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Seventeenth Annual Report

Radiation Exposures For DOE and DOE Contractor Employees - 1984

December 1985

Prepared for:
U. S. Department of Energy
Assistant Secretary for
Environment, Safety and Health
Office of Nuclear Safety
Washington, D. C. 20545

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Under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington, 99352

SEVENTEENTH ANNUAL REPORT
RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES
1984

PREFACE

This report is one of a series of annual reports provided by the U.S. Department of Energy (DOE) summarizing occupational radiation exposures received by DOE and DOE contractor employees. These reports provide an overview of radiation exposures received each year as well as identification of trends in exposures being experienced over the years.

In 1968, the U.S. Atomic Energy Commission (AEC) established a program for reporting certain occupational radiation exposure information to a central radiation records repository. At the same time, a contract was established with Union Carbide Corporation at Oak Ridge, Tennessee, to computerize the processing of the radiation exposure reporting system. Annual summary reports were published from 1969 through 1973 (WASH-1350-R1 through WASH-1350-R6), and included information on AEC contractor employees and visitors, as well as employees and visitors of companies in the private sector licensed by the AEC.

In January 1975, with the separation of the AEC into the Energy Research and Development Agency (ERDA) and the U.S. Nuclear Regulatory Commission (NRC), each agency assumed responsibility for collecting and maintaining occupational exposure information reported by the facilities under its jurisdiction. Former AEC licensees reported to the NRC while contractors reported to ERDA. At the same time, a contract was established with Union Carbide Corporation at Oak Ridge, Tennessee, to computerize the reporting and processing of both the ERDA and NRC radiation exposure reporting systems. On October 1, 1977, DOE was formed and assumed the responsibilities of ERDA. Processing and programming of exposure information continued at Oak Ridge until October 1978, when the management and further development of the DOE radiation exposure reporting system was assigned to the System Safety Development Center, EG&G Idaho, Inc.; the NRC system remained at Oak Ridge.

Radiation exposure data for ERDA and ERDA contractor employees and visitors for 1974 through 1976 were reported in ERDA 76/119, ERDA 77-29, and DOE/EV-0011/9. The DOE and DOE contractor radiation exposure data for 1977-1979 were presented in DOE/EV-0066/10, 11, and 12, respectively. The data for 1980-1982 were presented in DOE/EP-0040, DOE/EP-0040/1, and DOE/EP-0040/2. The data for 1983 were presented in DOE/PE-0072. A revised version of the 1979 report was issued as DOE/EP-0039. This report contains 1984 radiation exposure data for DOE and DOE contractor employees and visitors.

Previous reports for AEC/ERDA/DOE government and contractor employees and visitors may be obtained from the U.S. DOE Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

SUMMARY

All Department of Energy (DOE) and DOE contractors are required by DOE Order 5484.1, Chapter IV, to submit occupational exposure records to a central repository. The data required include a summary of whole-body exposures to ionizing radiation, a summary of internal depositions of radioactive materials above specified limits, and occupational exposure reports for terminating employees. This report is a summary of the data submitted by DOE and DOE contractors for 1984.

A total of 89,526 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposures in 1984. This represents 53.9% of all DOE and DOE contractor employees and is an increase (1,243) from the number of employees monitored in 1983. In addition to the employees, 88,214 visitors were monitored.

Of all employees monitored, 52.8% received a dose equivalent that was less than measurable, 45.4% a measurable exposure less than 1 rem, and 1.8% an exposure greater than 1 rem. The exposure received by 93.4% of the visitors to DOE facilities was less than measurable. Only 6.6% of the visitors received a measurable exposure less than 1 rem, and 0.01% of the visitors received an exposure greater than 1 rem. No employees or visitors received a dose equivalent greater than 5 rem.

The collective dose equivalent for DOE and DOE contractor employees was 7,926 person-rem. The collective dose equivalent for visitors was 352 person-rem. The total dose equivalent for employees and visitors combined was 8,278 person-rem. The average dose equivalent for all individuals (employees and visitors) monitored was 47 mrem, and the average dose equivalent for all individuals who received a measurable exposure was 172 mrem. The highest average dose equivalent for all monitored individuals was observed at fuel fabrication facilities (258 mrem), and the lowest was observed for visitors (4 mrem) to DOE facilities. These averages are significantly less than the DOE 5-rem/year radiation protection standard for whole-body exposures.

One new case of internal deposition was reported in 1984. The deposition was less than 50 percent of the annual dose-equivalent standard. The internal deposition was the result of an accidental, not planned, exposure. Six other cases reported during 1984 were considered to be the continued tracking of previous depositions.

A total of 8,234 monitored employees terminated their employment in 1984. The average cumulative dose equivalent for terminated employees who worked one to two years was 0.17 rem; two to four years, 0.36 rem; four to six years, 0.34 rem; and longer than six years, 3.45 rem. The average cumulative dose equivalent for employees who terminated with more than six years of employment appears high in comparison with the other data. However, this average includes the cumulative exposure of individuals who worked for DOE or DOE contractors for over 20 years.

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INTRODUCTION

One of the basic Department of Energy (DOE) radiation protection policy objectives is that radiation exposures be maintained as low as is reasonably achievable (ALARA) and within the occupational exposure guidelines provided in DOE Order 5480.1, Chapter XI (Table 1). Assurance that occupational exposures do not exceed the guidelines is not considered, in itself, sufficient. All operations are to be conducted "in a manner to assure that radiation exposures to individuals and population groups are limited to the lowest levels technically and economically feasible."

TABLE 1. Radiation Protection Standards for External and Internal Dose Equivalents for Individuals in Controlled Areas

Type of Exposure	Exposure Period	Dose Equivalent (Dose or Dose Commitment)(rem)[a]
Whole body, head and trunk, gonads, lens of the eye,[c] red bone marrow, active blood-forming organs	Year	5[b]
	Calendar quarter	3
Unlimited areas of the skin (except hands and forearms), other organs, tissues, and organ systems (except bone)	Year	15
	Calendar quarter	5
Bone	Year	30
	Calendar quarter	10
Forearms[d]	Year	30
	Calendar quarter	10
Hands[d] and feet	Year	75
	Calendar quarter	25

(a) To meet the dose commitment standards above, operations must be conducted in such a manner that it would be unlikely that an individual would assimilate in a critical organ, by inhalation, ingestion, or absorption, a quantity of radionuclide(s) that would commit the individual to an organ dose that exceeds the limits specified in this table.

(b) In special cases with the approval of the Deputy Assistant Secretary for Safety, Health, and Quality Assurance, a worker may exceed 5 rem/year provided his/her average exposure per year since age 18 will not exceed 5 rem/year.

(c) A beta exposure below a maximum energy of 700 keV will not penetrate the lens of the eye; therefore, the applicable limit for these energies would be that for the skin (15 rem/year).

(d) All reasonable effort shall be made to keep exposure of forearms and hands to the general limit for the skin.

To assist in the determination that exposures to individuals are maintained at the lowest level reasonably achievable, DOE requires the submittal of occupational radiation exposure records to a central repository. The data required include a summary of whole-body exposures to ionizing radiation, a summary of internal depositions of radioactive materials, and occupational exposure reports for terminating employees. The central data base also includes occupational radiation exposure information for the Atomic Energy Commission (AEC) and the Energy Research and Development Agency (ERDA).

This report includes a summary of the data submitted for 1984 by DOE and DOE contractor facilities. Data from previous years are also included so that trends can be analyzed. Appendices A, B, and C present whole-body exposure data for 1984.

SUMMARY OF WHOLE-BODY IONIZING RADIATION EXPOSURES

Monitoring is required by DOE Order 5480.1, Chapter XI, where the potential exists for an individual to receive a dose or dose commitment in any calendar quarter in excess of 10 percent of the quarterly or annual occupational exposure guidelines shown in Table 1. Depending on the administrative policy of the contractor, monitoring may also be provided to individuals, such as clerical workers, for whom the exposure potential is extremely low.

The number of individuals who received an occupational whole-body exposure in one of 16 dose-equivalent intervals ranging from "less than measurable" to "greater than 10 rem" is provided annually by each DOE and DOE contractor facility. A positive, measurable exposure is any recorded exposure greater than the minimum sensitivity of a personnel monitoring device. The data are further subdivided into one of 10 facility types.

