-03	3.5E-04	6.3E-05	5.6E-05	4.8E-05
NNE	1.3E-03	4.8E-04	6.6E-05	5.8E-05	4.9E-05

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SUMMARY
Page 6

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Distance (m)

Direction	L.sum				
	40	65	300	400	1200
N	1.7E-08	6.4E-09	8.5E-10	6.9E-10	5.1E-10
NNW	1.8E-08	6.8E-09	7.5E-10	6.3E-10	5.0E-10
NW	1.7E-08	6.3E-09	8.0E-10	6.6E-10	5.0E-10
WNW	1.5E-08	5.3E-09	7.2E-10	6.2E-10	5.0E-10
W	1.3E-08	4.0E-09	6.4E-10	5.7E-10	4.9E-10
WSW	1.1E-08	2.7E-09	5.5E-10	5.2E-10	4.9E-10
SW	9.9E-09	2.1E-09	5.3E-10	5.1E-10	4.9E-10
SSW	8.2E-09	2.2E-09	5.3E-10	5.1E-10	4.9E-10
S	7.0E-09	2.7E-09	6.1E-10	5.5E-10	4.9E-10
SSE	6.7E-09	2.9E-09	6.5E-10	5.8E-10	4.9E-10
SE	7.2E-09	2.7E-09	5.8E-10	5.4E-10	4.9E-10
ESE	8.6E-09	2.2E-09	5.4E-10	5.1E-10	4.9E-10
E	1.0E-08	2.2E-09	5.4E-10	5.2E-10	4.9E-10
ENE	1.2E-08	2.9E-09	5.5E-10	5.2E-10	4.9E-10
NE	1.3E-08	4.1E-09	6.7E-10	5.9E-10	5.0E-10
NNE	1.6E-08	5.6E-09	7.1E-10	6.1E-10	5.0E-10

K.sum

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

D O S E A N D R I S K E Q U I V A L E N T S U M M A R I E S

Non-Radon Individual Assessment
Mar 14, 2002 9:02 am

Facility: LEHR
Address: Old Davis Road, MS ITEH
City: Davis
State: CA Zip: 95616

Source Category: Non-point source
Source Type: Area
Emission Year: 2001

Comments:

Dataset Name: EDP-IND-02
Dataset Date: Mar 14, 2002 9:01 am
Wind File: WNDFILES\SAC0320.WND

Mar 14, 2002 9:02 am

SUMMARY
Page 1

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)
GONADS	3.50E-07
BREAST	3.60E-07
R MAR	4.15E-05
LUNGS	6.27E-04

	K.sum	
THYROID		3.52E-07
ENDOST		5.12E-04
RMNDR		1.03E-06
EFFEC		9.61E-05

PATHWAY EFFECTIVE DOSE EQUIVALENT SUMMARY

Pathway	Selected Individual (mrem/y)
INGESTION	6.80E-07
INHALATION	9.54E-05
AIR IMMERSION	1.21E-10
GROUND SURFACE	1.30E-08
INTERNAL	9.60E-05
EXTERNAL	1.31E-08
TOTAL	9.61E-05

□ Mar 14, 2002 9:02 am

SUMMARY
Page 2

NUCLIDE EFFECTIVE DOSE EQUIVALENT SUMMARY

Nuclide	Selected Individual (mrem/y)
BI-212	1.58E-09
SR-90	5.59E-08
TH-234	7.40E-09
U-235	5.62E-07
BI-214	8.78E-11
CS-137	2.00E-08
PB-214	7.32E-11
TL-208	4.44E-11
TH-228	4.39E-05
TH-232	5.15E-05
H-3	9.47E-11
TOTAL	9.61E-05

□ Mar 14, 2002 9:02 am

SUMMARY
Page 3

CANCER RISK SUMMARY

Cancer	K.sum Selected Individual Total Lifetime Fatal Cancer Risk
LEUKEMIA	3.74E-11
BONE	2.42E-11
THYROID	6.74E-14
BREAST	5.82E-13
LUNG	1.11E-09
STOMACH	4.83E-13
BOWEL	7.35E-13
LIVER	2.05E-12
PANCREAS	3.35E-13
URINARY	3.03E-13
OTHER	4.10E-13
TOTAL	1.18E-09

