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Lawrence Berkeley Laboratory

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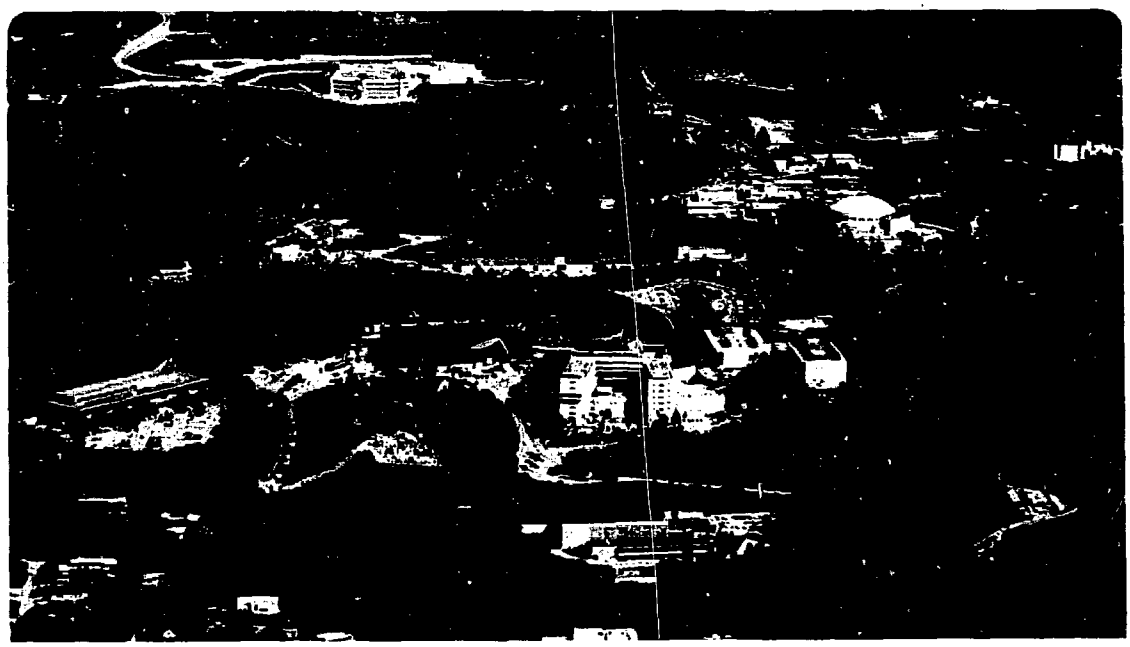
Engineering & Technical Services Division

ANNUAL ENVIRONMENTAL MONITORING REPORT OF THE LAWRENCE BERKELEY LABORATORY 1979

Prepared by the Staff of the
Engineering and Technical Services Division
Lawrence Berkeley Laboratory
University of California, Berkeley 94720

June 1980



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ANNUAL ENVIRONMENTAL MONITORING REPORT OF THE LAWRENCE BERKELEY LABORATORY

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Prepared by the staff of the
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Berkeley, California 94720

Editor: Gary E. Schleimer

ABSTRACT: The data obtained from the Environmental Monitoring Program of the Lawrence Berkeley Laboratory for the calendar year 1979 are described and general trends are discussed.

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TABLE OF CONTENTS

ABSTRACT i

PREFACE. iv

1. ENVIRONMENTAL MONITORING DATA - 1979 1

1.1 Accelerator Produced Radiation. 1

1.2 Radionuclide Measurements and Release 2

1.2.1 Atmospheric Sampling 2

1.2.2 Water Sampling 5

1.2.3 Sewer Sampling 5

1.3 Population Dose Equivalent Resulting from LBL Operations. . . 5

1.3.1 Accelerator Produced Penetrating Radiation 5

1.3.2 Airborne Radionuclides 6

1.4 Non-Radioactive Pollutants. 10

2. SUMMARY OF ENVIRONMENTAL MONITORING DATA AND TRENDS. 10

2.1 Accelerator Produced Penetrating Radiation. 10

2.2 Release of Radionuclides. 10

REFERENCES 15

DISTRIBUTION LIST. 16

PREFACE

In 1976 we published the Annual Environmental Monitoring Report in two parts. Part one, LBL-4678 (Ref. 1), discussed in detail the modeling used to determine the population dose equivalent due to Laboratory operations. That volume also described natural radiation background, geological features, climate and meteorology, and the environmental surveillance program of the Lawrence Berkeley Laboratory. Part two, LBL-4827 (Ref. 2), included the results of the sampling and measuring programs and the other necessary data to determine the environmental impact of Laboratory operations for 1975.