Contractors have the option of reporting the distribution of whole-body occupational dose equivalents only for those individuals for whom monitoring is required as defined by DOE Order 5480.1, Chapter XI, or for all those for whom monitoring is provided. Many contractors choose to report the latter, thus increasing the number of individuals who are considered to be radiation workers. To account for this effect, the average dose equivalent per individual receiving a measurable exposure is calculated as well as the average dose equivalent per individual monitored.

The annual collective dose equivalent is expressed in units of person-rem and is calculated by multiplying the number of individuals in each dose range by the numerical midpoint of the range, and then summing the products. This procedure allows an estimate of the collective dose equivalent to be calculated without knowledge of each individual's annual dose. However, a source of error is introduced into the calculation by the assumption that the midpoint of the dose-equivalent range is the mean dose equivalent of the individuals reported in each dose-equivalent range. Frequently, the actual mean dose equivalent in each range is less than the assumed arithmetic mean. Thus, collective dose equivalents presented in this report may be slightly higher than the actual collective dose equivalents.

DISTRIBUTION BY DOSE INTERVAL

The number of employees and visitors who received a dose equivalent in each of 16 dose-equivalent ranges is presented in Table 2. There were no DOE employees or visitors who received a dose equivalent greater than the DOE radiation protection standard of 5 rem. A total of 89,526 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposure in 1984. This represents 53.9 percent of all DOE and DOE contractor employees. In addition to the employees, 88,214 visitors were monitored at DOE facilities. Visitors may include radiation workers from another DOE facility present on an interim basis.

TABLE 2. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees and Visitors by Dose-Equivalent Interval, 1984

Dose-Equivalent Interval (rem)	Number of Persons			Collective Person-rem		
	Employees	Visitors	Total	Employees	Visitors	Total
<Measurable	47,275	82,365	129,640	0	0	0
Measurable to 0.10	30,056	5,540	35,596	1,503	277	1,780
0.10 to 0.25	5,273	245	5,518	923	43	966
0.25 to 0.50	3,215	50	3,265	1,206	19	1,225
0.50 to 0.75	1,373	7	1,380	858	4	862
0.75 to 1.00	754	2	756	660	2	662
1 to 2	1,226	5	1,231	1,839	7	1,846
2 to 3	312	0	312	780	0	780
3 to 4	31	0	31	108	0	108
4 to 5	11	0	11	49	0	49
5 to 6	0	0	0	0	0	0
6 to 7	0	0	0	0	0	0
7 to 8	0	0	0	0	0	0
8 to 9	0	0	0	0	0	0
9 to 10	0	0	0	0	0	0
>10	0	0	0	0	0	0
TOTAL	89,526	88,214	177,740	7,926	352	8,278

A comparison of DOE and DOE contractor employees, the number of employees monitored and the number of employees who did not receive a measurable dose equivalent in the last seven years is presented in Figure 1. The number of employees monitored in 1984 increased slightly from the number reported in previous years (Figure 1).

Of the employees monitored in 1984, 52.8 percent received a dose equivalent that was less than measurable, 45.4 percent a measurable dose equivalent less than 1 rem, and 1.8 percent a dose equivalent greater than 1 rem (Figure 2). The dose equivalent received by 93.4 percent of the visitors to DOE facilities was less than measurable. Only 6.6 percent of the visitors received a dose equivalent between measurable and 1 rem, and <0.01 percent of the visitors received a dose equivalent greater than 1 rem (Figure 2).

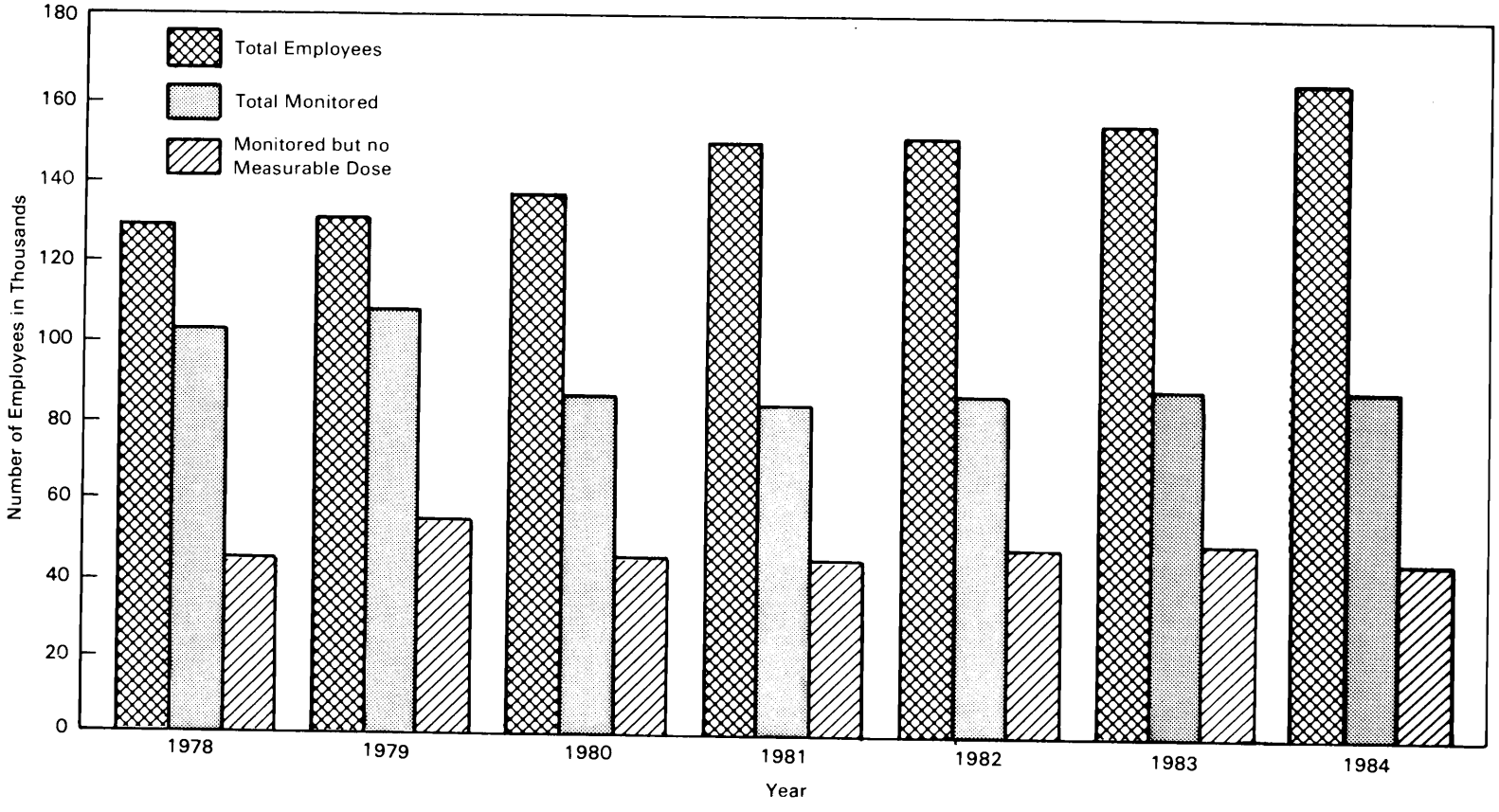

FIGURE 1. Comparison of Number of Employees, Number of Employees Monitored, and Number of Employees Monitored Who Received No Measurable Dose Equivalent

