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Nineteenth Annual Report

Radiation Exposures for DOE and DOE Contractor Employees - 1986

December 1987

Prepared for:

U.S. Department of Energy

Assistant Secretary for
Environment, Safety and Health
Office of Nuclear Safety

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Pacific Northwest Laboratory
Richland, Washington, 99352

NINETEENTH ANNUAL REPORT
RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES
1986

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), which 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 Administration (ERDA) and the U.S. Nuclear Regulatory Commission (NRC), each agency assumed responsibility for collecting and maintaining occupational radiation 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. A revised version of the 1979 report was issued as DOE/EP-0039. The data for 1980-1982 were presented in DOE/EP-0040, DOE/EP-0040/1, and DOE/EP-0040/2. The data for 1983-1985 were presented in DOE/PE-0072, DOE/EH-0011, and DOE/EH-0036, respectively. This report contains 1986 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 DOE Technical Information Center, P.O. Box 62, Oak Ridge, TN 37830.

SUMMARY

All U.S. Department of Energy (DOE) and DOE contractors are required by DOE Order 5484.1, Chapter IV, to submit occupational radiation exposure records to a central repository. The data required include a summary of whole-body exposures to ionizing radiation and a summary of internal depositions of radioactive materials above specified limits. This report is a summary of the data submitted by DOE and DOE contractors for 1986.

A total of 94,040 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposures in 1986. This represents 56.2% of all DOE and DOE contractor employees and is a decrease (1,766) from the number of employees monitored in 1985. In addition to the employees, 63,463 visitors were monitored.

Of all employees monitored, 58.0% received a dose equivalent that was less than measurable, 40.2% a measurable dose equivalent less than 1 rem, and 1.8% a dose equivalent greater than 1 rem. Two employees received dose equivalents greater than 5 rem. The dose equivalent received by 87.7% of the visitors to DOE facilities was less than measurable. Only 12.2% of the visitors received a measurable dose equivalent less than 1 rem, and 0.03% of the visitors received a dose equivalent greater than 1 rem. No visitors received a dose equivalent greater than 4 rem.

The collective dose equivalent for DOE and DOE contractor employees was 7,911 person-rem. The collective dose equivalent for visitors was 554 person-rem. The total dose equivalent for employees and visitors combined was 8,465 person-rem. The average dose equivalent for all individuals (employees and visitors) monitored was 54 mrem, and the average dose equivalent for all individuals who received a measurable exposure was 179 mrem. The highest average dose equivalent for all monitored individuals was observed at fuel fabrication facilities (205 mrem), and the lowest was observed for visitors (9 mrem) to DOE facilities. These averages are significantly less than the DOE 5-rem/year radiation protection standard for whole-body exposures.

Three new cases of internal depositions were reported in 1986 that exceeded 50 percent of the pertinent annual dose-equivalent standard. Of these three cases, two occurred in 1974 and are reported now because recent revisions in the dose calculations established these cases as reportable depositions. The third case occurred in 1985, but was not reported until evaluation was completed in early 1987. There were no uptakes of radioactive material reported to have occurred in 1986.

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NINETEENTH ANNUAL REPORT

RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES 1986

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 standards 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. This does not apply to emergency situations.

(c) A beta exposure below a maximum energy of 700 keV will not penetrate the lens of the eye; therefore, the applicable standard 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 standard 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 and a summary of internal depositions of radioactive materials. The central data base also includes occupational radiation exposure information for the Atomic Energy Commission (AEC) and the Energy Research and Development Administration (ERDA).

This report includes a summary of the data submitted for 1986 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 1986.

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 radiation exposure standards 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.

Recent revisions in the reporting requirements promulgated by DOE include a revised format for reporting occupational exposures. Beginning with reports for exposures occurring in 1987, contractors will be required to submit exposure data for individual employees and visitors. In the past, contractors were required only to report 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." The data were further subdivided into one of ten facility types. Because individual exposure data were not provided, annual collective dose equivalents presented in previous annual reports (expressed in units of person-rem) were 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.

For this report, some facilities reported individual exposure data based on the revised format. However, most of the exposure data were reported using the same format used for previous years. Because reporting under the revised format was incomplete, collective dose equivalents presented in this report were calculated using the same method used for previous reports. A comparison of the calculated data with the actual data provided by some contractors suggest that using the midpoint of the dose equivalent ranges to calculate collective dose equivalent results in an overestimation of the actual dose equivalent by approximately 10%. As a result, it is likely that the collective dose equivalents calculated in this and previous reports are slightly higher than the actual collective dose equivalents.

Contractors have the option of reporting the distribution of whole-body occupational dose equivalents only for those individuals for whom monitoring is required 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.

