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ANNUAL ENVIRONMENTAL MONITORING REPORT OF THE LAWRENCE BERKELEY LABORATORY

1984

Prepared by the Staff of the
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PREFACE

In 1976 R.H. Thomas published the LBL Annual Environmental Monitoring Report in two parts. Part I (LBL-4678) discussed in detail the modeling used to determine the population dose equivalent due to Laboratory radiological operations. That volume also described natural radiation background, geological features, climate and meteorology, and the environmental surveillance program of the Lawrence Berkeley Laboratory (LBL). Part II (LBL-4827) included only the results of the sampling and measuring programs and other data necessary to determine the environmental impact of Laboratory radiological operations for 1975. A format similar to LBL-4827 was used in the 1976, 1977, 1978, and 1979 Annual Monitoring Reports (LBLs 6405, 7530, 9080, and 11192, respectively).

While the 1980 Annual Report, LBL-12604, was kept brief, abstracted sections from LBL-4678 were included so that the document might stand alone. The same format has been used in this report, along with updates to LBL-4678 where appropriate, and a greatly expanded description of LBL's nonradiological environmental activities.

Readers wishing a more comprehensive discussion of LBL site characteristics and population dose modeling may obtain a copy of LBL-4678 from

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R. Pauer and G.E. Schleimer of the Environmental Health and Safety Department of the Facilities Management and Technical Services Division contributed to the preparation of this report.

The bulk of the sample preparation and lab work was done by R.E. Thomas. Sample assays and computer data entry were done by W.B. Corniea.

The editor wishes to gratefully acknowledge the assistance of the Technical Information Department's editorial and word processing groups without whose help this report (and its predecessors) would have remained foundlings.

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ABSTRACT

The Environmental Monitoring Program of the Lawrence Berkeley Laboratory is described. Data for 1984 are presented and general trends are discussed.

INTRODUCTION

Lawrence Berkeley Laboratory (LBL) is a large, multifaceted research Laboratory that conducts programs of pure and applied research in the physical, biological, energy, and environmental sciences. LBL, birthplace of the cyclotron, was founded by the late Nobel Laureate Ernest Orlando Lawrence 53 years ago.

The Laboratory is located on the western slopes of the hills east of the Berkeley campus of the University of California, between elevations of 350 and 1000 feet. The site (Figs. 1 and 2) enjoys a Mediterranean climate, with an annual rainfall of 25.8 inches (25-year average), prevailing northwesterly winds during the traditionally dry summers, and southwesterly winds during winter storms. LBL straddles two canyons that contain the headwaters of Strawberry and Blackberry Creeks. The population within a 50-mile (80-km) radius of the Laboratory is approximately 5.2 million (1980 census); this includes most of the residents of the greater metropolitan San Francisco Bay Area.

LBL research facilities include: four large accelerators, several small accelerators, a number of radiochemical laboratories, and a tritium (^{3}H) labeling laboratory. The Bevatron (Building 51 in Fig. 1) is the most massive of LBL's accelerators. Originally designed as a 6-GeV proton synchrotron, it is presently capable of accelerating ions up to ^{40}Ca from 8.5 MeV/nucleon to 2.1 GeV/nucleon, and ions up to uranium to 1 GeV/nucleon, when using the SuperHILAC as an injector. (This combination is called the Bevalac). The SuperHILAC (Building 71), a heavy ion accelerator, is a multiprogrammable research accelerator in its own right and produces ion beams up to 8.5 MeV/nucleon. The 88-Inch Variable Energy Sector-Focused Cyclotron (Building 88) routinely produces intense beams of protons to about 60 MeV, alpha particles to 140 MeV, and heavy ions to mass 40 to energies of 350 MeV. The 184-Inch Cyclotron (Building 6) provides alpha particle beams with energies up to approximately 1 GeV. The first three of these accelerators provide beams around the clock; the 184-Inch Cyclotron is only run for brief periods each week, mostly for tumor therapy.

KEY TO LBL BUILDINGS SHOWN IN FIGURE 1

Bldg. No	Description
	Hill-Site Buildings
4	Magnetic Fusion Energy (MFE)
5	Magnetic Fusion Energy (MFE)
6	184-Inch Cyclotron
7	Central Stores & Electronics Shops
9	Magnetic Fusion Energy—EBIS
10	Biomedical Research
12	MFE—EBIS/Central Stores Annex
14	Nuclear Instrumentation
16	Magnetic Fusion Energy Laboratory
17	Storage
25	Mechanical Technology
25A	Electronics Development
26	Medical Services
27	Cable Shop & High Voltage Test
29	Instrumentation Techniques & Biomedical Research
37	Utilities Service
40	Electronics Warehouse
42	Equipment Storage—Geothermal
41	WIN Training Center
43	Employee Buying Service
44	Indoor Air Pollution Studies
45	Fire Apparatus
46	Accelerator Development, Electronics Projects, & Real Time Systems Group (RTSG)
46A	Real Time Systems Group (RTSG)
47	Advanced Accelerator Study
50	Physics, Accelerator & Fusion Divisions
50A	Physics & Director's Office
50B	Physics & Computation Department
50D	MMRD & Nuclear Science
50E	Accelerator Development
51	Bevalac
51A	Bevalac Annex
51B	External Particle Beam (EPB) Hall
52	Magnetic Fusion Energy Laboratory
53	SuperHILAC Development
54	Cafeteria
55	Research Medicine
56	Cryogenic Facility
58	Accelerator Research & Development
58A	Accelerator Research & Development Addition
60	Cryogenic Laboratory
61	Standby Propane Plant
62	Materials & Molecular Research
63	Accelerator & Fusion Research
64	Accelerator & Fusion Research
65	Data Processing
68	Upper Pump House
69	Supply Services
69A	Supply Services
70	Nuclear Science, Applied Science, & Earth Sciences
70A	Nuclear Science, Materials & Molecular Research, & Earth Sciences
71	Heavy Ion Linear Accelerator (HILAC)
71A	HILAC Rectifier
72	MMRD, National Center for Electron Microscopy, Atomic Resolution Microscope (ARM), & High Voltage Electron Microscope (HVEM)
73	Atmospheric Aerosol Research
74	Biomedical Laboratory
74B	Biomedical Laboratory Annex
75	Radioisotope Service
76	Craft & Maintenance Shops
77	Mechanical Shops
78	Craft Stores
79	Metal Stores
80	General Research Laboratory
80A	Telephone Services
81	Liquid Gas Storage
82	Lower Pump House
83	Cell Culture Laboratory
88	88-Inch Cyclotron
90	Applied Science, Chief Financial Office Earth Sciences, Engineering, Personnel, Protective Services, & Technical Information Department
	Small Buildings
B-13A	Environmental Monitoring West of 88
B-13B	Environmental Monitoring West of 90
B-13C	Environmental Monitoring South of UC Recreation Area
B-13D	Environmental Monitoring North of 71
B-13E	Sewer Monitoring Station, Hearst Avenue
B-13F	Sewer Monitoring Station, Strawberry Canyon
	Campus Buildings Assigned LBL Numbers
1	Donner Laboratory
3	Melvin Calvin Laboratory (MCL)
18	Gilman Hall
21	Low Temperature Laboratory—Giauque Hall
22	Latimer Hall
38	Lewis Hall
57	Cowell Hospital --Donner Pavilion