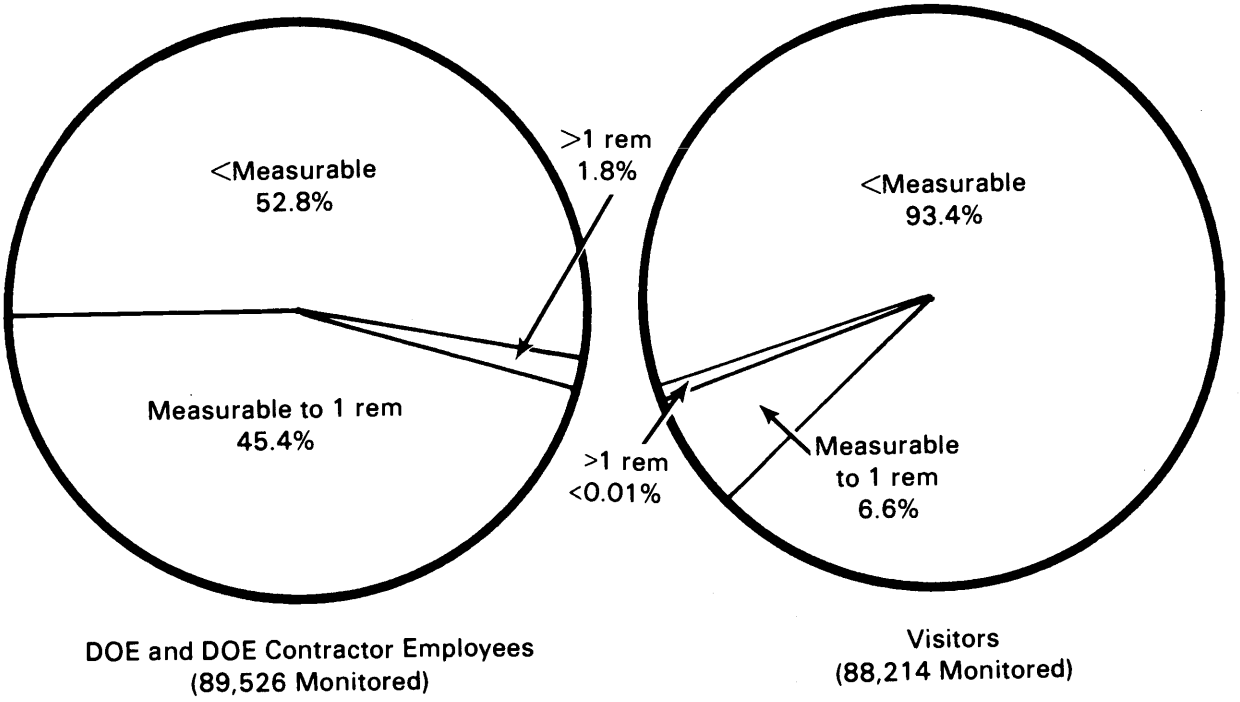

FIGURE 2. Percentage of Monitored Employees and Percentage of Monitored Visitors Who Received an Exposure Less Than Measurable, Measurable to 1 rem, or Greater Than 1 rem, 1984

The collective dose equivalent was 7,926 person-rem for all DOE and DOE contractor employees, and 352 person-rem for visitors to DOE facilities, for a total collective dose equivalent of 8,278 person-rem. The contribution of the individuals in each dose-equivalent interval to the collective dose equivalent is shown in Figure 3. Individuals whose exposure was less than 1 rem contributed the greatest portion of the total person-rem.

The distribution of whole-body exposures for the years 1965-1984 is presented in Table 3. As can be observed in Table 3, the number of employees who received a dose equivalent greater than 1 rem has gradually declined since 1965. This same downward trend in the occupational exposures can be observed in Figure 4, which shows the collective dose equivalent for all individuals from 1965 to 1984 who received an exposure greater than 1 rem. The collective dose equivalent for individuals who received an exposure less than 1 rem was not included because before 1974, a less-than-measurable exposure was not distinguished from measurable exposures in the reporting system. This decrease in the collective dose equivalent has been achieved even though some work was performed in older facilities which were not constructed using current design criteria. This trend reflects both changes in the nature of the work performed at DOE facilities and the consistent application of ALARA practices throughout all DOE operations.

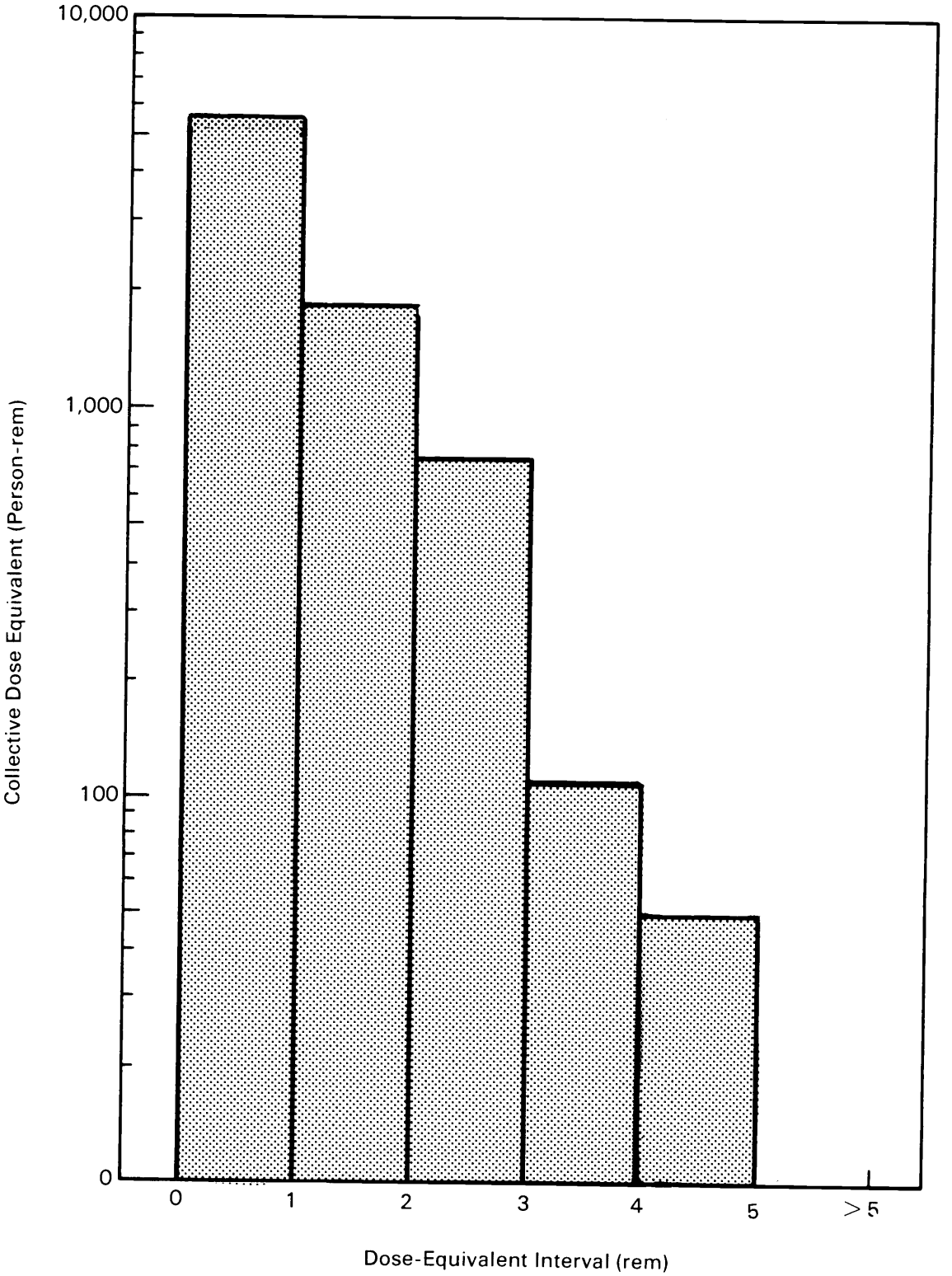

FIGURE 3. Contribution of Each Dose-Equivalent Interval to the Total Collective Dose Equivalent, 1984