PATHWAY RISK SUMMARY

Pathway	Selected Individual Total Lifetime Fatal Cancer Risk
INGESTION	3.67E-12
INHALATION	1.18E-09
AIR IMMERSION	2.95E-15
GROUND SURFACE	3.00E-13
INTERNAL	1.18E-09
EXTERNAL	3.03E-13
TOTAL	1.18E-09

□ Mar 14, 2002 9:02 am

SUMMARY
Page 4

NUCLIDE RISK SUMMARY

Nuclide	Selected Individual Total Lifetime Fatal Cancer Risk
BI-212	2.03E-14
SR-90	9.42E-13
TH-234	2.51E-13
U-235	7.40E-12
BI-214	1.02E-14
CS-137	5.23E-13
PB-214	1.25E-14
TL-208	1.09E-15
TH-228	8.81E-10

	K.sum
TH-232	2.90E-10
H-3	2.56E-15
TOTAL	1.18E-09

□ Mar 14, 2002 9:02 am

SUMMARY
Page 5

INDIVIDUAL EFFECTIVE DOSE EQUIVALENT RATE (mrem/y)
(All Radionuclides and Pathways)

Direction	Distance (m)						
	130	140	150	165	180	500	1000
N	9.6E-05	8.5E-05	7.6E-05	6.4E-05	5.4E-05	7.6E-06	2.0E-06
NNW	7.8E-05	6.6E-05	5.7E-05	4.6E-05	3.9E-05	5.4E-06	1.5E-06
NW	8.5E-05	7.4E-05	6.6E-05	5.5E-05	4.6E-05	6.4E-06	1.7E-06
WNW	6.7E-05	5.8E-05	5.0E-05	4.2E-05	3.5E-05	4.8E-06	1.3E-06
W	4.6E-05	4.0E-05	3.5E-05	2.9E-05	2.4E-05	3.3E-06	9.0E-07
WSW	2.1E-05	1.8E-05	1.5E-05	1.2E-05	1.0E-05	1.4E-06	4.0E-07
SW	1.3E-05	1.1E-05	9.6E-06	7.9E-06	6.6E-06	9.5E-07	2.9E-07
SSW	1.5E-05	1.2E-05	1.0E-05	8.1E-06	6.8E-06	9.7E-07	3.0E-07
S	3.4E-05	3.0E-05	2.6E-05	2.2E-05	1.8E-05	2.6E-06	7.2E-07
SSE	4.4E-05	3.9E-05	3.5E-05	3.0E-05	2.5E-05	3.5E-06	9.8E-07
SE	2.8E-05	2.4E-05	2.1E-05	1.7E-05	1.4E-05	2.0E-06	5.8E-07
ESE	1.7E-05	1.4E-05	1.2E-05	9.7E-06	8.2E-06	1.2E-06	3.5E-07
E	1.7E-05	1.5E-05	1.3E-05	1.1E-05	9.2E-06	1.3E-06	3.9E-07
ENE	2.2E-05	1.8E-05	1.5E-05	1.2E-05	1.0E-05	1.4E-06	4.2E-07
NE	5.0E-05	4.4E-05	3.9E-05	3.3E-05	2.8E-05	3.9E-06	1.1E-06
NNE	6.5E-05	5.5E-05	4.8E-05	3.9E-05	3.3E-05	4.7E-06	1.3E-06

□ Mar 14, 2002 9:02 am

SUMMARY
Page 6

INDIVIDUAL LIFETIME RISK (deaths)
(All Radionuclides and Pathways)

Direction	Distance (m)						
	130	140	150	165	180	500	1000
N	1.2E-09	1.0E-09	9.3E-10	7.9E-10	6.7E-10	9.2E-11	2.4E-11
NNW	9.5E-10	8.1E-10	7.0E-10	5.7E-10	4.8E-10	6.6E-11	1.8E-11
NW	1.0E-09	9.1E-10	8.1E-10	6.8E-10	5.7E-10	7.9E-11	2.1E-11
WNW	8.2E-10	7.1E-10	6.2E-10	5.1E-10	4.3E-10	5.9E-11	1.5E-11
W	5.6E-10	4.9E-10	4.3E-10	3.5E-10	3.0E-10	4.0E-11	1.1E-11
WSW	2.6E-10	2.2E-10	1.8E-10	1.5E-10	1.2E-10	1.7E-11	4.5E-12