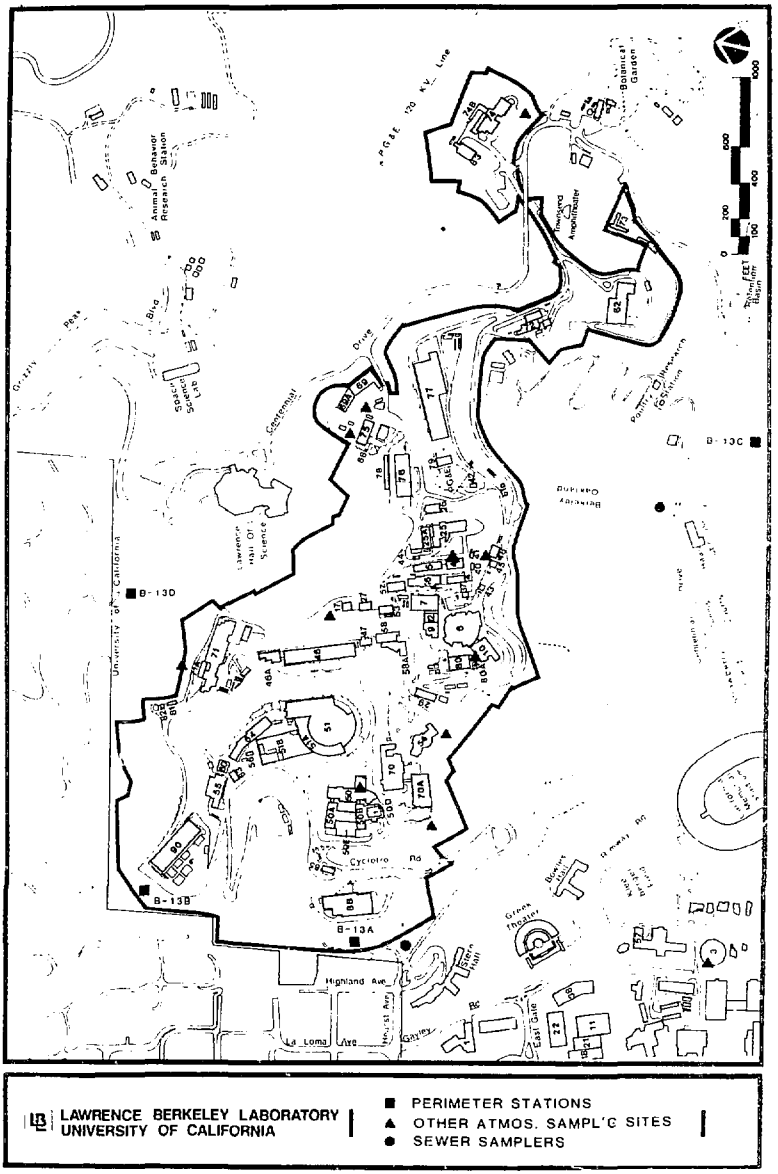

Figure 1. Lawrence Berkeley Laboratory buildings. XBL 844-1476

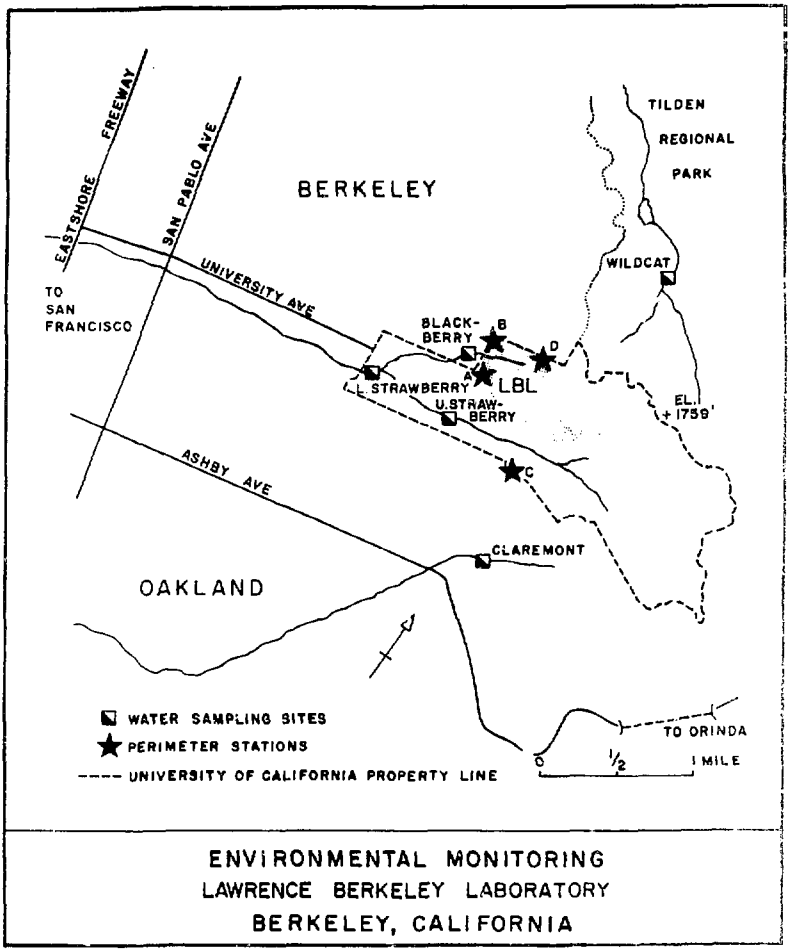

Figure 2. Environmental Monitoring, Lawrence Berkeley Laboratory.

The tritium facility located in Building 75 was designed to handle kilocurie quantities of tritium used as a labeling agent for a variety of molecules subsequently employed in chemical and biomedical research. The facility was expanded during 1983 and is now funded by the National Institutes of Health. Radiochemical and radiobiological studies performed in many laboratories at LBL typically use millicurie quantities of a variety of radionuclides. The workplace and effluent release points of all installations at LBL where significant quantities of radionuclides are handled are continuously sampled.

The proximity of populated areas to LBL significantly influenced the structure and implementation of the Laboratory's environmental monitoring program. Since there is essentially no buffer zone as is common for many remote U.S. Department of Energy (DOE) facilities, the program is heavily focused on measurements performed on site, close to the sources of potential environmental insults. Based on extensive studies of Laboratory operations and site characteristics, described in LBL-4678, an environmental program was developed that provides comprehensive and continuous surveillance of LBL activities.

1984 ENVIRONMENTAL MONITORING SUMMARY

In order to establish whether LBL research activities produced any impact on the population surrounding the Laboratory, a program of environmental air and water sampling and continuous radiation monitoring was carried on throughout the year.[1] For 1984, as in the previous several years, dose equivalents attributable to LBL radiological operations were a small fraction of the relevant radiation protection guidelines (RPG).[2]

We define the maximum dose equivalent delivered to a hypothetical member of the community as the maximum perimeter dose equivalent. That value was $\leq$ 5.4 mrem [the 1984 dose equivalent measured at the Olympus Gate Environmental Monitoring Station (MS) B-15D, about 1% of the RPG]. The total population dose equivalent attributable to LBL operations during 1984 was $\leq$ 14 man-rem, about 0.002% of the RPG of 170 mrem/person to a suitable sample of the population. (The total population dose equivalent is defined as the sum of the doses delivered to all individuals within a 50-mile (80-km) radius of the Laboratory.)

Small amounts of ^{14}C, ^{125}I, ^{131}I, and unidentified alpha and beta-gamma emitters were released from LBL laboratory stacks. The population dose equivalent attributable to the foregoing releases is ~0.3 man-rem. The majority of the impact of LBL radionuclide operations is from the release of tritium, which is responsible for a population dose equivalent of approximately 7.5 man-rem.

To put the Laboratory's impact into perspective, an approximate value for absorbed dose from external natural sources (e.g., cosmic rays, radiation from continental rocks) to each person within 50 miles (80 km) of LBL is roughly 0.1 rem/yr, which produces a natural annual

population dose of ~520,000 man-rem.

On the night of February 27, 1984, the neck of a reaction flask broke in an enclosure in the Building 75 Tritium Facility, releasing 240 curies of tritium (as HTO) from the Building 75 tritium stack. During the period that the tritium was released, the winds were southeasterly at approximately 3-6 m/sec. Evidence of the plume was detected as a slight increase in tritium in downwind deposition samples. The incident was reported promptly to the San Francisco Operations Office of DOE.

A worst-case safety analysis report prepared in 1980 by the Lawrence Livermore National Laboratory for the LBL Tritium Facility[3] predicted a maximum total integrated exposure to an off-site individual of 1.8 mrem for a 1200-curie HTO release under meteorological conditions similar to those listed above. Thus the maximum exposure to an off-site individual from the February 27 release is estimated to have been less than 0.5 mrem. The safety analysis report also provided hypothetical isopleths (lines of equal total integrated exposure) mapped over the city of Berkeley, which would have resulted from a 1200-curie worst-case release. By integrating the areas within the isopleths (making the simplified assumption that Berkeley's population is uniformly distributed at 3900 people/km^2 using data from the 1980 U.S. census[4]), the population exposure attributable to the February 27 tritium (HTO) release was estimated at 0.1 man-rem.

Routine releases from the Building 75 Tritium Facility amounted to 260 curies of HTO during 1984, which is slightly more than twice the 1983 amount (see Fig. 7, p. 31). The population exposure attributable to routine tritium releases for 1984 was 7.5 man-rem.

On November 29, 1984, 145 gallons of a 12% chromic acid solution (4% chromium) was released to the nearest sanitary sewer from LBL's Building 25 printed circuit board shop. Chromium levels that exceeded East Bay Municipal Utility District (EBMUD) mandated limits were observed in Hearst sewage samples (see Table 10d, p. 23). The release was reported to EBMUD, and steps were taken to prevent a recurrence.