TABLE 3. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees, 1965-1984

Year	Number of Employees Receiving Exposures in Each Dose-Equivalent Range (rem)														Total Monitored
	0-1[a] <Meas.	0-1[a] Meas.-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	>12	
1965	128,360		4,158	1,704	515	294	70	32	26	25	22	6	2		135,214
1966	131,522		3,706	1,630	593	313	88	47	24	6	2			1	137,932
1967	102,510		3,472	1,572	555	168	35	29	23	17	4	1			108,386
1968	103,206		2,799	1,408	425	144	3	1							107,986
1969	98,625		2,554	1,313	335	86	4					1			102,918
1970	92,185		2,698	1,329	279	158	5	4	2		1				96,661
1971	90,640		2,380	888	275	118	8	3				1		2	94,315
1972	86,077		2,130	929	219	95	8	2							89,460
1973	89,071		1,944	727	172	60	2	1							91,977
1974	43,184	32,500	1,667	688	149	40	4								78,232
1975	43,310	42,141	1,846	753	232	142				1					88,425
1976	40,083	47,886	1,679	475	70	6	1								90,200
1977	43,017	49,948	1,579	545	103	23			1	2				2	95,220
1978	44,898	55,296	1,323	439	53	11									102,020
1979[b]	50,003	53,235	1,286	416	33	10	1							2	104,986
1980	45,054	38,895	1,113	387	16										85,465
1981[b]	45,224	36,561	967	263	29	5									83,049
1982	48,968	34,949	1,010	313	56	28									85,324
1983	49,871	36,768	1,270	294	49	31									88,283
1984	47,275	40,671	1,226	312	31	11									89,526

(a)Separation of data before 1974 is unavailable.
(b)Data differ slightly from those listed in previous reports because of errors reported by individual contractors after publication of the annual report.

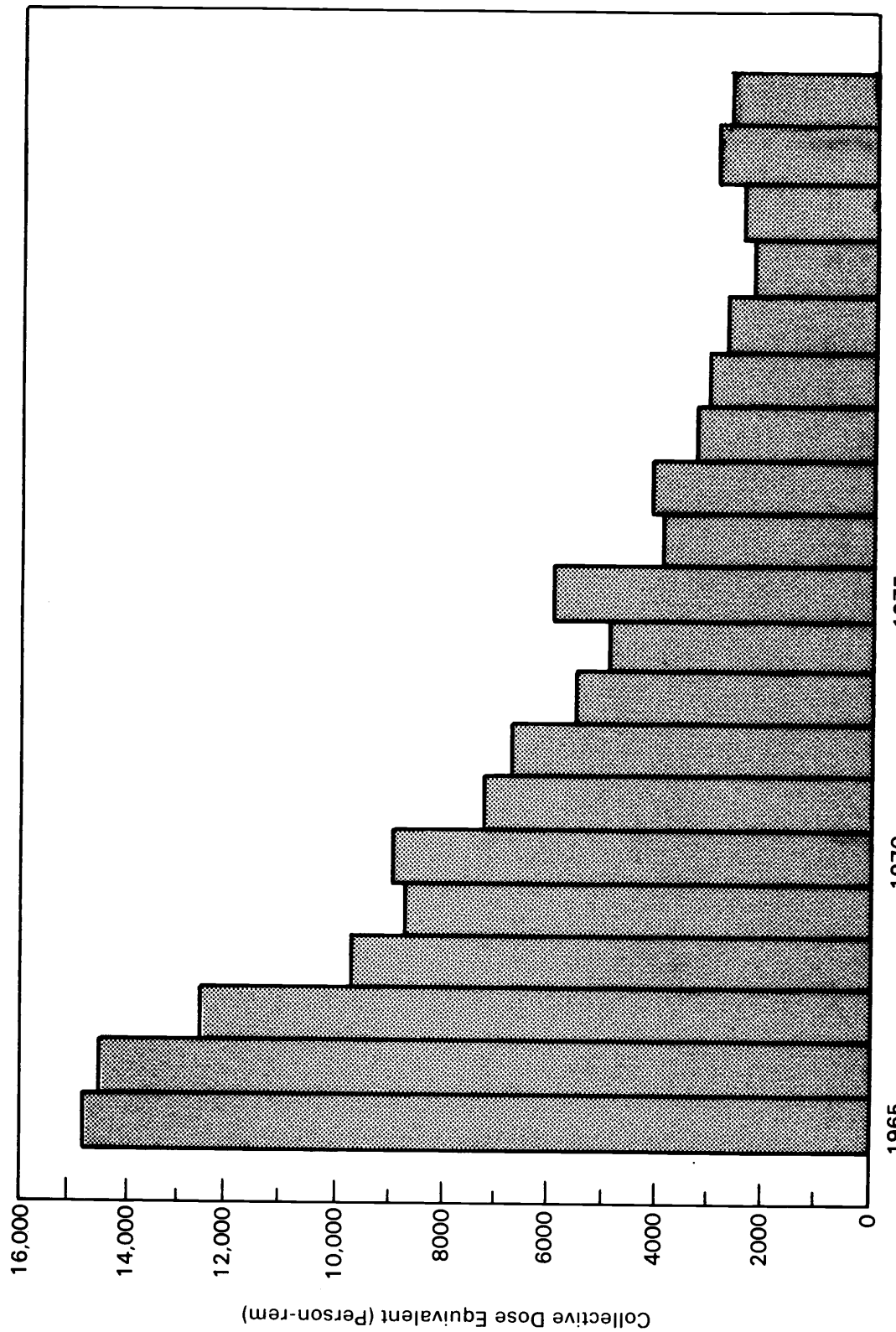

FIGURE 4. Total Collective Dose Equivalent for All DOE/DOE Contractor Employees Who Received an Exposure Greater Than 1 rem, 1965-1984

DISTRIBUTION BY FACILITY TYPE

The number of individuals and the distribution of the annual whole-body exposures in each of 10 facility categories were reported to the central repository. The assignment of exposures to a given facility type is a policy decision of each field organization. For this report, visitors were considered a facility type. The contribution of each facility type to the collective dose equivalent is shown in Figure 5. The largest percentage of the total collective dose equivalent was in the category "Other." Examples of facilities included in the "Other" category are radioactive waste handling and construction. The smallest contribution was from DOE Offices. A summary of the data is presented in Table 4.

The average dose equivalent by facility type per individual monitored and per individual monitored with measurable exposure is shown in Table 5. The average dose equivalent per individual monitored for all facilities combined was 47 mrem. The highest average dose equivalent per individual monitored was observed at fuel fabrication facilities (258 mrem), and the lowest was observed for visitors to DOE facilities (4 mrem). The average dose equivalent per individual monitored with a measurable exposure was 172 mrem. The highest average dose equivalent for individuals monitored with a measurable exposure was observed at reactor facilities (323 mrem), and the lowest was observed for visitors (60 mrem).