This year we will only reference LBL-4678, thereby reducing the Annual Environmental Report to the essential details.

Copies of LBL-4678 are available upon request from:

National Technical Information Services
U. . Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

1. ENVIRONMENTAL MONITORING DATA - 1979

1.1 Accelerator-Produced Radiation

In order to establish the population dose resulting from the operation of its accelerators, LBL continuously monitors "fence-post" neutron fluence and gamma radiation at four site-perimeter stations. Table 1 summarizes the net dose values measured at the four stations during 1979.

The fence-post neutron fluence attributable to LBL accelerator operation for 1979 is characterized as follows: a) the 184-Inch Cyclotron produced no measurable fence-post dose (Panoramic M.S. data, Table 1); b) the SuperHILAC and Bevatron contributed 33% and 67%, respectively, of the dose measured at the Olympus Gate M.S., and the dose from those two accelerators was fairly uniformly accrued throughout the operating year. The 88-Inch Cyclotron dose was delivered in 2 "compartments;" 60% (6.1 mrem) was produced during five, approximately 100-hour, Helium-3 beam runs which began May 9, August 31, October 19, November 24, and December 6, 1979. The remaining 40% (4.0 mrem) was rather uniformly distributed throughout the remainder of the beam year.

The continuous gamma measurements telemetered from the four perimeter stations demonstrated no significant correlation with the operation of any of the LBL accelerators and were background for 1979.

Table 1.

Radiation Levels at the LBL Boundary Due to Accelerator Operation — 1979.

	1979 Total Above Background		
Station	γ (mrem)	n (mrem)	Total[a] (mrem)
Olympus Gate M.S.	background	6.30	6.30 ± 0.04
Building 90 M.S.	background	0.30	0.30 ± 0.1
Building 88 M.S.	background	10.10	10.10 ± 0.08
Panoramic M.S.	background	background	0
Standard for comparison (Ref. 4):			500

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

1.2 Radionuclide Measurements and Release

1.2.1 Atmospheric Sampling

The total quantities of radionuclides discharged into the atmosphere are summarized in Table 2. The figures represent a significant decrease compared to the 1978 values, and the releases resulted in a small population dose equivalent (see Table 9).

The general air sampling program gave data all of which were within the range of normal background (Table 3). The measurements of atmospheric deposition at perimeter stations all lie within the range of normal background, although small amounts of tritium were detected in rainfall collected within the Laboratory boundary (Table 4).

TABLE 2.

Total Quantities Discharged into the Atmosphere – 1979.

Nuclide(s)	Quality discharged (Ci)
Alpha emitters	1×10^{-9}
Unidentified beta-gamma emitters	6×10^{-5}
Carbon-14	0.13
Tritium	48
Iodine-125	4×10^{-4}

The special air sampling program for ^{14}C and ^{3}H found detectable concentrations of these nuclides (Table 5). Essentially 100% of the tritium released from LBL was discharged from the Building 75 stack. Average concentration for that stack was about 1.2 times the radiation protection standards.

TABLE 3.

Summary of Air Samples — 1979.

		Concentration, 10^{-15} μCi/ml						% of Standard (Ref. 4)	
		Alpha			Beta-Gamma			Alpha	Beta-gamma
	No. of samples	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.	Avg.
On-site average of 10 locations	483	0.83±.11	< 2	7	25 ± 4	< 80	180	4	0.3
Perimeter Stations									
Bldg 88	51	1.69±.36	< 2	7	24±12	< 80	160	8	0.2
Bldg 90	50	1.27±.35	< 2	6	36±12	< 80	230	6	0.4
Panoramic Way	50	1.62±.36	< 2	6	21±12	< 80	90	8	0.2
Olympus Gate	51	1.37±.35	< 2	6	30±12	< 80	160	7	0.3
Standard for comparison		20			10,000				

TABLE 4.