1984 ENVIRONMENTAL ACTIVITIES AND PERMITS ISSUED

Pursuant to LBL's long-term development plan, three environmental assessments (EAs) were prepared in 1984 by the Laboratory's Plant Engineering Department in consultation with Ira Fink and Associates of Berkeley, California. These assessments have the following titles:

1. LBL Roadwork Safety Program
2. Environmental Assessment -- Building 69A
3. Environmental Assessment -- Center for Advanced Materials

Copies of these assessments were presented to the San Francisco Operations Office of DOE and to the University of California. The assessments were prepared in compliance with the National Environmental Policy Act (NEPA).

For further information about these assessments contact

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In order to carry on its research, LBL designs and builds much of its required apparatus. These activities require substantial technical support, including the operation of fabrication, assembly, testing, and waste-handling facilities. The Laboratory operates these facilities under a series of environmental permits issued by state and local agencies. A list of these permits by type and issuing agency, with expiration date, is given below.

Environmental Permits

1) Source Operating Permits, Bay Area Air Quality Management District, Expire July 1, 1985.
   - Solvent Spray Hood, Building 25
   - Vapor Degreaser, Building 25A
   - Solvent Hood, Building 50
   - Vapor Degreaser, Building 51
   - Ultrasonic Degreaser, Building 53
   - Machine Shop Tools, Building 53
   - Machine Shop Tools, Building 58
   - Vapor Degreaser, Building 62
   - Machine Shop Tools, Building 70A
   - Sawdust Collector, Building 74
   - Spray Degreaser, Building 76
   - Sawdust Collector, Building 76
   - Paint Spray Booth, Building 76
   - Gasoline Storage Tank, Building 76
   - Solder/Grinding Hood, Building 77
   - Ultrasonic Degreaser, Building 77
   - Vapor/Spray Degreaser, Building 77
   - Machine Shop Tools, Building 77
   - Paint Spray Booth, Building 77
   - Sandblast Exhaust, Building 77
   - Beryllium Machine Shop Tools, Building 77
   - Ceramic Machine Shop Tools, Building 77
   - Paint Drying Oven, Building 77
   - Machine Shop Tools, Building 88, Room 134
   - Machine Shop Tools, Building 88, Room 147
   - Solder Hood, Building 88

2) Wastewater Discharge Permit, East Bay Municipal Utility District, Expires June 9, 1985.
   - Plating Shop, Building 25
   - Plating Shop, Building 77

3) Hazardous Waste Facility Part B Permit, California Department of Health Services, Expires November 7, 1988.

4) Storage Tank Registration. California Department of Health Services. Eight underground storage tanks, seven for petroleum fuel, one for waste oil.

Environmental Activities

1) Metal Finishing Wastewater Control. A treatment unit was installed at the Building 77 plating shop in order to achieve compliance with the Federal Pretreatment Categorical Standards in both the current Electroplating Category (40 CFR 413) and the pending Metal Finishing Category (40 CFR 433). Parameters to be controlled include pH, cyanide, cadmium, copper, lead, nickel, silver, and zinc.

2) Polychlorinated Biphenyl Storage and Disposal. A storage facility meeting all federal and state standards has been completed. Ongoing activities include the collection of excess and defective PCB equipment and their disposal at an EPA approved incinerator.

ENVIRONMENTAL MONITORING RESULTS

Radiological Results

Penetrating Radiation

To determine the radiological impact of LBL accelerator operations, we maintain permanent monitoring stations at four points about LBL's perimeter (see Fig. 1 and Table 1).

Each station contains sensitive neutron and gamma pulse counters. The neutron detectors are ~500 cm^3 cylindrical BF_3 chambers housed in 2.5-inch-thick cylindrical paraffin moderators. The gamma detectors are energy-compensated Geiger-Muller chambers. The output pulses from each of the eight detectors (one of each type is installed at each monitoring station) are prescaled and telemetered to registers in Building 75.[5] Each LBL accelerator building contains at least one somewhat smaller moderated BF_3 neutron detector whose output pulses are also prescaled and telemetered to Building 75. By comparing the accelerator neutron monitor output with the output of the perimeter station neutron monitors, one may assign the perimeter dose equivalent to the accelerator responsible for it. Operational checks of the system are performed daily, and detectors are calibrated semiannually. A typical dose equivalent per register-pulse value for a perimeter monitoring station neutron detector corresponds to 0.43 μrem/pulse. A gamma register-pulse corresponds to about 1.3 μR.

The neutron background attributable to cosmic rays measured at LBL exhibits small fluctuations about a mean value of 3.3 mrem/year.[6] Table 2 lists the fence-post dose equivalents measured at each environmental monitoring station during 1984.

The fence-post neutron dose equivalent and gamma-ray dose equivalent attributable to LBL accelerator operations in 1984 are characterized as follows.

Table 1. Location of LBL monitoring stations (MS).

Building No. (see Fig. 1)	Name
B-13A	Building 88 Environmental MS
B-13B	Building 90 Environmental MS
B-13C	Panoramic Environmental MS
B-13D	Olympus Gate Environmental MS

Table 2. Fence-post dose at LBL boundary due to accelerator operation, 1984.

Station	1984 total above background		
	gamma (mrem)	n (mrem)	Total[a] (mrem)
Olympus Gate MS	Background	5.4 ± 0.5	5.4 ± 0.5
Building 90 MS	Background	$\leq$ 0.2	$\leq$ 0.2
Building 88 MS	$\leq$ 0.6	1.6 ± 0.3	2.2 ± 0.7
Panoramic MS	Background	Background	Background
Standard for comparison (Dose to individuals at maximum point of exposure)			500[b]

[a]The errors shown are those associated with the actual counts. Dose conversion factors are not known to this accuracy.

[b]Source: Reference 2.

1. The 184-Inch Cyclotron produced no dose discernible above background as measured at the Panoramic Environmental Monitoring Station.

2. While the SuperHILAC and Bevatron both contributed to the fence-post dose equivalent measured at the Olympus Gate Environmental Monitoring Station, the dose equivalent is entirely assigned to the Bevatron (a conservative assumption). The 5.4 mrem was delivered fairly uniformly during the Bevatron's operating year.

3. The 88-Inch Cyclotron fence-post dose equivalent of 2.2 mrem is primarily attributable to 20 light-ion (helium-3, p^+, D^+, helium-4) runs that occurred at two- or three-week intervals during 1984.

The U.S. Department of Energy orders, which provide detailed requirements for radiation protection, under which DOE contractors (LBL, for example) operate include a table (see Ref. 2) that assigns dose equivalent rate vs. neutron flux density values for neutrons of various energies. In the interest of more accurately reporting the impact of the 88-Inch Cyclotron on LBL's neighbors, measurements of the average energies of the stray neutrons that were produced during the 88-Inch Cyclotron light-ion runs were made at the 88-Inch Environmental Monitoring Station (EMS) in 1984. The measurements[7] indicated that historically reported values of fence-post dose equivalent caused by neutrons from the 88-Inch EMS were conservatively reported by a factor of more than five. The value of 1.6 ± 0.3 mrem reported for 1984 reflects less conservative but more realistic neutron energy vs. dose equivalent values.

4. The continuous gamma measurements telemetered from three of the four monitoring stations showed no significant correlation with LBL accelerator operation and were thus interpreted as constituting the natural background for 1984. The mean value of gamma background inside the monitoring stations was 81 ± 7 mrem for 1984. The gamma measurements telemetered from the 88-Inch Cyclotron monitoring station indicated an accelerator-produced gamma dose equivalent of $\leq$ 0.6 mrem.

LBL's Environmental Health and Safety Department (EH&S) operates a radiological and chemical waste storage yard and an instrument calibration facility south of Building 75. (The small trailer "complex" on Fig. 1 south of Building 75 is Building 75B that houses EH&S administrative and operational personnel.)

In April 1984 a recording Geiger-Muller instrument was installed in the southwest corner of 75B to assess impact from waste handling and calibration activities. The instrument recorded a total exposure of 95 ± 6 mrem for the final nine months of 1984 for a net extrapolated annual exposure of [(95 × 4/3) - 81] = ~46 mrem (no "unusual" calibration or waste handling activities occurred in pre-April 1984.

The instrument is located roughly 10 m from sources of radiation, 70 m from the perimeter fence, 270 m from the nearest commercial (40 hour/wk) occupancy [the Lawrence Hall of Science (LHS)], and 500 m from the nearest home.