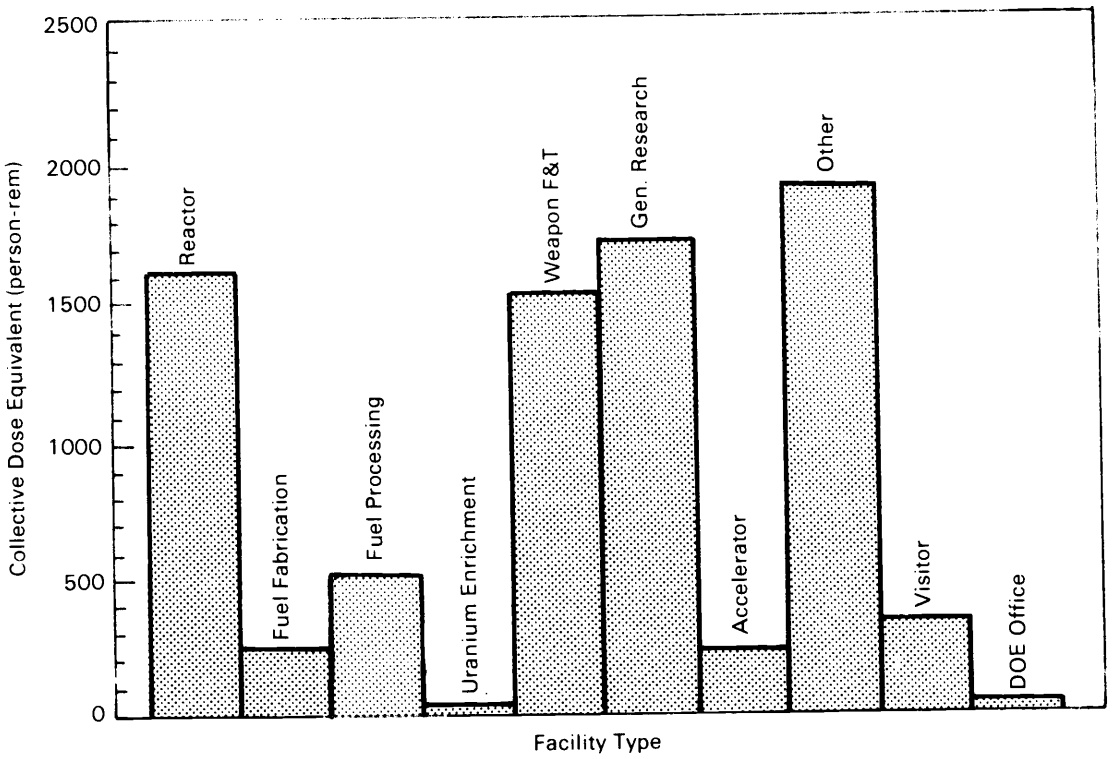

FIGURE 5. Contribution of Each Facility Type to the Total Collective Dose Equivalent, 1984

TABLE 4. Distribution of Annual Whole-Body Exposures for DOE/DOE Contractor Employees and Visitors by Facility Type, 1984(a)

Facility Type	Total Persons Monitored	Number of Persons Receiving Exposures in Each Dose-Equivalent Range (rem)																	Total Person-rem
		<Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	10-11	11-12	>12	
Reactor	7,385	2,372	2,990	693	477	214	143	329	167											1,620
Fuel Fabrication	1,021	87	223	273	306	106	24	2												264
Fuel Processing	2,832	1,083	832	332	260	140	81	101	3											515
Uran. Enrichment	1,241	895	285	49	11	1														28
Weapon F&T	19,899	10,558	6,945	1,052	607	285	166	254	31	1										1,544
Gen. Research	30,984	19,685	8,925	1,166	533	219	130	225	67	23	11									1,736
Accelerator	3,875	2,609	872	170	96	51	29	40	7	1										248
Other	20,483	8,634	8,552	1,524	920	355	181	274	37	6										1,944
Visitors	88,214	82,365	5,540	245	50	7	2	5												352
DOE Offices	1,806	1,352	432	14	5	2		1												29
TOTAL PERSONS	177,740	129,640	35,596	5,518	3,265	1,380	756	1,231	312	31	11									
TOTAL PERSON-REM			1,780	966	1,224	863	662	1,846	780	108	49									8,278

(a) Throughout this report there may be minor variations in collective dose-equivalent values because of rounding.

TABLE 5. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Facility Type, 1984

Facility Type	No. Individuals Monitored	No. Individuals With Measurable Exposure	Collective Dose Equivalent (Person-rem)	Average Dose Equivalent (mrem) Per Individual Monitored	Average Dose Equivalent (mrem) Per Individual Monitored With Measurable Exposure
Reactor	7,385	5,013	1,620	219	323
Fuel Fabrication	1,021	934	264	258	283
Fuel Processing	2,832	1,749	515	182	294
Uran. Enrichment	1,241	346	28	22	80
Weapon F&T	19,899	9,341	1,544	78	165
Gen. Research	30,984	11,299	1,736	56	154
Accelerator	3,875	1,266	248	64	196
Other	20,483	11,849	1,944	95	164
Visitors	88,214	5,849	352	4	60
DOE Offices	1,806	454	29	16	63
TOTAL	177,740	48,100	8,278	47	172

DISTRIBUTION BY FIELD ORGANIZATION

For each field organization, the number of employees monitored and the collective dose equivalent are shown in Table 6. Differences in the collective dose equivalent at each field organization reflect differences in the nature of the work performed and the administrative policy concerning whether the dose distribution is reported for all employees or only for those for whom monitoring is required. Table 7 provides an indication of the work done at each field organization by showing the fraction of the collective dose equivalent at each field organization attributed to each facility type. Trends in collective dose equivalent from 1977 to 1984 for each field organization are shown in Table 8.

TABLE 6. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1984

Field Organization	No. Individuals Monitored	No. Individuals With Measurable Exposure	Collective Dose Equivalent (Person-rem)	Average Dose Equivalent (mrem) Per Individual Monitored	Average Dose Equivalent (mrem) Per Individual Monitored With Measurable Exposure
Albuquerque	28,539	17,595	2,593	91	147
Chicago	17,296	4,249	615	36	145
Idaho	40,675	1,893	441	11	233
Nevada	25,151	228	24	1	104
Oak Ridge	4,972	1,869	419	84	224
Pittsburgh Naval Reactor	2,648	2,202	180	68	82
Richland	12,253	8,573	2,399	196	280
San Francisco	26,382	1,810	195	7	108
Savannah River	17,315	8,005	1,283	74	160
Schenectady Naval Reactor	2,501	1,676	130	52	78
TOTAL(a)	177,740	48,100	8,278	47	172

(a) Energy Technology Centers report 8 persons were monitored with no measurable exposure; included in total individuals monitored.

TABLE 7. Fraction of Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors Attributed to a Facility Type Within Each Field Organization, 1984

Field Organization	Facility Type									
	Reactor	Fuel Fab.	Fuel Proc.	Uran. Enrich.	Weapon F&T	Gen. Research	Acceler.	Other	Visitor	DOE Office
Albuquerque					0.56	0.36		<0.01	0.07	0.01
Chicago	0.09					0.22	0.39	0.18	0.11	
Idaho	0.33		0.46					0.21		<0.01
Nevada					0.66			0.01	0.33	<0.01
Oak Ridge		0.30		0.07	0.15	0.37		0.10	0.02	
Pittsburgh Naval Reactor	0.27					0.69		0.01	0.02	0.01
Richland	0.49	0.03				0.08		0.39	0.01	<0.01
San Francisco					0.01	0.57	0.03	0.29	0.09	<0.01
Savannah River	0.08	0.06	0.24		0.01	0.04		0.54	0.03	<0.01
Schenectady Naval Reactor	0.75					0.21	<0.01	0.02	0.01	
ALL FIELD ORGANIZATIONS COMBINED	0.20	0.03	0.06	<0.01	0.19	0.21	0.03	0.23	0.04	<0.01

TABLE 8. Collective Dose Equivalent (person-rem) for DOE/DOE Contractor Employees and Visitors by Field Organization, 1978-1984

Field Organization	1978	1979(a)	1980	1981(a)	1982	1983	1984
Albuquerque	2,399	1,873	1,700	2,024	2,285	2,332	2,593
Chicago	1,167	1,061	918	758	587	623	615
Idaho	899	876	593	302	363	353	441
Nevada	47	55	50	36	29	25	24
Oak Ridge	1,566	1,332	604	437	401	371	419
Pittsburgh Naval Reactor	252	196	186	185	194	220	180
Richland	2,596	2,571	2,256	2,093	2,272	2,458	2,399
San Francisco	307	264	240	171	289	267	195
Savannah River	1,289	1,343	1,391	1,401	1,310	1,293	1,283
Schenectady Naval Reactor	111	114	79	76	147	217	130
TOTAL	10,635	9,693	8,024	7,483	7,879	8,158	8,278

(a)The data differ slightly from those listed in previous reports because of errors reported by contractors after publication of the annual report.

SUMMARY OF INTERNAL EXPOSURES

Internal body depositions of radioactive material result from accidental, not planned, exposures. A report of internal body deposition of radioactive materials is required when:

1. any uptake of radioactive material occurred during the reporting year that either independently or when added to a current burden was estimated to result in a dose commitment to the ciritical organ in excess of 50 percent of the pertinent annual dose-equivalent standard set forth in DOE Order 5484.1, Chapter XI; or when

2. any previously unreported uptake of radioactive material was determined to have been reportable according to the above criteria by reason of the most recent dose-equivalent estimates.

Table 9 gives a five-year comparison of new cases of internal body depositions. Only those cases occurring within each year are included. Cases where the effects of prior years' depositions are continuing or where a new uptake is not clearly identified are not included.