Beginning this reporting year, facilities are no longer required to submit a separate report of occupational exposure reports for terminating employees. Data for these individuals is included in the revised format for reporting occupational exposure. Although some facilities chose to report these data for workers terminating in 1986, many did not. As a result, exposure data for terminating employees are not provided in this annual report.

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 two DOE employees who received dose equivalents greater than the DOE radiation protection standard of 5 rem. A total of 94,040 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposure in 1986. This represents 56.2% of all DOE and DOE contractor employees. In addition to the employees, 63,463 visitors were monitored at DOE facilities. Visitors may include radiation workers from another DOE facility present on a temporary basis.

TABLE 2. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees and Visitors by Dose-Equivalent Interval, 1986

Dose-Equivalent Interval	Number of Persons			Collective Person-rem		
(rem)	Employees	Visitors	Total	Employees	Visitors	Total
<Measurable	54,581	55,670	110,251	0	0	0
Measurable to 0.10	27,226	7,251	34,477	1,361	363	1,724
0.10 to 0.25	5,218	321	5,539	913	56	969
0.25 to 0.50	3,304	126	3,430	1,239	47	1,286
0.50 to 0.75	1,357	45	1,402	848	28	876
0.75 to 1.00	669	28	697	585	25	610
1 to 2	1,298	21	1,319	1,947	32	1,979
2 to 3	349	0	349	873	0	873
3 to 4	35	1	36	123	3	126
4 to 5	1	0	1	5	0	5
5 to 6	0	0	0	0	0	0
6 to 7	1	0	1	6	0	6
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	1	0	1	11	0	11
TOTAL	94,040	63,463	157,503	7,911	554	8,465

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 1986 decreased slightly from the number reported in previous years (Figure 1).

Of the employees monitored in 1986, 58.0% received a dose equivalent that was less than measurable, 40.2% a measurable dose equivalent less than 1 rem, and 1.8% a dose equivalent greater than 1 rem (Figure 2). The dose equivalent received by 87.7% of the visitors to DOE facilities was less than measurable. Only 12.2% of the visitors received a dose equivalent between measurable and 1 rem, and <0.03% of the visitors received a dose equivalent greater than 1 rem (Figure 2).