The 46 mrem net exposure at 75B predicts an impact of ~0.9 mrem/yr at the perimeter; < 0.02 mrem/yr (40 hours/wk occupancy) at LHS and < 0.02 mrem/yr at the nearest home.

Airborne Radionuclides

Gross atmospheric beta and alpha activities are measured by air sampling at 14 points: Four perimeter environmental monitoring stations and 10 of the 12 "other atmospheric sampling sites" identified in Fig. 2. The sites on the north side of Building 75 and the roof of Building 4 are rain collectors. The Building 3 site contains samplers for HTO (tritiated water) and $^{14}CO_2$.

The gross beta and alpha sampling media are 4 × 6 inch cellulose-asbestos filters through which air is pumped at 4 ft^3/min. Samples are removed weekly. Before they are counted, they are set aside for five days to enable short-lived radon and thorium daughters (naturally occurring airborne radionuclides) to decay. The filters are loaded into an automatic counter that determines their gross alpha activity by means of a large-area 0.25-mil Mylar window gas proportional counter. Gross beta activity is counted with Geiger-Muller detectors with 30 mg/cm^2 windows. The detection limit for alpha emitters is 2×10^{-15} µCi/ml. The detection limit for beta emitters is 80×10^{-15} µCi/ml.

To ensure accuracy of all counting results, each group of samples counted includes at least one radiation standard sample and a number of background samples.

Tritium, as HTO, is sampled by passing atmospheric air through a column containing silica gel. Adsorbed water is "exchanged" into distilled water, and an aliquot (5 ml) is placed in a vial and counted in a scintillation counter. The detection limit for HTO in air is 700×10^{-12} µCi/ml.

As with gross alpha and beta samples, silica gel HTO samples are changed weekly. Each of the four perimeter environmental monitoring stations contains a tritium sampler, as does the Building 3 site. The stack from the tritium labeling facility is also monitored for tritium as described above.

Two additional sampling sites for airborne HTO (not shown on Fig. 1) were added during 1984. One site designated 75 Yard5 was located in the middle of the corporation yard (east of Building 75) and ran from 1/84 until 7/84 when construction made it necessary to move the sample approximately 60 yards southeast of its original site. The sample was then designated ENV 69A and is presently located at the northeast corner of Building 69.

The concentration of $^{14}CO_2$ in air is determined by air sampling with NaOH. Samples are changed weekly. Air is bubbled through a jar containing 30 ml of 0.2 M NaOH and thymol blue as a pH indicator. If acid fumes in the sampled air drop the pH of the sample to about 6, a color change results, and the sample is assumed to be invalid. An aliquot (5 ml) of the NaOH is added to a scintillation cocktail and counted in a liquid scintillation counter. The detection limit for $^{14}CO_2$ is 200×10^{-12} µCi/ml.

The total quantities of radionuclides discharged into the atmosphere are summarized in Table 3. The figures are similar to those of last year, and the releases resulted in a small population dose equivalent (see Table 11, see p. 25). One may note that a number of the average values listed in several of the tables in this report (notably Tables 4, 6, 7, and 8) are less than the minimum values listed for individual samples. The foregoing occurs whenever the actual average value of a substance measured is less than the detection limit for that substance in an individual sample, and the average represents the arithmetic sum of all measurements divided by the number of measurements taken (as in this report). The uncertainties listed with tabular quantities represent 95% confidence limits of the assay values (or sum of assay values).

While small quantities of radionuclides (Table 3) were discharged into the atmosphere during 1984, all data from the general environmental air sampling program were within the range of normal background (Table 4). All measurements of atmospheric deposition at outlying perimeter stations lie within the range of normal background; however, tritium was detected in rainfall collected within the Laboratory boundary near the stack from the Building 75 tritium facility (Table 5).

The environmental air sampling program for ^{14}C and ^{3}H found detectable concentrations of these nuclides (Table 6). Essentially, 100% of the tritium released from LBL was discharged from the Building 75 stack.

Waterborne Radionuclides

Rainwater, creek water, and sewage from LBL's two sewer outfalls are analyzed for gross beta and alpha emitters (see Fig. 1; the Strawberry Sanitary Sewer is the southern site, Hearst is the western sewer). Additionally, sewer effluent is analyzed for gross halogen (radioiodine) content. Rainwater is analyzed for tritium (the Building 75 tritium labeling facility does not release liquid effluent into the sewer or surface streams).

Sewer outfalls are sampled continuously, sample-to-flow ratios are designed to be between 10 and 20 ppm, and composite samples are taken weekly. The five creek sample points indicated in Fig. 2 are sampled weekly. A one-quart grab sample is taken from each site and analyzed for gross alpha and beta emitters only.

The four perimeter environmental monitoring stations have 18-inch-diameter cylindrical rainfall collectors on their roofs. During rainy months (generally October through May) rainwater is picked up monthly and analyzed for gross alpha and beta activities and for tritium. During the dry California summer, each collector is rinsed with a quart of tap water, and the rinse is analyzed for "dry deposition." The 10 other atmospheric sampling sites alluded to in the air sampling section of this report also contain 18-inch-diameter combination rain/dry deposition collectors, which are sampled on a monthly basis in the same manner as the four perimeter environmental monitoring stations.

Rain that falls into the collector on the north side of Building 75 is analyzed on a storm-by-storm basis for tritium and gross alpha and beta activities. Tritium analysis of water samples is accomplished by

Table 3. Total quantities of radionuclides discharged into the atmosphere, 1984.

Nuclides	Quantity discharged (Ci)
Unidentified alpha emitters	$< 8 \times 10^{-7}$
Unidentified beta-gamma emitters	6×10^{-5}
Carbon-14	7×10^{-2}
Tritium	500
Iodine-125	9×10^{-4}
Iodine-131	7×10^{-6}

Table 4. Summary of air samples, 1984.

	No. of samples	Concentration (10^{-15} µCi/ml)						Average as % of standard	
		Alpha			Beta			Alpha	Beta
		Avg.	Min.	Max.	Avg.	Min.	Max.		
On-site average of 10 locations	488	0.28 ± 0.06	< 2	3 ± 2	< 4	< 80	140 ± 100	1.4	0.04
Perimeter Stations									
Bldg. 88	44	0.46 ± 0.23	< 2	3 ± 2	< 12	< 80	< 80	2.3	0.1
Bldg. 90	49	0.47 ± 0.22	< 2	2 ± 2	< 12	< 80	120 ± 100	2.4	0.1
Panoramic Way	45	0.52 ± 0.23	< 2	2 ± 2	< 12	< 80	100 ± 80	2.6	0.1
Olympus Gate	49	0.39 ± 0.21	< 2	3 ± 2	< 11	< 80	120 ± 100	2.0	0.1
Standard for comparison[a]		20			10,000				

[a]Source: Reference 2.

Table 5. Summary of atmospheric deposition, 1984.

	Total deposition (10^{-3} µCi/m^2)						Tritium in rainfall (µCi/m^2) as HTO[a]		
	No. of samples	Alpha		Beta			No. of samples	Avg.	Max[b]
		Avg.	Max.[b]	Avg.	Min.	Max.[b]			
On-Site (9 locations)	108	0.05 ± 0.03	0.13	0.6 ± 0.4	0.2	1.6	122	19	110
Perimeter (4 locations)	48	0.05 ± 0.02	0.08	< 1	0.04	3	36	< 0.2	0.2

No standards for comparison have been established

[a]The on-site tritium-in-rainfall data are computed from samples taken at 11 locations.

[b]Highest total for any one site.

Table 6. Summary of airborne environmental HTO and $^{14}CO_2$ sampling, 1984.

	No. of samples	Concentration (10^{-9} µCi/ml) Avg.	Min.	Max.	Average as % of standard
Samples for Tritium as HTO					
On-Site					
Bldg. 3 roof	51	0.6	< 0.7	< 6	0.03
ENV 69A[a]	22	3.9 ± 1	< 0.7	9 ± 3	0.2
75 Yard5[a]	28	24 ± 3	< 0.7	100 ± 30	1.2
Standard for Comparison			2000		
Perimeter					
LHS	48	0.5	< 0.7	< 7	0.3
B-13D (Olympus)	49	0.4	< 0.7	7 ± 3	0.2
Standard for Comparison			200		
Samples for Carbon-14 (as $^{14}CO_2$)					
On-Site					
Bldg. 3 roof	51	0.6	< 0.2	30 ± 10	0.06
Standard for Comparison			1000		

[a]The 75 Yard5 sample was discontinued 7/17 due to construction and "replaced" by the ENV 69A sample.

liquid scintillation counting. Water samples are prepared for gross alpha and beta analysis by acidification (HNO_3) and evaporation into 2-inch stainless steel planchettes. Organic residues not wet-ashed by the nitric acid treatment are oxidized by flaming the planchettes.