TABLE 9. Dose Distributions for Cases of Internal Body Depositions, 1980-1984

Year	Radionuclide	Critical Organ	Dose-Equivalent Interval (rem) 7.5-10	10-15	15-25	25-50	50-100	100-200
1980	^{238}Pu	Bone			3(a)	1(b)		
	^{234}U, ^{235}U, ^{238}U	Lung	1					
1981	^{238}Pu, ^{239}Pu, ^{240}Pu	Bone		1	1			
		Lung	1					
	^{234}U, ^{235}U, ^{238}U	Lung	3					
1982	^{238}Pu	Bone			1(a)	1(a)		
	^{238}Pu, ^{239}Pu, ^{240}Pu	Bone						1
		Liver	1					
1983	^{239}Pu, ^{240}Pu, ^{241}Am	Bone			1			
	^{234}U, ^{235}U	Lung	4					
1984	None							

(a) These previously unreported individuals exceeded 50 percent of the annual standard during 1980 as a result of chronic buildup caused by translocation from the lungs from prior years' exposure. No acute exposure is known to have occurred.

(b) One individual exceeded 100 percent of the annual standard in 1980 for unknown reasons. This individual received a Type B plutonium lung exposure as a result of an incident in 1971, and has been excluded from work with plutonium since that time. Since the systemic burden was less than half the standard in 1978, this new information was also reported. This individual's case is being closely followed to see if some mechanism for the increase in systemic burden can be determined.

Of 7 reported internal depositions for 1984, none are included in Table 9. The seven reported are not included for the following reasons: in three cases, the current burden has decreased from the measured level of previous years; in three other cases, the current burden has increased slightly. These six instances are judged as continued tracking of a previous uptake. In the one other case, the reported burden was not in excess of 50 percent of the pertinent annual dose-equivalent standard.

SUMMARY OF WORKER TERMINATIONS

A total of 8,234 monitored workers terminated their employment with DOE or DOE contractors in 1984. Table 10 gives the length of employment as well as the average cumulative dose equivalent for the workers in each time interval. These data indicate that the average cumulative dose equivalent for workers terminating in 1984 after 1 to 365 days of employment was significantly less than the 5 rem/year radiation protection standard for the whole body.

The average cumulative dose equivalent for workers who terminated after more than six years of employment was 3.45 rem. This average appears high in comparison with the average cumulative dose equivalent for employees who terminated with less than six years of employment. However, this average includes the cumulative exposure of individuals who worked for DOE or DOE contractors for more than 20 years.

TABLE 10. Average Cumulative Dose Equivalent for Individuals Terminating in 1984

Length of Employment	Number of Terminated Employees	Total Cumulative Dose Equivalent (Person-rem)	Average Cumulative Dose Equivalent Per Terminated Employee (rem)
1-90 days	1,952	847.60	0.43
90-180 days	760	370.60	0.49
180-365 days	852	369.35	0.43
1-2 years	888	147.66	0.17
2-4 years	1,050	376.39	0.36
4-6 years	520	175.11	0.34
>6 years	2,212	7,642.23	3.45

APPENDIX A

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE FOR EACH DOE FIELD ORGANIZATION, 1984

TABLE A.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
ALBUQUERQUE FIELD ORGANIZATION
1984

Facility Type	Total Monitored	< Meas.	Dose-Equivalent Ranges (rem) Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	9,642	908	6,610	873	545	258	163	253	31	1								1,452
Gen. Research	10,816	5,704	4,106	456	198	68	49	143	61	20	11							931
Accelerator																		
Other	305	120	185															9
Visitors	7,127	3,766	3,251	97	12			1										186
DOE Offices	649	446	187	8	5	2		1										15
TOTAL	28,539	10,944	14,339	1,434	760	328	212	398	92	21	11							
TOTAL PERSON-REM			717	251	285	205	186	597	230	73	49							2,593

TABLE A.2
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
CHICAGO FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	475	197	159	55	34	16	6	8										58
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	3,105	2,245	622	115	56	26	21	20										137
Accelerator	3,657	2,417	854	166	96	49	28	39	7	1								242
Other	2,114	1,004	1,034	23	34	3		4	6	6								112
Visitors	7,911	7,152	636	90	23	5	2	3										66
DOE Offices	34	32	2															
TOTAL	17,296	13,047	3,307	449	243	99	57	74	13	7								
TOTAL PERSON-REM			165	79	91	62	50	111	33	24								615

TABLE A.3
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
IDAHO FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	2,259	1,537	394	156	113	23	22	14										144
Fuel Fabrication																		
Fuel Processing	1,637	895	387	151	94	34	28	45	3									202
Uran. Enrichment																		
Weapon F&T																		
Gen. Research																		
Accelerator																		
Other	1,012	623	251	41	33	30	21	9	4									93
Visitors	35,610	35,610																
DOE Offices	157	117	40															2
TOTAL	40,675	38,782	1,072	348	240	87	71	68	7									
TOTAL PERSON-REM			54	61	90	54	62	102	18									441

TABLE A.4
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
NEVADA FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- ≤0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	9,447	9,310	99	23	11	4												16
Gen. Research																		
Accelerator																		
Other	486	483	3															
Visitors	14,747	14,661	66	15	5													8
DOE Offices	471	469	2															
TOTAL	25,151	24,923	170	38	16	4												
TOTAL PERSON-REM			8	7	6	3												24

TABLE A.5
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
OAK RIDGE FIELD ORGANIZATION
1984

Facility Type	Total Monitored	< Meas.	Dose-Equivalent Ranges (rem) Meas.-≤0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication	420	15	69	122	150	50	14											125
Fuel Processing																		
Uran. Enrichment	1,241	895	285	49	11	1												28
Weapon F&T	418	112	98	138	44	22	3	1										63
Gen. Research	629	134	183	117	93	54	23	24	1									157
Accelerator																		
Other	1,713	1,431	168	78	31	2	1	1	1									40
Visitors	551	516	19	11	2	2		1										6
DOE Offices																		
TOTAL	4,972	3,103	822	515	331	131	41	27	2									
TOTAL PERSON-REM			41	90	124	82	36	41	5									419

TABLE A.6
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1984

Facility Type	Total Monitored	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
	Dose-Equivalent Ranges (rem)																	
Reactor	853	78	705	63	7													49
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,495	208	1,021	181	61	14	9	1										124
Accelerator																		
Other	33	15	18															1
Visitors	214	129	85															4
DOE Offices	53	16	35	2														2
TOTAL	2,648	446	1,864	246	68	14	9	1										
TOTAL PERSON-REM			93	43	26	9	8	1										180

TABLE A.7
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
RICHLAND FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	2,032	324	636	196	179	121	106	303	167									1,174
Fuel Fabrication	268	30	87	58	55	29	7	2										62
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	2,199	632	1,264	162	70	26	16	24	4	1								198
Accelerator																		
Other	5,731	1,190	3,047	610	424	160	87	187	26									940
Visitors	1,884	1,461	423															21
DOE Offices	139	43	94	2														5
TOTAL	12,253	3,680	5,551	1,028	728	336	216	516	197	1								
TOTAL PERSON-REM			278	180	273	210	189	774	493	3								2,400

TABLE A.8
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SAN FRANCISCO FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- ≤0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor																		
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T	119	105	6	4	4													3
Gen. Research	10,752	9,694	907	81	32	21	6	8	1	2								111
Accelerator	218	192	18	4		2	1	1										5
Other	848	432	356	19	14	5	8	14										58
Visitors	14,372	14,079	272	16	5													18
DOE Offices	73	70	3															
TOTAL	26,382	24,572	1,562	124	55	28	15	23	1	2								
TOTAL PERSON-REM			78	22	21	18	13	34	2	7								195

TABLE A.9
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SAVANNAH RIVER FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	540	77	199	128	94	33	7	2										97
Fuel Fabrication	333	42	67	93	101	27	3											77
Fuel Processing	1,195	188	445	181	166	106	53	56										313
Uran. Enrichment																		
Weapon F&T	273	123	132	14	3	1												11
Irrad. Facility																		
Gen. Research	972	579	306	43	23	10	6	5										50
Accelerator																		
Other	8,214	3,321	3,478	753	384	155	64	59										691
Visitors	5,581	4,826	736	16	3													41
DOE Offices	207	154	52	1														3
TOTAL	17,315	9,310	5,415	1,229	774	332	133	122										
TOTAL PERSON-REM			271	215	290	208	116	183										1,283