Summary of Atmospheric Deposition — 1979.

	Total Deposition, 10^{-3} μCi/m^2					Tritium in Rainfall, μCi/m^2 (as HTO)		
		Alpha		Beta				
	No. of samples	Avg.	Max.[a]	Avg.	Max.[a]	No. of samples	Avg.	Max.[a]
On-Site (9 locations)	104	0.04	.12±.09	1.5	2.9±.2	177	0.72	1.6[b]
Perimeter (4 locations)	47	0.04	.11±.08	2.6	5.3±.2	38	0.20	0.4

No standards for comparison have been established.

[a]Highest total for any one site.

[b]Although "on-site", this location is very near the fence and representative of the area just outside the perimeter. The average tritium-in-rainfall concentration at this location (Bldg 75 deposition collector) was 6.0×10^{-6} μCi/ml, 0.2% of the drinking water concentration guide (CG); the maximum observed concentration was 180×10^{-6} μCi/ml or 6% of the guideline (Ref. 4).

TABLE 5.

Summary of Special Air Sampling — 1979.

	No. of samples	Concentration, $10^{-9}\mu Ci/ml$ Avg.	Max.	Percent of standard
Samples for Tritium as HTO				
On Site				
Bldg 3 roof	50	1.5	19	0.8
Perimeter				
LHS	51	1.0	3.2	0.5
B31D (Olympus)	50	1.1	3.4	0.6
Standard for Comparison		200		
Samples for Carbon-14 in Air (as CO_2)				
On Site				
Bldg 3 roof	49	0.026	0.37	0.026
Standard for Comparison		100		

1.2.2 Water Sampling

Table 6 summarizes the 1979 data from the surface water and tap water sampling program. 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 the Laboratory.

1.2.3 Sewer Sampling

Table 7 summarizes the sewage sampling data for 1979. LBL's historical release practices were maintained during 1979, and the Hearst sewage average β concentration was about 0.5% of the DOE standard for β discharges to sewers.[4] The campus of the Universtity of California discharges radioactive waste into the Strawberry sewer above the point at which LBL monitors it. While the average Strawberry β concentration for 1979 was a significant fraction (85%) of the standard, the figure represents about a five-fold decrease from the previous year (1978 average Strawberry β concentration was 460% of the standard -- see Table 7 and Section 2.2).

1.3 Population Dose Equivalent Resulting from LBL Operations

1.3.1 Accelerators

The LBL model for determining population dose equivalent resulting from accelerator operation[5] assumes that fence-post dose rate is uncorrelated with fluctuations in population. The "Helium-3 beam" component of the 88-Inch Cyclotron's contribution to the fence-post dose (Section 1.1) does not seriously compromise the model's assumption inasmuch as the five dose "spikes" were distributed throughout the year.

The model's expression relating population dose equivalent M to maximum measured fence-post dose H_0 is:

$$M \leq 1000\ H_0\ [1 - 0.56\ f]$$

where f = fraction of the fence-post dose contributed by the SuperHILAC and 88-Inch Cyclotron, and H_0 is in rem. Substituting the data from Table 1 and Section 1.1 into the above, we find:

$$M \leqslant 1000 \times 0.0101 \left\{ 1 - 0.56 \left[\frac{(10.1 + 2.1)}{(10.1 + 6.3 + 0.3)} \right] \right\}$$

$$M \leqslant 6.0 \text{ man-rem}$$

1.3.2 Airborne Radionuclides

The population dose equivalent resulting from airborne releases of radioactive nuclides can be determined from the model described in Ref. 6.

For the sake of providing more consistent reporting of these data, new values have been calculated for the constant "αR" (man-rem per curie released). The new values shown in Table 8 are based on MPC data listed in Chapter 0524 (Ref. 4). These values replace those listed in Ref. 1, Table 16.