Since radioiodine is driven out of the water samples when they are acidified, aliquots of the sewer effluent samples are preserved for radioiodine analysis. The iodine contained in the samples is precipitated with silver using stable KI as a carrier. The iodine aliquots are filtered, and the filtrate is processed in the same manner as the acid (HNO_3) samples described earlier. After flaming the filtrate planchette, the filter containing any precipitated radioiodine is placed in the planchette and counted.

The prepared planchettes are weighed (the tare weight of each planchette is first determined) and counted in a thin-window, low-background gas proportional counter for both gross alpha and beta activities. Since the samples are thick, self-absorption is computed based on areal sample density, which is the sample weight divided by the area of the planchette (20.26 cm^2), assuming an alpha energy of 5.2 MeV and a beta energy of 1 MeV.

Table 7 summarizes the 1984 data from the surface water and tap water sampling programs. These results are similar to those obtained in past years and all lie within the normal range of background activity. There is no reason to suspect that any of the observed radioactivity originated from LBL.

Table 8a,b summarizes the sewage sampling data for 1984. The average and maximum values listed for sewer beta concentrations reflect the weekly activity found in the hotter of the acid or radioiodine planchettes. The ^{131}I released to the Hearst sewer between 10/31 to 11/13 was traced to a Laboratory employee's "voiding" after treatment with ^{131}I for hyperthyroidism (the treatment was not performed by LBL).

Nonradioactive Pollutants

Airborne Pollutants

Beryllium shop airborne emissions. The beryllium shop consists of eight beryllium work areas: layout box, glove box, drill press, small mill, saw, Thompson grinder, lathe, and large mill. The machining operations carried out in these work areas may generate beryllium aerosols. All beryllium work areas are partially or entirely enclosed, and these enclosures are maintained at negative pressures to the work room. High Efficiency Particulate (HEPA) filters are installed on the exhaust vent of all machine enclosures to remove beryllium particles before the air is discharged to the environment. Stack exhaust air is sampled whenever the equipment is used. Samples are sent to the Lawrence Livermore National Laboratory where they are analyzed for beryllium by atomic absorption.

Beryllium emissions are regulated by the Clean Air Act, Section 112, National Emission Standards for Hazardous Air Pollutants and the

Table 7. Summary of surface water and tap water samples, 1984.

		Concentration (10^{-9} µCi/ml)						Average as % of standard	
		Alpha			Beta				
	No. of samples	Avg.	Min.	Max.	Avg.	Min.	Max.	Alpha	Beta
On-site streams									
Blackberry	51	0.17 ± 0.16	< 0.4	1.8 ± 1.7	1.6 ± 0.1	< 0.5	2.8 ± 0.8	0.6	2
Lower Strawberry	51	< 0.07	< 0.2	0.8 ± 0.6	1.6 ± 0.1	< 0.4	3.4 ± 0.9	< 0.3	2
Upper Strawberry	51	< 0.15	< 0.4	2.1 ± 1.8	1.7 ± 0.1	0.7 ± 0.5	3.2 ± 0.8	< 0.5	2
Average		< 0.13			1.6 ± 0.03			< 0.4	2
Off-site streams									
Claremont	51	0.3 ± 0.2	< 0.5	3 ± 2	1.7 ± 0.1	< 0.4	7.6 ± 0.7	1	2
Wildcat	51	1.0 ± 0.1	< 0.6	< 1.4	1.0 ± 0.1	< 0.4	3 ± 0.9	3	1
Tap Water	51	0.03	< 0.2	0.3	0.9 ± 0.1	< 0.4	7.3 ± 1	0.1	1
Standard of Comparison[a]			30			100			

[a]Source: Reference 2.

Table 8a. Summary of sewage sampling data, 1984.

Total quantities discharged	Total volume (10^6 liters)	Alpha (μCi)	Beta (mCi)
Hearst Sewer	170	9	14[a]
Strawberry Sewer	74(E)	2(E)	5(E)

Table 8b. Summary of sewage sampling data, 1984 (continued).

Net concentrations	No. of samples	Concentration (10^{-9} μCi/ml)						Average as % of standard	
		Alpha			Beta				
		Avg.	Min.	Max.	Avg.	Min.	Max.	Alpha	Beta
Hearst	51	0.05	$\leq$ 0.5	< 5	80	$\leq$ 3	1100 ± 50[c]	0.001	3
Strawberry	39	0.02	< 0.5	< 2	70	5 ± 2	250 ± 10	0.0005	2
Overall	90	0.04			80			0.001	3
Standard for comparison[b]			400			3000			

[a] Includes 9 MCI of ^{131}I released between 10/31 and 11/13.
[b] Source: Reference 2.
[c] Mostly ^{131}I.
(E) = Estimate: poor flow measurements during 1984 (system replaced in early 1985).

Bay Area Air Quality Management District Regulation No. 11, Rule 3. Monthly reports have been mandated by the Bay Area Air Quality Management District and are sent to the Enforcement Section.

Table 9 summarizes the beryllium sampling results. The sampling results show full compliance with emission requirements.

Table 9. Beryllium sampling results, 1984.

Date of operation	Amount of beryllium (grams per 24 hours)
01-19-84	< 0.01
02-16-84	< 0.01
02-29-84	< 0.01
03-01-84	< 0.01
03-09-84	< 0.01
03-16-84	< 0.01
04-16-84	< 0.01
08-09-84	< 0.01
10-09-84	< 0.01
Discharge limit	10

Waterborne Pollutants

Plating shop wastewater discharges. There are two plating shops at LBL, Building 25 and Building 77. Both shops are subject to the EPA Electroplating Pretreatment Standard (40 CFR 413), effective April 27, 1984. In general, this standard regulates metal and cyanide discharges based on discharge volume. Since the Building 77 plating shop discharges more than 10,000 gallons per day, it must meet the more stringent set of limits. Building 25, which discharges less than 10,000 gallons per day, must meet the less stringent limits. Effective February 15, 1986, the plating shops will be required to meet a Metal Finishing Pretreatment Standard (40 CFR 433). This standard will lower the discharge limits for cyanide and most regulated metals. The Federal Categorical Pretreatment Standards have been adopted by the East Bay Municipal Utility District (EBMUD) in Ordinance No. 296.

A facility was installed in 1984 to treat all the wastes from the Building 77 shop. However, it was inadequate to handle all of the waste. Only the rinse water is treated now, and the spent solution continues to be handled off site by a commercial disposal firm. Water samples taken since this action show that the plating shop is in full compliance with both Federal Categorical Pretreatment Standards. Table 10a summarizes the Building 77 plating shop samples.

Due to the nature of the operations at the Building 25 plating shop, EBMUD mandated grab samples for this plating shop with each result correlated to specific operations. Sampling is performed annually and the results are sent to EBMUD in a compliance report. Samples are taken before the plating shop's wastewater combines with significant amounts from nonelectroplating operations. The sample results indicate the shop

Table 10a. Summary of heavy metal and cyanide concentrations in wastewater released from the Building 77 plating shop.

Sample Dates	CN (ppm)	Cu (ppm)	Ni (ppm)	Cr (ppm)	Zn (ppm)	Pb (ppm)	Cd (ppm)
01-25-84 to 01-26	< 0.02	0.28	0.08	0.13	0.15	0.09	0.005
01-26 to 01-27	< 0.02	0.96	0.04	0.06	0.07	< 0.03	0.004
01-27 to 01-28	< 0.02	0.48	0.05	0.21	0.12	< 0.03	0.004
01-30 to 01-31	0.02	0.32	0.21	0.30	0.03	< 0.03	< 0.004
01-31 to 02-01	0.12	0.88	0.37	0.04	0.04	< 0.03	< 0.004
02-01 to 02-02	0.08	0.09	0.19	0.04	0.13	< 0.03	0.014
02-02 to 02-03	0.06	0.85	0.51	0.92	0.19	0.03	0.009
02-06 to 02-07	< 0.02	5.3	2.0	0.78	0.13	0.64	0.019
02-07 to 02-08	0.08	2.1	0.35	0.67	0.19	0.53	0.007
02-08 to 02-09	0.04	0.15	0.18	0.83	0.16	0.08	0.015
Treatment Unit Put into Operation in July							
09-06 to 09-07	0.04	0.35	2.4	0.15	0.04	0.36	0.004
09-24 to 09-25[a]	0.4	5.5	70.0	1.4	0.43	0.8	0.17
10-29 to 10-30[a]	0.4	0.76	0.62	9.2	0.09	1.1	0.01
11-12 to 11-13-84	0.16	1.2	0.33	1.6	0.074	0.31	0.15
LIMITS (1984):	1.9	4.5	4.1	7.0	4.2	0.6	1.2
LIMITS (1986):	1.2	3.38	3.98	2.0	2.61	0.69	0.69

[a]Samples collected and analyzed by EBMUD.

to be in compliance with existing electroplating standards, but not in compliance with future metal finishing standards. Table 10b summarizes the Building 25 plating shop sample results.