TABLE A.10
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SCHENECTADY NAVAL REACTOR FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Facility Type	Total Monitored	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Reactor	1,226	159	897	95	50	21	2	2										98
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,008	481	516	11														28
Accelerator																		
Other	27	15	12															1
Visitors	217	165	52															3
DOE Offices	23	5	17	1														1
TOTAL	2,501	825	1,494	107	50	21	2	2										
TOTAL PERSON-REM			75	19	19	13	2	3										131

APPENDIX B

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR FOR EACH DOE FIELD ORGANIZATION, 1984

TABLE B.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Albuquerque Misc.																	
Employees		1,846	57	8	3												107
Visitors																	
Total		1,846	57	8	3												107
Chem-Nuclear Systems																	
Employees	11	34															2
Visitors																	
Total	11	34															2
General Electric Co.																	
Employees	261	113	10	3													9
Visitors	23																
Total	284	113	10	3													9
Inhalation Toxicology																	
Employees	300	62	5	1													4
Visitors	300																
Total	600	62	5	1													4
Jacobs Engineering																	
Employees	21	7															
Visitors																	
Total	21	7															
Mason & Hanger-Silas (Amarillo, TX)																	
Employees	436	311	163	78	32	23	24	1									152
Visitors	655	48															2
Total	1,091	359	163	78	32	23	24	1									154
Mason & Hanger-Silas (Los Alamos, NM)																	
Employees	199	128	1														7
Visitors																	
Total	199	128	1														7

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Morrison-Knudsen Co.																	
Employees	4	12															1
Visitors																	
Total	4	12															1
Morrison-Knudsen UMTRA Subcontractors																	
Employees	71	64															3
Visitors																	
Total	71	64															3
Rockwell International																	
Employees		4,326	642	456	223	140	229	30									1,180
Visitors		2,499	23	1													129
Total		6,825	665	457	223	140	229	30									1,309
Ross Aviation, Inc.																	
Employees	8	64															3
Visitors																	
Total	8	64															3
Roy F. Weston, Inc.																	
Employees	5	4															
Visitors																	
Total	5	4															
Sandia Laboratories (Albuquerque, NM)																	
Employees	2,354	363	38	11	8	5	3	2	2								55
Visitors	1,889	271	18	2			1										19
Total	4,243	634	56	13	8	5	4	2	2								74

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Sandia Laboratories (Livermore, CA)																	
Employees	507	37	2														2
Visitors	92	2															
Total	599	39	2														2
The Bendix Corp.																	
Employees	211	14	1						1								4
Visitors																	
Total	211	14	1						1								4
The Zia Company																	
Employees	631	943	59	36	9	7	5										90
Visitors																	
Total	631	943	59	36	9	7	5										90
Unversity of California																	
Employees	1,713	2,573	351	150	51	37	135	59	18	11							773
Visitors	807	431	56	9													35
Total	2,520	3,004	407	159	51	37	135	59	18	11							808
TOTAL ALBUQUERQUE	10,498	14,152	1,426	755	326	212	397	92	21	11							2,578

TABLE B.2
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Ames Laboratory																	
Employees		49															2
Visitors																	
Total		49															2
Argonne National Lab.																	
Employees	1,976	304	125	59	29	14	15										112
Visitors	3,131	55	1														3
Total	5,107	359	126	59	29	14	15										115
Brookhaven National Lab.																	
Employees	845	604	138	94	54	37	48	7	1								249
Visitors	178	197	73	23	5	2	3										41
Total	1,023	801	211	117	59	39	51	7	1								289
Chicago Misc.																	
Employees	361	97	19	11	6	2	7	6	6								64
Visitors	221	6															
Total	582	103	19	11	6	2	7	6	6								65
Fermi National Lab.																	
Employees	1,546	524	50	18	1												42
Visitors	1,616	361	16														21
Total	3,162	885	66	18	1												63
Massachusetts Institute of Technology																	
Employees	309	123	10	11	3	2	1										17
Visitors	1,982	16															1
Total	2,291	139	10	11	3	2	1										18

TABLE B.2 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Princeton University																	
Employees	753	959	13	27	1												61
Visitors																	
Total	753	959	13	27	1												61
TOTAL CHICAGO	12,918	3,295	445	243	99	57	74	13	7								614

TABLE B.3
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
American Protective Service																	
Employees	150	114	2														6
Visitors																	
Total	150	114	2														6
Bendix Field Eng.																	
Employees	195	47	1														3
Visitors																	
Total	195	47	1														3
Biggers Const.																	
Employees		3	2	1													1
Visitors																	
Total		3	2	1													1
Bingham Mechanical																	
Employees		3	4	5			1										4
Visitors																	
Total		3	4	5			1										4
EG & G Idaho, Inc.																	
Employees	1,202	337	151	109	23	19	13										135
Visitors	23,155																
Total	24,357	337	151	109	23	19	13										135
Exxon Nuclear Co.																	
Employees	45	5	1														
Visitors																	
Total	45	5	1														

TABLE B.3 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Idaho Miscellaneous																	
Employees	261	80	8	6		3	2										13
Visitors																	
Total	261	80	8	6		3	2										13
Lehigh Design Co., Inc																	
Employees	4																
Visitors																	
Total	4																
Morrison-Knudsen																	
Employees	78	123	33	11	2	1	7										29
Visitors																	
Total	78	123	33	11	2	1	7										29
Ormond Construction																	
Employees	4	7					1										2
Visitors																	
Total	4	7					1										2
Waters Asbestos																	
Employees		1	1	1													1
Visitors																	
Total		1	1	1													1
West Valley Nuclear																	
Employees	278	94	38	33	30	21	9	4									84
Visitors																	
Total	278	94	38	33	30	21	9	4									84

TABLE B.3 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Westinghouse Idaho Nuclear																	
Employees	838	218	107	74	32	27	35	3									161
Visitors	12,155																
Total	12,993	218	107	74	32	27	35	3									161
TOTAL IDAHO	38,365	1,032	348	240	87	71	68	7									439

TABLE B.4
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Air Resources Lab.																	
Employees	46																
Visitors	2																
Total	48																
CER Geonuclear																	
Employees	1																
Visitors																	
Total	1																
Defense Nuclear Agency																	
Employees	540	5															
Visitors	3,111	25	2														2
Total	3,651	30	2														2
EG&G, Inc. (Las Vegas)																	
Employees	1,403	12	1														1
Visitors	83																
Total	1,486	12	1														1
Environmental Protec.																	
Employees	75																
Visitors	10																
Total	85																
Fenix & Scisson, Inc.																	
Employees	238	8	3	1													1
Visitors	132																
Total	370	8	3	1													1

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Halliburton Services																	
Employees	73	1															
Visitors	330																
Total	403	1															
Holmes & Narver, Inc.																	
Employees	590	9	2														1
Visitors	223																
Total	813	9	2														1
Nevada Misc.																	
Employees	450																
Visitors	278																
Total	728																
Reynolds Electrical																	
Employees	5,768	65	17	10	4												12
Visitors	5,676	1	1														
Total	11,444	66	18	10	4												13
U.S. Department of Interior																	
Employees	210	2															
Visitors	20																
Total	230	2															
Wackenhut Services																	
Employees	343																
Visitors	171																
Total	514																

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Westinghouse Electric																	
Employees	56																
Visitors	65																
Total	121																
TOTAL NEVADA	19,894	128	26	11	4												18