	K. sum						
SW	1.6E-10	1.4E-10	1.2E-10	9.6E-11	8.1E-11	1.1E-11	3.2E-12
SSW	1.8E-10	1.5E-10	1.3E-10	9.9E-11	8.3E-11	1.2E-11	3.2E-12
S	4.2E-10	3.6E-10	3.2E-10	2.7E-10	2.3E-10	3.1E-11	8.5E-12
SSE	5.4E-10	4.8E-10	4.3E-10	3.6E-10	3.1E-10	4.3E-11	1.2E-11
SE	3.4E-10	2.9E-10	2.5E-10	2.1E-10	1.8E-10	2.5E-11	6.7E-12
ESE	2.0E-10	1.7E-10	1.5E-10	1.2E-10	1.0E-10	1.4E-11	3.9E-12
E	2.1E-10	1.8E-10	1.6E-10	1.3E-10	1.1E-10	1.6E-11	4.3E-12
ENE	2.7E-10	2.2E-10	1.8E-10	1.5E-10	1.2E-10	1.7E-11	4.8E-12
NE	6.2E-10	5.4E-10	4.8E-10	4.1E-10	3.4E-10	4.8E-11	1.3E-11
NNE	8.0E-10	6.8E-10	5.8E-10	4.8E-10	4.0E-10	5.7E-11	1.5E-11

M.syn

□

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Population Assessment
Mar 14, 2002 12:33 am

Facility: LEHR
Address: Old Davis Road, MS ITEH
City: Davis
State: CA Zip: 95616

Effective Dose Equivalent
(mrem/year)

2.87E-05

At This Location: 250 Meters North
Source Category: Non-point source
Source Type: Area
Emission Year: 2001

Comments:

Dataset Name: EDP-POP-02
Dataset Date: Mar 14, 2002 12:31 am
Wind File: WNDFILES\SAC0320.WND
Population File: POPFILES\01LEHR.POP

□
Mar 14, 2002 12:33 am

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

Page 1

M.syn

Location Of The Individual: 250 Meters North
Lifetime Fatal Cancer Risk: 3.53E-10

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population (person-rem/y)
GONADS	1.01E-07	3.04E-07
BREAST	1.04E-07	3.13E-07
R MAR	1.23E-05	3.71E-05
LUNGS	1.87E-04	5.62E-04
THYROID	1.01E-07	3.05E-07
ENDOST	1.53E-04	4.59E-04
RMNDR	2.98E-07	9.06E-07
EFFEC	2.87E-05	8.61E-05

FREQUENCY DISTRIBUTION OF LIFETIME FATAL CANCER RISKS

Risk Range	Number of People	Number of People In This Risk Range Or Higher	Deaths/Year In This Risk Range	Deaths/Year In This Risk Range Or Higher
1.0E+00 TO 1.0E-01	0	0	0.00E+00	0.00E+00
1.0E-01 TO 1.0E-02	0	0	0.00E+00	0.00E+00
1.0E-02 TO 1.0E-03	0	0	0.00E+00	0.00E+00
1.0E-03 TO 1.0E-04	0	0	0.00E+00	0.00E+00
1.0E-04 TO 1.0E-05	0	0	0.00E+00	0.00E+00
1.0E-05 TO 1.0E-06	0	0	0.00E+00	0.00E+00
LESS THAN 1.0E-06	111228	111228	1.49E-08	1.49E-08

□

Mar 14, 2002 12:33 am

SYNOPSIS
Page 2

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
BI-212	W	1.00	6.1E-10	6.1E-10
SR-90	D	1.00	2.4E-10	2.4E-10
TH-234	Y	1.00	1.3E-09	1.3E-09
U-235	Y	1.00	5.7E-11	5.7E-11
BI-214	W	1.00	8.5E-10	8.5E-10
CS-137	D	1.00	2.8E-10	2.8E-10

				M.syn
PB-214	D	1.00	9.0E-10	9.0E-10
TL-208	D	1.00	3.2E-10	3.2E-10
TH-228	Y	1.00	2.3E-09	2.3E-09
TH-232	Y	1.00	1.9E-09	1.9E-09
H-3	*	0.00	1.8E-09	1.8E-09

SITE INFORMATION

Temperature: 16 degrees C
 Precipitation: 55 cm/y
 Mixing Height: 1000 m

□ Mar 14, 2002 12:33 am

SYNOPSIS
 Page 3

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.00
 Area (sq m): 3.90E+03

Plume Rise							
Pasquill Cat:	A	B	C	D	E	F	G
Zero:	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Beef Cattle Density: 8.81E-02
 Milk Cattle Density: 2.85E-02
 Land Fraction Cultivated
 for Vegetable Crops: 2.50E-01