Site Wastewater Discharges

The two sanitary sewers that drain wastewater from LBL are sampled for a number of heavy metals as mandated by EBMUD Ordinance No. 270. The pH of the sewage is continuously monitored as well.

Aliquots of the weekly flow-proportional grab samples (described previously in this report) are composited for a four-week period and analyzed for heavy metals. The analysis is performed by the Lawrence Livermore National Laboratory.

Tables 10b and 10c summarize the heavy metal released from the Strawberry and Hearst Sanitary Sewers. The LBL sewers drain to the regional EBMUD's treatment facility before discharge into the San Francisco Bay.

In Table 10c, the sample period of 9-5 to 10-2 shows that the discharge limits for copper, lead, and zinc had been exceeded. Since the Building 77 plating shop discharges its wastewater into this system, it is most likely that the excessive heavy metal levels were a result of its activities. As already discussed, the practice of discharging spent plating solutions has been discontinued, and the samples taken since then indicate full compliance.

In Table 10d, the sample periods from 2-22 to 3-20, 3-20 to 4-17, and 10-30 to 11-27 show that the discharge limits for chromium, copper, and/or zinc were exceeded. The cause for these discharges are being investigated. The sample taken from 11-27 to 12-18 showed that the discharge limit for chromium had been exceeded. This was due to an accidental release of 145 gallons of chromic acid through a drain line that had been valved open. This drain line has since been removed to prevent a recurrence.

POPULATION DOSE RESULTING FROM LBL OPERATIONS

The development of LBL's two models used to assess the population dose equivalent attributable to penetrating radiation and airborne radionuclides, respectively, was detailed in Ref. 6. Both of the models used population figures from the 1970 U.S. census.

While the population within 50 miles (80 km) of LBL increased by 13% during the 1970s[4,8,9] from 4.6 to 5.2 million people, the populations of Berkeley and Oakland, the two cities immediately adjacent to LBL, declined. Recomputing the population dose models with population statistics from the 1980 census produced no significant difference in the impact/insult values for either the penetrating radiation or radionuclide release models.

Table 10b. Summary of results of analyses done on Building 25 plating shop wastewater.

Sample #	Process Description	Copper (mg/L)	Chromium (mg/L)	Lead (mg/L)
1	Copper Oxide Wash	8	—	—
2	Pb/Sn Plate Rinse	—	—	0.4
3	Copper Plate Rinse	6	—	—
4	MRTL Etch Rinse	35	110	—
5	Ammonium Persulfate Rinse	10	—	—
6	Activator, 1st Rinse	0.7	—	—
7	Activator, 2nd Rinse	0.4	—	—
8	Sulfuric Acid Rinse	0.8	—	—
9	APS Rinse	12	—	—
10	Conditioner 190 Rinse	0.6	—	—
Electroplating Limits (effective 4/84):		none	none	0.6
Metal Finishing Limits (effective 2/86):		3.38	2.0	0.69

Table 10c. Summary of heavy metal concentrations released from the Strawberry Sanitary Sewer, 1984.

Sample Dates	pH	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Pb (ppm)	Ni (ppm)	Ag (ppm)	Zn (ppm)	Total Flow 10^6L
12-20-83 to 01-24	7.0	< 0.06	0.08	1.65	7.70	< 0.72	< 0.19	< 0.04	0.60	7
01-31 to 02-22	6.9	< 0.03	< 0.09	1.2	3.60	< 0.04	< 0.19	< 0.04	0.30	3
02-22 to 03-20	7.2	< 0.02	< 0.04	0.52	4.7	< 0.37	< 0.10	< 0.03	0.25	4
03-20 to 04-17	7.1	0.03	< 0.04	1.3	5.75	< 0.37	< 0.10	< 0.03	0.33	4
04-17 to 05-15	6.8	0.03	0.04	1.18	2.18	< 0.36	0.12	< 0.04	0.80	5
05-15 to 06-12	7.1	0.07	0.08	1.18	11.75	< 0.35	0.10	< 0.04	0.95	5
06-12 to 07-11	6.5	< 0.03	0.16	3.95	32.8	0.65	0.25	< 0.04	1.80	4
07-11 to 08-07	6.7	0.05	0.20	3.00	16.5	< 0.32	0.19	< 0.04	1.25	—
08-07 to 09-05	7.2	0.04	0.11	4.85	18.1	0.50	0.11	< 0.03	2.0	—
09-05 to 10-02	7.1	0.08	1.21	14.6	61.87	2.3	4.0	< 0.03	7.0	10
10-02 to 10-30	6.8	< 0.03	1.31	0.68	6.5	< 0.37	< 0.10	0.03	0.16	7
10-30 to 11-27	6.6	< 0.03	0.22	0.39	6.2	< 0.39	0.52	< 0.04	0.34	5
11-27 to 12-18-84	6.6	< 0.03	< 0.05	0.18	7.8	< 0.40	0.16	< 0.04	0.23	2
Discharge limits[a]	5.5	1	2	5	100	2	5	1	5	

[a]East Bay Municipal Utility District (EBMUD).

Table 10d. Summary of heavy metal concentrations released from the Hearst Sanitary Sewer, 1984.

Sample Dates	pH	Cd (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Pb (ppm)	Ni (ppm)	Ag (ppm)	Zn (ppm)	Total Flow 10^6L
12-20-83 to 01-24	7.0	< 0.06	0.60	2.00	2.60	< 0.72	< 0.19	< 0.07	0.83	13
01-24 to 02-22	6.9	< 0.03	0.24	1.9	1.24	< 0.04	< 0.19	0.05	0.48	13
02-22 to 03-20	6.8	< 0.03	0.83	8.75	6.75	< 0.04	< 0.10	0.11	15.25	15
03-20 to 04-17	7.0	0.03	0.89	6.25	2.0	< 0.37	< 0.10	< 0.03	5.25	13
04-17 to 05-15	7.0	0.03	0.37	1.54	0.68	< 0.36	< 0.11	0.04	2.10	12
05-15 to 06-12	6.3	0.03	0.27	0.77	0.62	< 0.35	< 0.10	0.05	0.44	12
06-12 to 07-10	6.4	< 0.03	0.20	0.60	0.74	< 0.37	< 0.19	0.16	0.38	13
07-10 to 08-07	6.5	< 0.03	0.13	0.34	0.42	< 0.32	< 0.09	0.06	0.16	15
08-07 to 09-05	6.2	< 0.03	0.15	0.42	1.24	< 0.32	< 0.09	0.04	0.36	25
09-05 to 10-02	6.3	< 0.03	0.33	0.26	1.27	< 0.37	< 0.10	< 0.03	0.37	29
10-02 to 10-30	6.7	< 0.03	0.31	1.18	0.42	< 0.37	< 0.10	0.03	0.37	12
10-30 to 11-27	2.7	< 0.06	2.8	38	7.6	< 0.39	0.28	0.13	10	8
11-27 to 12-18-84	6.8	< 0.03	2.1	0.82	1.04	< 0.40	< 0.10	< 0.04	0.48	6
Discharge Limits[a]	5.5	1	2	5	100	2	5	1	5	7

[a]East Bay Municipal Utility District (EBMUD).

Accelerator-Produced Radiation

The LBL model developed by Thomas[6] for determining population dose equivalent from the maximum measured value of perimeter (fence-post) dose assumes that the fence-post rate changes are uncorrelated with fluctuations in population. During 1984 the maximum fence-post dose was measured at the Olympus Gate Monitoring Station and was 5.4 man-mrem for the year (Table 2). An examination of the time sequence of the telemetrized neutron fluence from the Olympus detector indicated that the neutron fluence peaks correlated well with the fluence peaks from the neutron detector located in the Bevatron building. The Bevatron operated continuously seven days a week during 1984 except for a two-week shutdown in early June, a "summer" shutdown from August 20 through October 2, and a year-end shutdown December 24-31.