TABLE B.5
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Bechtel National																	
Employees	526	80	16	7	1	1	1	1									15
Visitors																	
Total	526	80	16	7	1	1	1	1									15
Goodyear Atomic Corp.																	
Employees	621	234	20	4	1												17
Visitors																	
Total	621	234	20	4	1												17
Martin Marietta/ORGDP																	
Employees	262	44	8	3													5
Visitors																	
Total	262	44	8	3													5
Martin Marietta/Y-12																	
Employees	112	98	138	44	22	3	1										63
Visitors																	
Total	112	98	138	44	22	3	1										63
Martin Marietta/ORNL																	
Employees	33	57	117	93	54	23	24	1									151
Visitors	516	19	11	2	2		1										6
Total	549	76	128	95	56	23	25	1									157
Martin Marietta/Paducah																	
Employees	12	7	21	4													6
Visitors																	
Total	12	7	21	4													6

TABLE B.5 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
National Lead Co.																	
Employees	14	69	122	150	50	14											125
Visitors																	
Total	14	69	122	150	50	14											125
Oak Ridge Assoc. Univ.																	
Employees	65	125															6
Visitors																	
Total	65	125															6
Puerto Rico Nuclear Ctr.																	
Employees	70	2															
Visitors																	
Total	70	2															
RMI Company																	
Employees	23	48	33	13													13
Visitors																	
Total	23	48	33	13													13
Rust Engineering Co.																	
Employees	848	21	26	7													8
Visitors																	
Total	848	21	26	7													8
Woven Structures, Inc.																	
Employees		18	3	4	1												4
Visitors																	
Total		18	3	4	1												4
TOTAL OAK RIDGE	3,102	822	515	331	131	41	27	2									419

TABLE B.6
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Duquesne Light Co.																	
Employees	5	273	25														18
Visitors	17	50															3
Total	22	323	25														21
Westinghouse Electric/BAPL																	
Employees	196	829	41	25	14	9	1										76
Visitors	42	29															1
Total	238	858	41	25	14	9	1										78
Westinghouse Electric/NRF																	
Employees	85	624	178	43													78
Visitors	70	6															
Total	155	630	178	43													79
Westinghouse Plant Appa.																	
Employees	15	18															1
Visitors																	
Total	15	18															1
TOTAL PITTSBURGH	430	1,829	244	68	14	9	1										178

TABLE B.7
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas. <0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
BCS Richland Inc.																	
Employees	14	8															
Visitors																	
Total	14	8															
General Electric Co.																	
Employees	15	40	5														3
Visitors	56	2															
Total	71	42	5														3
Hanford Eng. Dev. Lab.																	
Employees	371	621	86	37	10	4	8										82
Visitors	97	38															2
Total	468	659	86	37	10	4	8										84
Hanford Environ. Health Found.																	
Employees	6	8	1														1
Visitors																	
Total	6	8	1														1
J. A. Jones Const. Co.																	
Employees	298	508	107	121	58	41	73	1									274
Visitors	21	6															
Total	319	514	107	121	58	41	73	1									274
Kaiser Engineers-Hanford																	
Employees	79	240	13	5		1											17
Visitors	5	2															
Total	84	242	13	5		1											17

TABLE B.7 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas. <0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Pacific Northwest Laboratory																	
Employees	367	798	90	43	19	14	23	4	1								144
Visitors	195	49															2
Total	562	847	90	43	19	14	23	4	1								146
Rockwell Hanford Oper.																	
Employees	660	2,073	461	282	96	41	97	25									594
Visitors	691	239															12
Total	1,351	2,312	461	282	96	41	97	25									606
United Nuclear Ind. Inc.																	
Employees	359	736	263	240	153	115	315	167									1,259
Visitors	193	47															2
Total	552	783	263	240	153	115	315	167									1,261
TOTAL RICHLAND	3,427	5,415	1,026	728	336	216	516	197	1								2,392

TABLE B.8
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Rockwell International Energy Systems Group																	
Employees	397	303	19	14	5	8	14										55
Visitors	250	114															6
Total	647	417	19	14	5	8	14										61
Stanford Linear Accel. Center																	
Employees	192	18	3														1
Visitors																	
Total	192	18	3														1
University of California/LBL																	
Employees	786	533	26	6		1			1								38
Visitors																	
Total	786	533	26	6		1			1								38
University of California/LLNL																	
Employees	8,928	352	53	26	21	4	7	1	1								70
Visitors	12,733	155	16	5													12
Total	21,661	507	69	31	21	4	7	1	1								82
University of California/LEHR																	
Employees	35	53															3
Visitors																	
Total	35	53															3

TABLE B.8 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
University of California/LNM																	
Employees	16	25	3		2	2	2										8
Visitors																	
Total	16	25	3		2	2	2										8
University of California/MC																	
Employees	34																
Visitors																	
Total	34																
University of California/NTS																	
Employees	105	6	4	4													3
Visitors	1,096	3															
Total	1,201	9	4	4													3
TOTAL SAN FRANCISCO	24,572	1,562	124	55	28	15	23	1	2								195

TABLE B.9
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
SAVANNAH RIVER FIELD ORGANIZATION
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
E. I. Du Pont/SRP-Opns.																	
Employees	3,189	2,917	704	547	255	105	105										883
Visitors	4,826	736	16	3													41
Total	8,015	3,653	720	550	255	105	105										924
E. I. Du Pont/SRP-Const.																	
Employees	1,071	1,642	505	224	77	28	17										353
Visitors																	
Total	1,071	1,642	505	224	77	28	17										353
Savannah River Ecol. Lab.																	
Employees	42	46	1														2
Visitors																	
Total	42	46	1														2
Southern Bell Tel.																	
Employees	10	10	2														1
Visitors																	
Total	10	10	2														1
U. S. Forest Service																	
Employees	18	12															1
Visitors																	
Total	18	12															1
TOTAL SAVANNAH RIVER	9,156	5,363	1,228	774	332	133	122										1,281

TABLE B.10
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
SCHENECTADY NAVAL REACTOR FIELD ORGANIZATION
1984

Contractor	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
General Electric Company																	
Employees	640	1,413	106	50	21	2	2										126
Visitors	165	52															3
Total	805	1,465	106	50	21	2	2										129
General Electric/MAO																	
Employees	15	12															1
Visitors																	
Total	15	12															1
TOTAL SCHENECTADY	820	1,477	106	50	21	2	2										129

TABLE B.11
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR
MORGANTOWN ENERGY TECHNOLOGY CENTERS
1984

Dose-Equivalent Ranges (rem)

Contractor	< Meas.	Meas.- <0.10	0.10- 0.25	0.25- 0.50	0.50- 0.75	0.75- 1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
EG&G WASC, Inc.																	
Employees	2																
Visitors																	
Total	2																
TOTAL MORGANTOWN	2																

APPENDIX C

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION, 1984

TABLE C.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1984

Organization	Dose-Equivalent Ranges (rem)																Total
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Person-rem
Albuquerque Operations	317	43	1														2
Amarillo Area Office	28	13	1														1
Kansas City Area Office	21																
Los Alamos Area Office	53	65	2	3	2												6
Pinellas Area Office	12	6															
Rocky Flats Area Office		57	4	2			1										6
Sandia Area Office	10																
UMTRA Project Office	5	3															
TOTAL	446	187	8	5	2		1										15
Chicago Operations	32	2															
Environmental Meas. Lab.	32	2															
New Brunswick Lab.	65	8	4														1
TOTAL	129	12	4														1
Idaho Operations Office	413	39															2
West Valley Nuclear	4	1															
TOTAL	417	40															2
Nevada Operations	5,029	42	12	5													6
TOTAL	5,029	42	12	5													6

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1984

Organization	Dose-Equivalent Ranges (rem)																Total Person-rem
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	
Oak Ridge Operations	1																
TOTAL	1																
Pittsburgh Naval Reactors	16	35	2														2
TOTAL	16	35	2														2
Richland Operations	253	136	2														7
TOTAL	253	136	2														7
Schenectady Naval Reactors	5	13															1
West Milton Field Office		3	1														
Windsor Field Office		1															
TOTAL	5	17	1														1
Savannah River Operations	154	52	1														3
TOTAL	154	52	1														3

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1984

Organization	Dose-Equivalent Ranges (rem)																
	< Meas.	Meas.-<0.10	0.10-0.25	0.25-0.50	0.50-0.75	0.75-1.00	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	>10	Total Person-rem
Energy Technology Centers	6																
TOTAL	6																

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