Table 9 summarizes the total population dose equivalent due to Laboratory operations.

1.4 Non-Radioactive Pollutants

The Laboratory does not carry out routine monitoring of airborne non-radioactive pollutants; however, sewer sampling is carried out for heavy metals. The analysis is achieved by atomic absorption.

Table 10 summarizes the sewer sampling data for heavy metals.

TABLE 6:

Surface Water and Tap Water Samples 1979.

	No. of samples	Concentration, 10^{-9} µCi/ml Alpha Avg.	Alpha Max.	Beta Avg.	Beta Max.	% of Standards	
On-Site Streams							
Blackberry	51	< 0.4	3.0	2.1±0.1	11	< 1.3	2.1
Lower Strawberry	51	< 0.4	1.7	4.8±0.2	27	< 1.3	4.8
Upper Strawberry	51	0.5±0.4	14.	2.1±0.2	8	1.7	2.1
Average		0.24±0.18		3.02±0.08		0.8	3.0
Off-Site Streams							
Claremont	51	< 0.4	5.4	1.3±0.1	3.3	< 1.3	1.3
Wildcat	51	< 0.3	3.3	1.4±0.1	2.6	< 1.0	1.4
Average		< 0.3		1.4±0.1		< 1.0	1.4
Tap Water:	51	< 0.08		0.81±0.10		< 0.3	0.8
Standard of Comparison:		30		100			

Table 7.

Summary of Sewage Sampling Data — 1979.

A. Total Quantities Discharged

	Total Volume 10^6 liters	Total, α µCi	Total, β - γ mCi
Hearst Sewer	247	57	3.8
Strawberry Sewer	302	139	770.
Total	559	196	774

B. Net Concentrations

	No. of samples	Concentration, 10^{-9} µCi/ml α Avg.	α Max.	β-γ Avg.	β-γ Max.	% of Standards α	β-γ
Hearst	43	0.2	4.9	15	25	0.05	0.5
Strawberry	45	0.5	5.0	2,550	13,800	0.13	85.
Overall		0.35		1,385		0.09	46.
Standard for Comparison		400		3,000			

TABLE 8.

Population Dose Equivalent Resulting from the Release of One Curie of Radionuclides.

Nuclide	MPC (μCi/ml)	$_R$(Ref. 6) (Rem $m^3 Ci^{-1} s^{-1}$)	α_R(Ref. 6) (man-rem/Ci)
Unidentified α emitters	2×10^{-14}	7.9×20^5	3×10^5
Unidentified β emitters	1×10^{-11}	1.6×10^3	7×10^2
^3H	2×10^{-7}	0.079	0.03
^{14}C	1×10^{-7}	0.16	0.07
^{125}I	8×10^{-11}	200.	80.

TABLE 9.

Population Dose Equivalent — 1979.

Contributing Factor	Population Dose (man-rem)
Penetrating radiation from accelerator operation	6.0
Radionuclide release:	
^3H	1.5
^{14}C	0.01
^{125}I	0.03
Unknown β,γ emitters	0.04
Unknown α emitters	0.0003
Total	7.6

TABLE 10.

Summary of Sewer Sampling Data for Heavy Metals – 1979.

	Metals Detected							
	Chromium	Copper	Zinc	Silver	Cadmium	Nickel	Iron	Lead
Standard for comparison, [a]EBMUD limitation on discharge (mg/l)	2	5	5	1	1	5	100	2
Hearst Sewer								
Average (mg/l)	0.2	0.7	1.3	< 0.1	< 0.1	<0.2	3.1	0.6
% of Standard	10	14	26	<10	<10	<4	3.1	30
Strawberry Sewer								
Average (mg/l)	0.5	2.0	1.0	< 0.1	< 0.1	<0.2	16.9	0.9
% of Standard	25	40	20	<10	<10	<4	16.9	45

[a]East Bay Municipal Utility District

2. SUMMARY OF ENVIRONMENTAL MONITORING DATA AND TRENDS

2.1 Acclerator-Produced Penetrating Radiation

Figures 1-4 show the annual accelerator-produced dose equivalent reported by the four perimeter environmental monitoring stations from the year they were established. During the past four years the LBL accelerators have run heavy ions an increasing fraction of their operating schedule. Successful work in beam development has served to increase beam currents in recent years. However, concomitant improvements in beam optics have minimized stray radiation losses along the beam transport lines resulting in small annual population doses.