Aside from shutdown periods the modest fence-post dose equivalent was produced with reasonable uniformity throughout the year and does not seriously compromise the Thomas model's assumptions. The model's expression relating population dose equivalent M (in man-rem) to maximum measured fence-post dose H_o (in rem) is

$$M < 10^3 \times H_o \, (1.0 - 0.56f) \, , \qquad (1)$$

where f = the fraction of the fence-post dose contributed by the 88-Inch Cyclotron and/or the SuperHILAC. Since the fence-post dose has been assigned to the Bevatron, f = 0 [in Eq. (1)].

Thus the expression becomes

$$M < 10^3 \, H_o \, . \qquad (2)$$

Since H_o was 5.4 mrem (or 0.0054 rem) the population dose equivalent attributable to LBL accelerator operation during 1984 was

$$M < 10^3 \times 0.0054$$
$$< 5.4 \text{ man-rem.}$$

Airborne Radionuclides

The population dose equivalent resulting from airborne releases of radioactive nuclides can be determined from the model developed by Cantelow.[6] To provide more consistent reporting of these data, new values have been calculated for the constant R (man-rem per curie released). These values, shown in Table 11, are based on maximum permissible concentration (MPC) data listed in Ref. 2. These values replace those listed in Table 16 of Ref. 6. Table 12 of this report summarizes the total population dose equivalent due to LBL operations. The reader will note the substantial difference in predicted population dose equivalent between the two almost equal tritium releases. This difference is a reflection of the conservatism built into the Cantelow model.

Table 11. Population dose equivalent resulting from the release of 1 Ci of various radionuclides.

Nuclide	MPC[a] (μCi/ml)	R[b] (rem $m^3 Ci^{-1} s^{-1}$)	α_R[b] (man-rem/Ci)
Unidentified α emitters	2×10^{-14}	7.9×10^5	3×10^5
Unidentified β emitters	1×10^{-11}	1.6×10^3	7×10^2
^3H	2×10^5	7×10^{-2}	3×10^{-2}
^{14}C	1×10^6	1.6×10^{-2}	7×10^{-2}
^{125}I	80	2.0×10^2	80
^{131}I	100	1.6×10^2	70

[a]Source: Reference 2.
[b]Source: Reference 6.

Table 12. Population dose equivalent, 1984.[a]

Contributing factor	Population dose (man-rem)
Penetrating radiation from accelerator operation	< 5.4
Radionuclide release:	
^3H "routine" releases	7.5
^3H February 27 release	0.1
^{14}C	0.005
^{125}I	0.07
^{131}I	0.0005
Unidentified alpha emitters	< 0.2
Unidentified beta emitters	0.04
Total	< 14

[a]For 1984, the population dose attributable to natural background sources for the population within 50 miles (80 km) of LBL was approximately 5.2×10^6 persons × 0.1 rem/person-yr = 520,000 man-rem.

TRENDS--LBL ENVIRONMENTAL IMPACT

Accelerator-Produced Penetrating Radiation

Figures 3-6 show the annual accelerator-produced dose equivalent reported by the four perimeter environmental monitoring stations from the year they were established to date. During the past several years, the LBL accelerators have run heavy ions during a significant fraction of their operating schedules. Successful work in beam development had served to increase beam currents in recent years and had increased the dose equivalent at the Building 88 Environmental Monitoring Station somewhat. That upward trend was reversed in 1983. The maximum perimeter dose equivalent (Fig. 5) remains a diminishing fraction of the radiation protection guidelines[2] reflecting improvements in accelerator beam optics, local shielding, and cave selection.

Airborne and Waterborne Radionuclides

Figure 7 shows the annual releases of tritium (as HTO) from the Building 75 Tritium Facility from 1973 to 1984.

The 250 curies released during routine operations is slightly more than twice the 1983 releases and is responsible for approximately 60% of the LBL-produced population-dose equivalent from all sources for 1984. The operational personnel of the tritium facility is investigating all sources of release so that future releases may be minimized. The releases occur during molecular tagging and tritium waste processing.

With the exception of occasional known releases, the atmospheric sampling program has yielded data over the past few years that are within the range of normal background.

The surface water program always yields results within the range of normal background. Because no substantial changes in the quantities of radionuclides used are anticipated, no changes are expected in these observations. Under the terms of its license, the University of California Berkeley campus has discharged radionuclides into the Strawberry sewer, complicating the analysis of LBL sewer sampling data. After 1979 the University discharges were sharply curtailed and are expected to remain modest in the future.

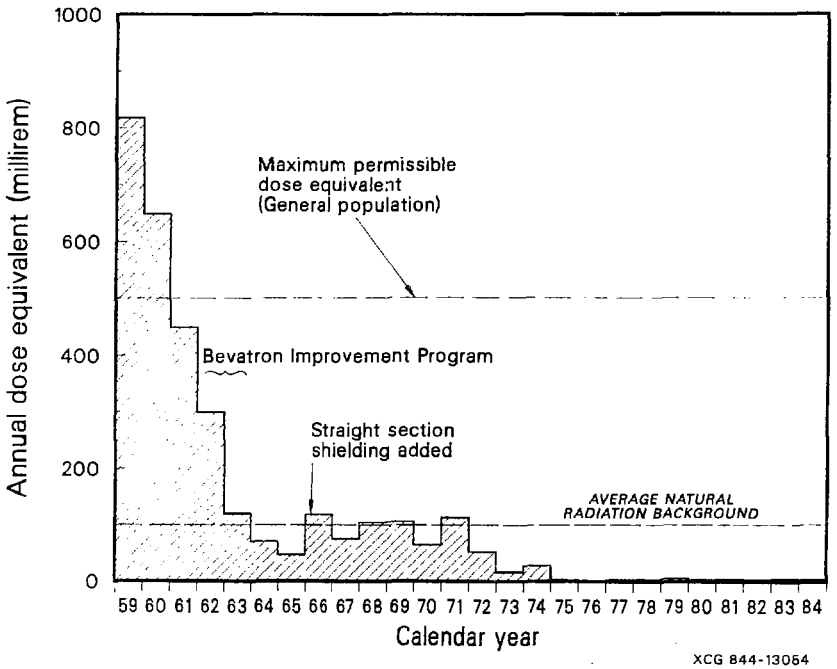

Figure 3. Annual accelerator-produced dose equivalent reported by the Olympus Gate Environmental Monitoring Station, 1959-1984. Maximum Permissible Dose (General Population) is the maximum permissible dose equivalent to any single individual in the general non-Laboratory population. The maximum permissible average dose to the general population is 170 mrem/year.

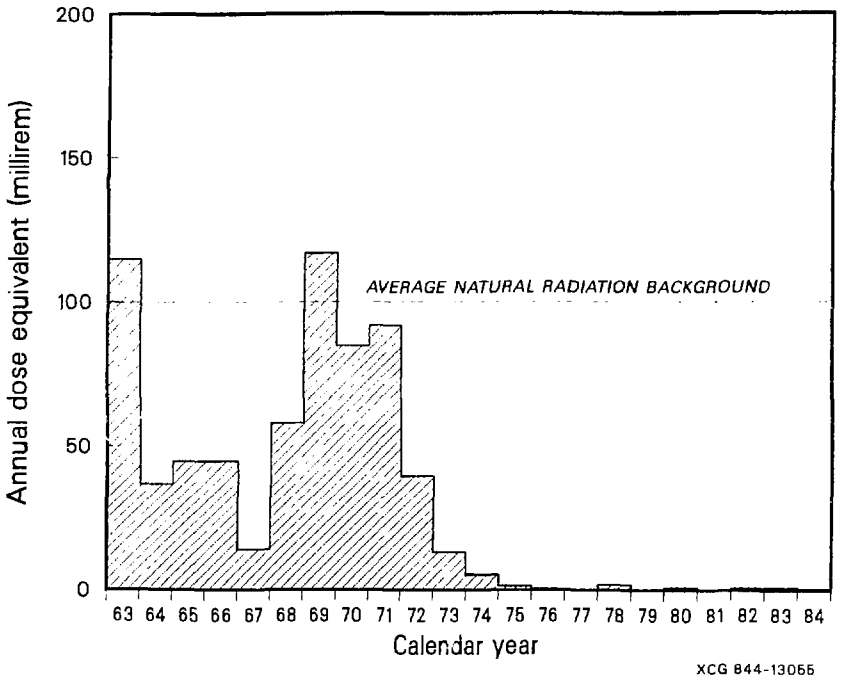

Figure 4. Annual accelerator-produced dose equivalent reported by the Building 90 Environmental Monitoring Station, 1962-1984.