□ Mar 14, 2002 12:33 am

SYNOPSIS
 Page 4

POPULATION DATA

Distance (m)

Direction	M.syn						
	250	750	1500	2500	3500	4500	6523
N	429	429	2232	2232	3923	1163	4400
NNW	429	429	2232	4465	2584	2297	288
NW	429	429	2232	2232	2232	6267	2355
WNW	429	429	2232	2232	2232	4465	335
W	429	108	10	10	10	10	10
WSW	0	0	5	5	5	5	1
SW	0	0	2	2	2	2	2
SSW	0	0	2	2	2	2	2
S	0	0	2	2	2	2	1
SSE	0	0	2	2	2	2	0
SE	0	0	2	2	2	2	1
ESE	0	0	2	2	2	2	2
E	0	0	0	223	223	1704	2039
ENE	113	113	558	1339	1451	4576	15003
NE	429	322	112	1289	8045	4261	322
NNE	429	429	3112	3125	3112	10	13

Direction	Distance (m)						
	9023						
N	1161						
NNW	112						
NW	84						
WNW	112						
W	56						
WSW	0						
SW	0						
SSW	0						
S	0						
SSE	2						
SE	2						
ESE	2						
E	1						
ENE	449						
NE	167						
NNE	2						

N.syn

□

C A P 8 8 - P C

Version 1.00

Clean Air Act Assessment Package - 1988

S Y N O P S I S R E P O R T

Non-Radon Population Assessment
Mar 21, 2002 11:16 am

Facility: LEHR
Address: Old Davis Road, MS ITEH
City: Davis
State: CA Zip: 95616

Effective Dose Equivalent
(mrem/year)

4.33E-05

At This Location: 250 Meters North
Source Category: Non-point source
Source Type: Area
Emission Year: 2001

Comments:

Dataset Name: WDP-POP-02
Dataset Date: Mar 21, 2002 11:16 am
Wind File: WNDFILES\SAC0320.WND
Population File: POPFILES\01LEHR.POP

□
Mar 21, 2002 11:16 am

SYNOPSIS
Page 1

MAXIMALLY EXPOSED INDIVIDUAL

N.syn

Location Of The Individual: 250 Meters North
Lifetime Fatal Cancer Risk: 5.08E-10

ORGAN DOSE EQUIVALENT SUMMARY

Organ	Selected Individual (mrem/y)	Collective Population (person-rem/y)
GONADS	6.27E-06	1.96E-05
BREAST	6.00E-06	1.88E-05
R MAR	2.65E-05	8.33E-05
LUNGS	1.64E-04	4.91E-04
THYROID	6.08E-06	1.90E-05
ENDOST	3.12E-04	9.82E-04
RMNDR	2.82E-05	8.86E-05
EFFEC	4.33E-05	1.33E-04

FREQUENCY DISTRIBUTION OF LIFETIME FATAL CANCER RISKS

Risk Range	Number of People	Number of People In This Risk Range Or Higher	Deaths/Year In This Risk Range	Deaths/Year In This Risk Range Or Higher
1.0E+00 TO 1.0E-01	0	0	0.00E+00	0.00E+00
1.0E-01 TO 1.0E-02	0	0	0.00E+00	0.00E+00
1.0E-02 TO 1.0E-03	0	0	0.00E+00	0.00E+00
1.0E-03 TO 1.0E-04	0	0	0.00E+00	0.00E+00
1.0E-04 TO 1.0E-05	0	0	0.00E+00	0.00E+00
1.0E-05 TO 1.0E-06	0	0	0.00E+00	0.00E+00
LESS THAN 1.0E-06	111228	111228	2.20E-08	2.20E-08

□ Mar 21, 2002 11:16 am

SYNOPSIS
Page 2

RADIONUCLIDE EMISSIONS DURING THE YEAR 2001

Nuclide	Class	Size	Source #1 Ci/y	TOTAL Ci/y
BI-212	W	1.00	2.3E-09	2.3E-09
BI-214	W	1.00	3.9E-09	3.9E-09
C-14	*	0.00	4.1E-08	4.1E-08
CS-137	D	1.00	4.2E-10	4.2E-10
CO-60	Y	1.00	1.0E-10	1.0E-10
PB-210	D	1.00	1.8E-08	1.8E-08