2.2 Release of Radionuclides

Over the past several years the atmospheric sampling program has, with the exception of occasional known releases, yielded data which are within the range of normal background. The surface water program always yields results within the range of normal background. As 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 historically discharged radionuclides into the Strawberry sewer, complicating the analysis of LBL sewer sampling data. U.C. discharge practice was sharply curtailed during 1979, however, and only a small fraction of the total radioactivity dumped in 1979 was released post-June 1979. This encouraging trend continued through the first few months of the current year (May 1980).

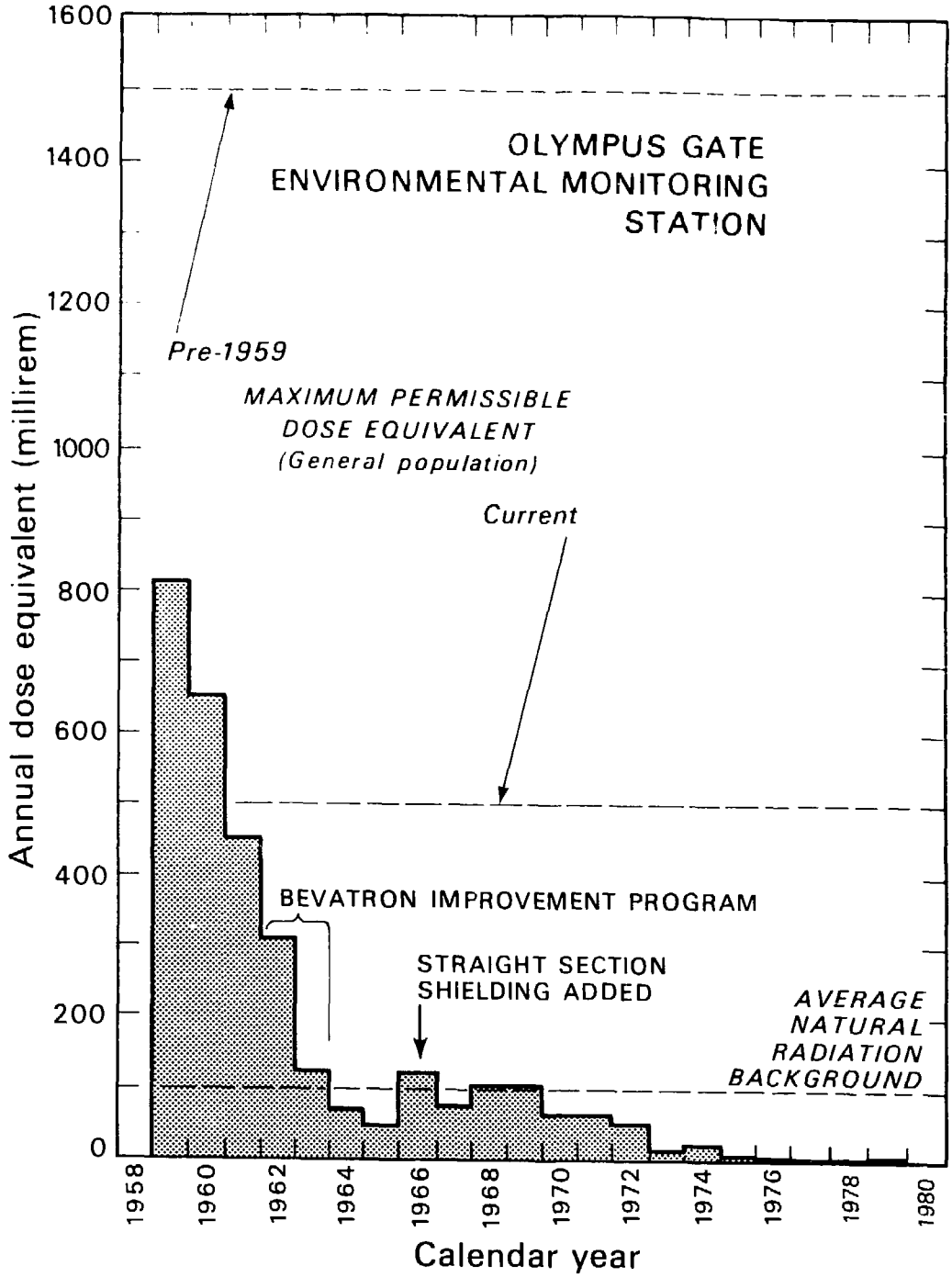
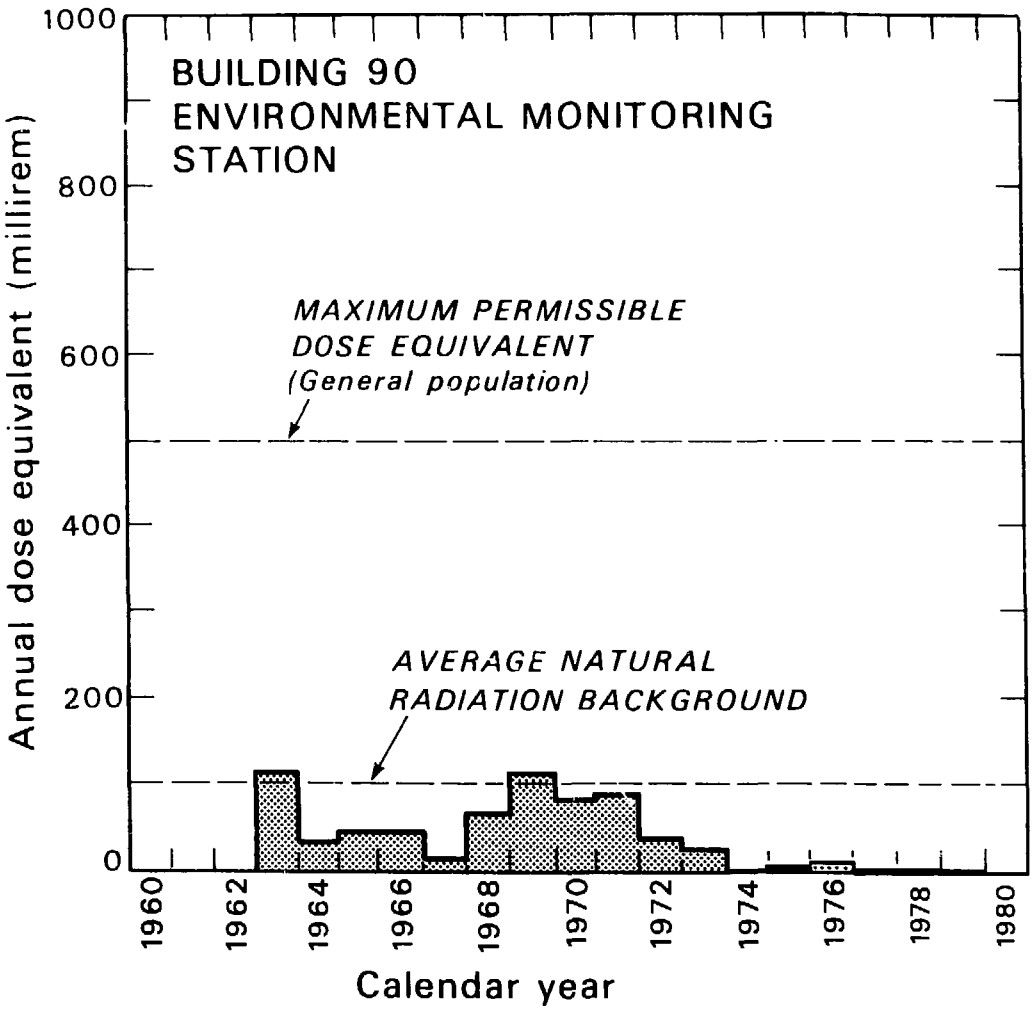
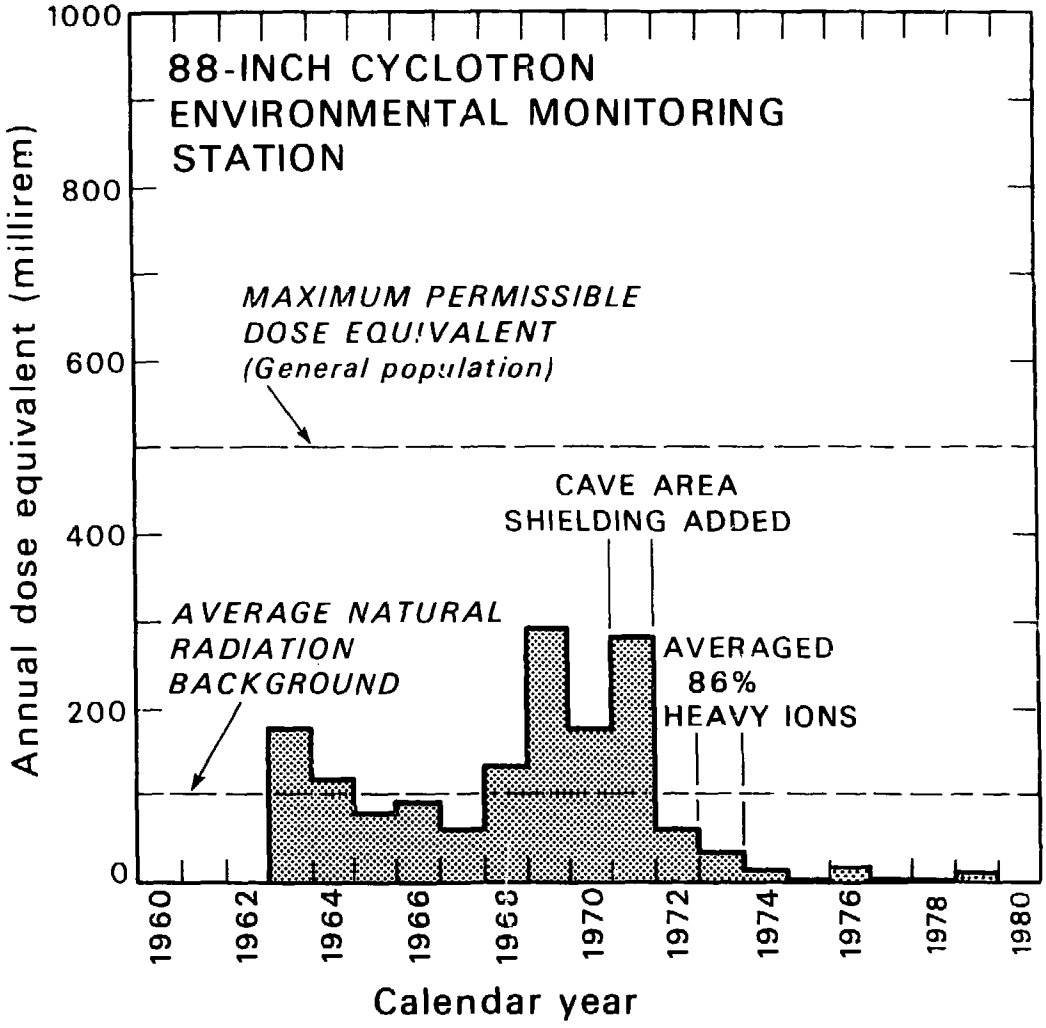