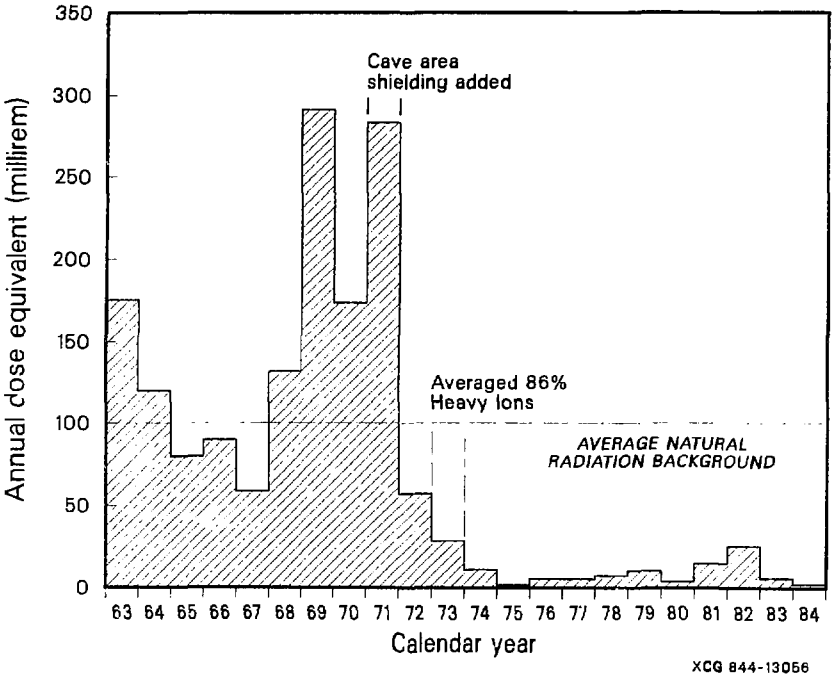

Figure 5. Annual accelerator-produced dose equivalent reported by the 88-Inch Cyclotron Environmental Monitoring Station, 1963-1984.

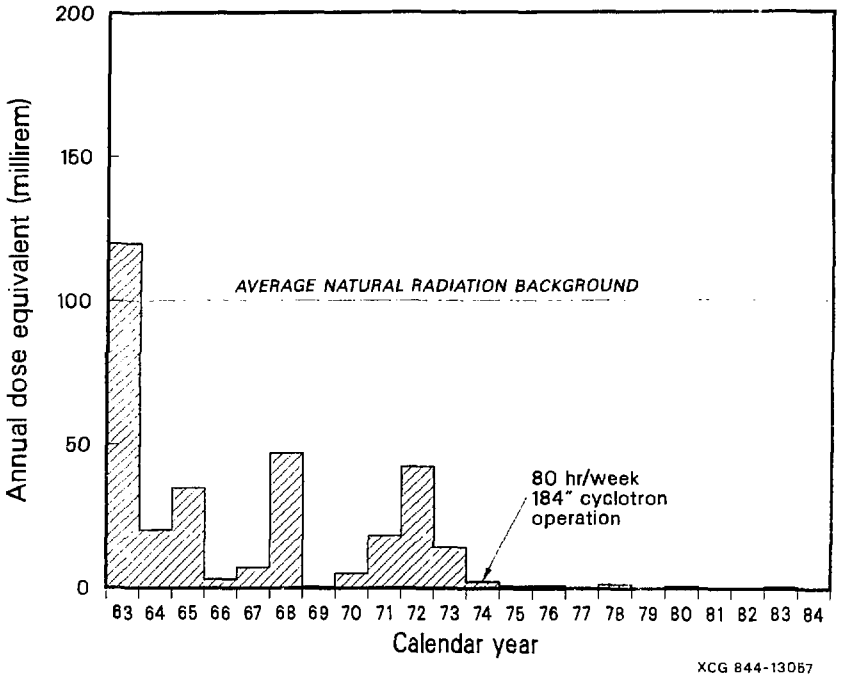

Figure 6. Annual accelerator-produced dose equivalent reported by the Panoramic Way Environmental Monitoring Station, 1963-1984.

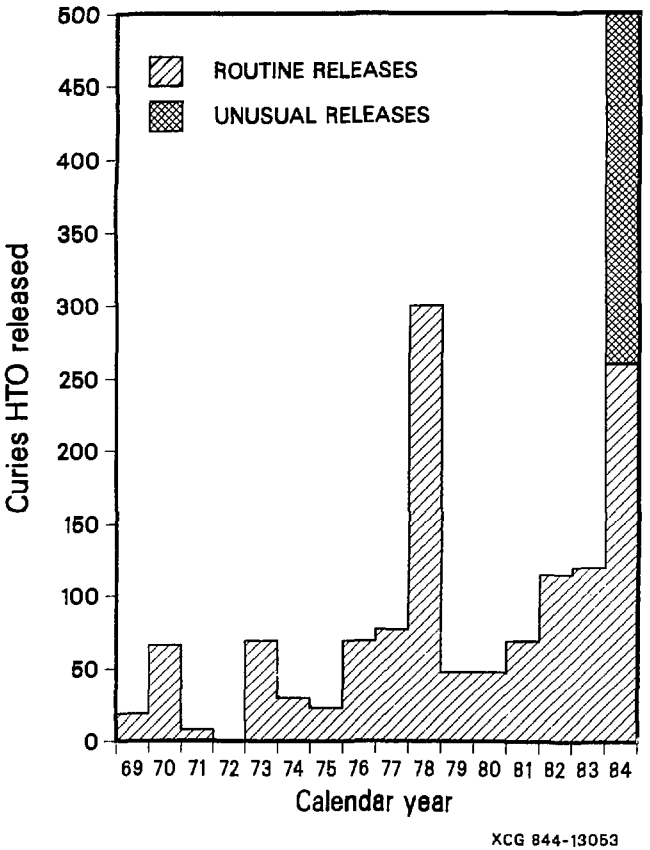

Figure 7. Annual releases of tritium (HTO) from the Building 75 Tritium Facility, 1969-1984.

QUALITY ASSURANCE

The Facilities Management and Technical Services Division of LBL is in the process of preparing a comprehensive division-wide quality assurance program. During 1984, in addition to the quality control procedures described in the body of this report, samples that were blind-spiked with tritium were worked up along with each batch of environmental samples assayed for HTO.

The LBL Environmental Surveillance Group analyzed DOE's Environmental Measurements Laboratory QAPXXII Water Sample (reported in Ref. 10) for tritium, with the following results:

LBL Value (pCi/mL HTO)	EML Value (pCi/mL HTO)	Ratio LBL/EML
21 ± 6	24.8 ± 0.7	0.85 ± 0.24

GROUND WATER MONITORING

LBL has no formal program to assay ground water at this time. As mentioned previously, the Laboratory does analyze the grab samples taken weekly from all permanent creeks that drain the LBL watershed (see Fig. 2 and Table 7).

REFERENCES

1. U.S. Department of Energy, Effluent and Environmental Monitoring Program Requirements, DOE 5484.1, Chapter III (1981) and (1985).
2. U.S. Department of Energy, Requirements for Radiation Protection, DOE 5480.1, Chapter XI (1981).
3. Greenly, G.D. and Peterson, R.D., "Environmental Impact of an Accidental Release at the Lawrence Berkeley National [sic] Laboratory Tritium Facility," Lawrence Livermore National Laboratory USAG 80-16 (internal document), June 9, 1980.
4. U.S. Department of Commerce Bureau of the Census, Characteristics of the Population: Number of Inhabitants--California 1980, PC 80 1 AC (March 1982).
5. Dakin, H.S. and Stephens, L.D., Environmental Radiation Telemetry System, Lawrence Radiation Laboratory report UCRL-16482 (1967).
6. Thomas, R.H. (ed.), The Environmental Surveillance Program of the Lawrence Berkeley Laboratory, Lawrence Berkeley Laboratory report LBL-4678 (1976).
7. Greenhouse, N.A., private communication.
8. University of California Systemwide News, UC Headcount Environments (October 31, 1983).
9. U.S. Department of Commerce Bureau of the Census, Census Tracts--San Francisco-Oakland, California (et al.) Standard Metropolitan Statistical Area (SMSA), PHC 80 2 321 (July 1983).
10. Sanderson, C.G. and Feiner, M.S., "Semi-Annual Department of Energy Quality Assessment Program Report," Environmental Measurements Laboratory EML-438, March 1, 1985.

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