N.syn

PB-212	D	1.00	2.7E-09	2.7E-09
RA-226	W	1.00	6.9E-09	6.9E-09
SR-90	D	1.00	2.4E-09	2.4E-09
TL-208	D	1.00	9.8E-10	9.8E-10
TH-234	Y	1.00	5.9E-09	5.9E-09
U-235	Y	1.00	8.4E-10	8.4E-10
AC-228	Y	1.00	2.6E-09	2.6E-09
PB-214	D	1.00	5.1E-09	5.1E-09
K-40	D	1.00	5.2E-08	5.2E-08
U-238	Y	1.00	5.9E-09	5.9E-09

SITE INFORMATION

Temperature: 16 degrees C
 Precipitation: 55 cm/y
 Mixing Height: 1000 m

□ Mar 21, 2002 11:16 am

SYNOPSIS
Page 3

SOURCE INFORMATION

Source Number: 1

Source Height (m): 0.00
 Area (sq m): 9.50E+03

Plume Rise							
Pasquill Cat:	A	B	C	D	E	F	G
Zero:	0.00	0.00	0.00	0.00	0.00	0.00	0.00

AGRICULTURAL DATA

	Vegetable	Milk	Meat
Fraction Home Produced:	0.700	0.399	0.442
Fraction From Assessment Area:	0.300	0.601	0.558
Fraction Imported:	0.000	0.000	0.000

Beef Cattle Density: 8.81E-02
 Milk Cattle Density: 2.85E-02
 Land Fraction Cultivated
 for Vegetable Crops: 2.50E-01

□ Mar 21, 2002 11:16 am

SYNOPSIS
Page 4

N.syn
POPULATION DATA

Direction	Distance (m)						
	250	750	1500	2500	3500	4500	6523
N	429	429	2232	2232	3923	1163	4400
NNW	429	429	2232	4465	2584	2297	288
NW	429	429	2232	2232	2232	6267	2355
WNW	429	429	2232	2232	2232	4465	335
W	429	108	10	10	10	10	10
WSW	0	0	5	5	5	5	1
SW	0	0	2	2	2	2	2
SSW	0	0	2	2	2	2	2
S	0	0	2	2	2	2	1
SSE	0	0	2	2	2	2	0
SE	0	0	2	2	2	2	1
ESE	0	0	2	2	2	2	2
E	0	0	0	223	223	1704	2039
ENE	113	113	558	1339	1451	4576	15003
NE	429	322	112	1289	8045	4261	322
NNE	429	429	3112	3125	3112	10	13

Direction	Distance (m)
	9023
N	1161
NNW	112
NW	84
WNW	112
W	56
WSW	0
SW	0
SSW	0
S	0
SSE	2
SE	2
ESE	2
E	1
ENE	449
NE	167
NNE	2

APPENDIX B

DOE SUPPLEMENTAL INFORMATION

B. DOE SUPPLEMENTAL INFORMATION

- **Provide an estimate of collective dose equivalent for 2001 releases.**
 - The collective population dose for calendar year 2001 emissions to the population within an 10-km distance of the facility is estimated to be 2.19×10^4 person-rem/yr.
- **Provide information on the status of compliance with Subparts Q and T of 40 CFR Part 61.**
 - LEHR is in compliance with Subparts Q and T of 40 CFR part 61, based on a radon study conducted at the LEHR Facility by DOE (DOE, 1990).
- **Provide information on radon-220 emissions from sources containing uranium-232 and thorium-232 where emissions potentially can exceed 0.1 mrem/yr to the public or 10% of the nonradon dose to the public.**
 - There are no unencapsulated uranium-232 or thorium-232 sources stored at the facility. The emissions from radon-220 from encapsulated sources would not result in a dose to a member of the public in excess of 0.1 mrem/yr or exceed 10% of the nonradon dose to the public from the Site.
- **Provide information on radon-222 emissions from nondisposal/nonstorage sources where emissions potentially can exceed 0.1 mrem/yr to the public or 10% of the nonradon dose to the public.**
 - There are no nondisposal or nonstorage sources of radon-222 located at the facility.
- **Give the number of emission points subject to the continuous monitoring requirements of Section 61.93(b) of 40 CFR, the number of these emission points that do not comply with Section 61.93(b) requirements, and the cost of upgrades. Describe site periodic confirmatory measurement plans. Indicate the status of the QA program described by Appendix B, Method 114.**
 - There are no point source emissions that require continuous monitoring according to Subpart H of 40 CFR.