OLYMPUS GATE
ENVIRONMENTAL MONITORING
STATION
Pre-1959
MAXIMUM PERMISSIBLE
DOSE EQUIVALENT
(General population)
Current
BEVATRON IMPROVEMENT PROGRAM
STRAIGHT SECTION
SHIELDING ADDED
AVERAGE
NATURAL
RADIATION
BACKGROUND
Annual dose equivalent (millirem)
1600
1400
1200
1000
800
600
400
200
0
1958
1960
1962
1964
1966
1968
1970
1972
1974
1976
1978
1980
Calendar year
XBL 753-4766 D

Fig. 1.



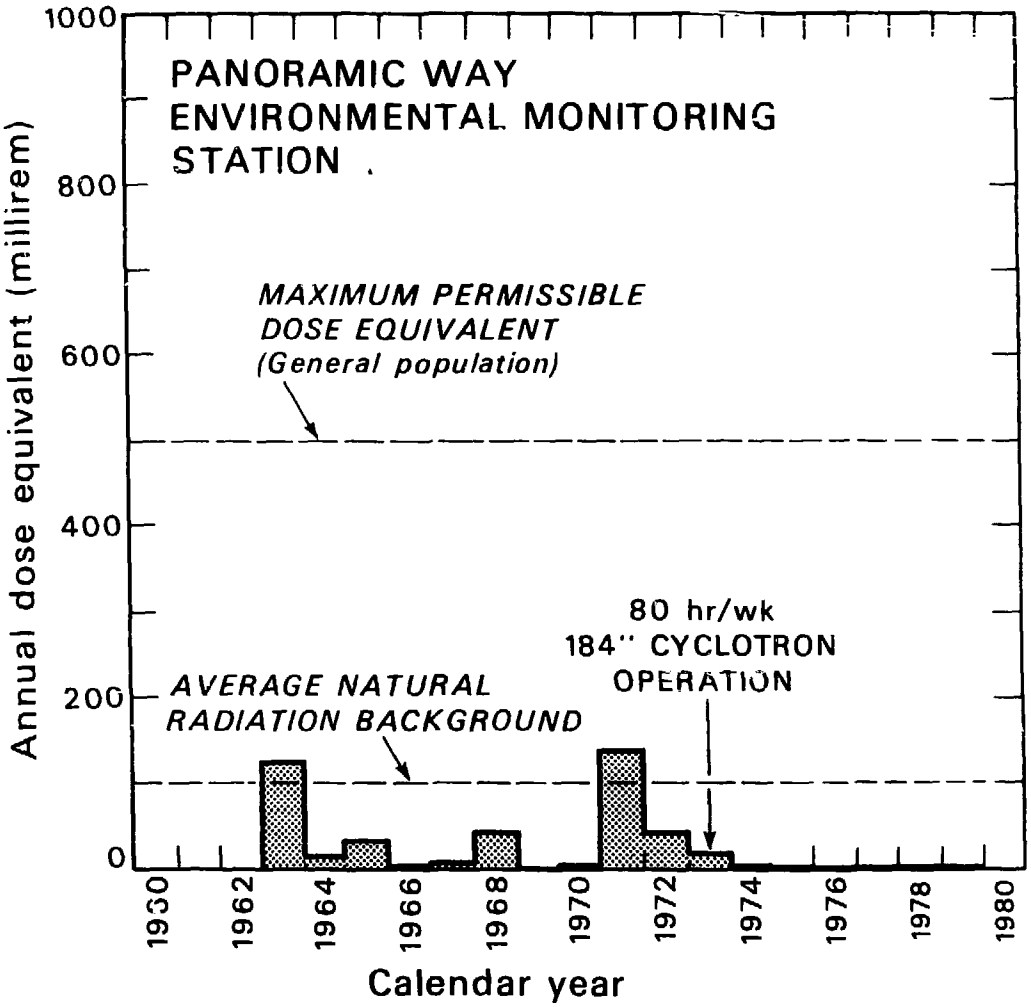
XBL 753-4768 C

Fig. 2.



XBL 753-4767 C

Fig. 3.



XBL 753-4769 C

Fig. 4.

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4. United States Energy Research and Development Administration Manual, Chapter 0524 -- Standards for Radiation Protection.

5. Op. Cit., Ref. 1, Section 4.2.3.

6. Op. Cit., Ref. 1, Section 4.3.4.