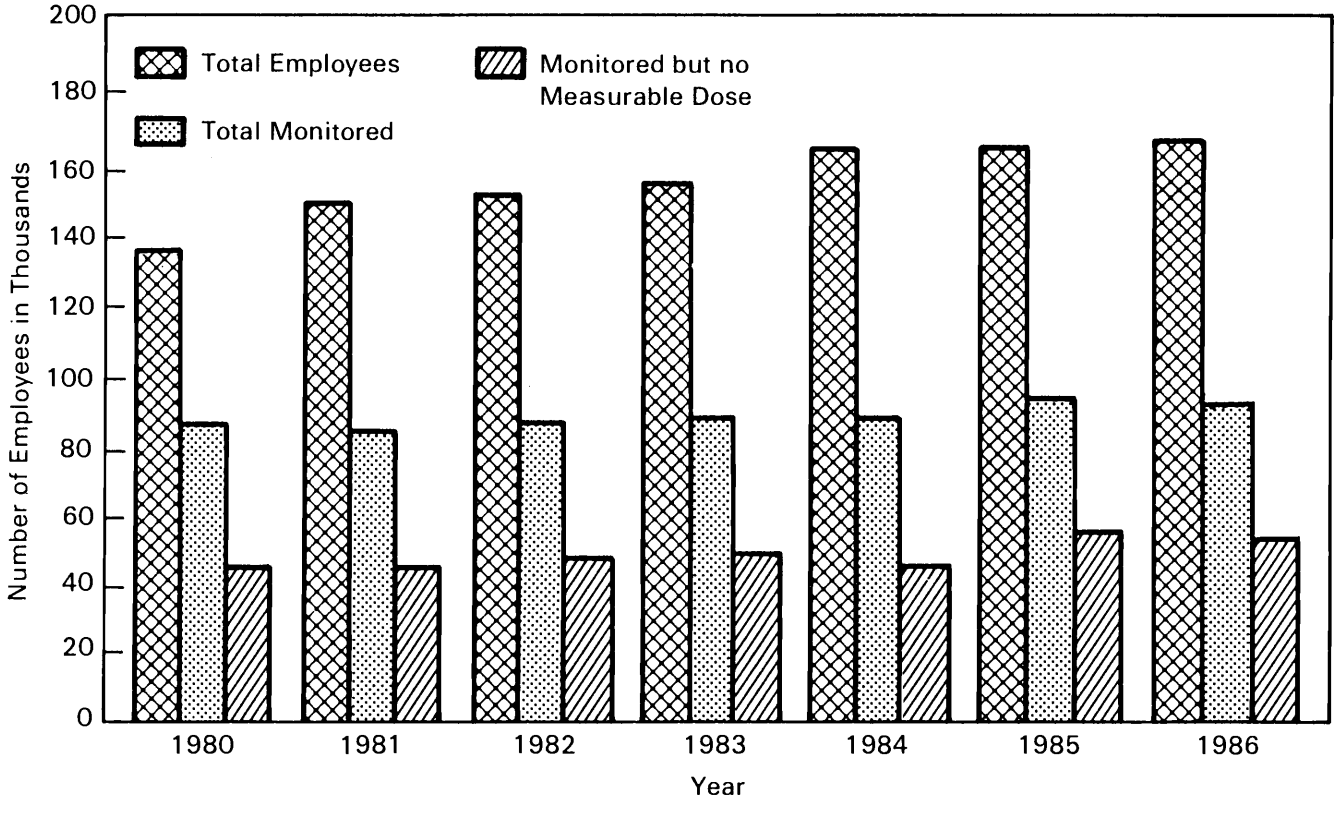

FIGURE 1. Comparison of Number of Employees, Number of Employees Monitored, and Number of Employees Monitored Who Received No Measurable Dose Equivalent, 1980-1986

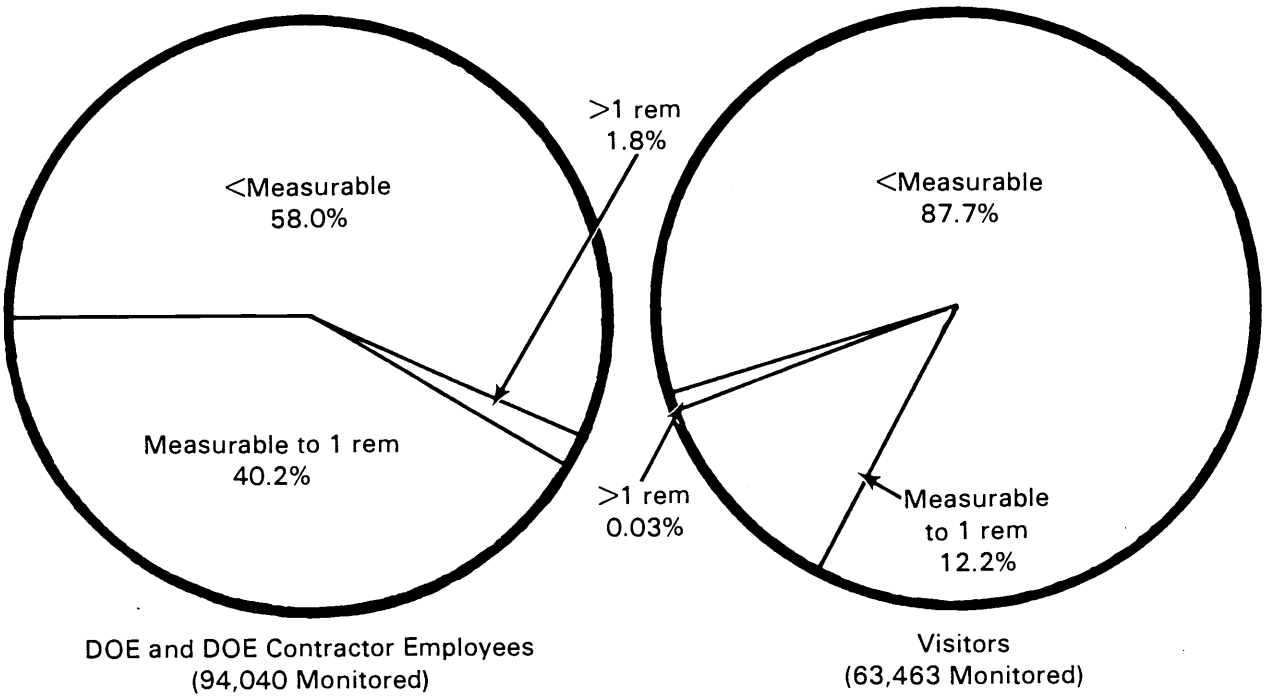

FIGURE 2. Percentage of Monitored Employees and Percentage of Monitored Visitors Who Received an Exposure Less Than Measurable, Measurable to 1 rem, or Greater Than 1 rem, 1986

The collective dose equivalent was 7,911 person-rem for all DOE and DOE contractor employees, and 554 person-rem for visitors to DOE facilities, for a total collective dose equivalent of 8,465 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 (64.6%) of the total person-rem.

The distribution of whole-body exposures for the years 1965-1986 is presented in Table 3. As can be observed in Table 3, the fraction of all monitored workers who received a dose equivalent greater than 1 rem has gradually declined since 1965, starting at about 5% and leveling off at about 2% for the last nine years. This general downward trend in occupational radiation exposures can be observed in Figure 4, which shows the collective dose equivalent for all individuals from 1965 to 1986 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, less-than-measurable exposures were 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.

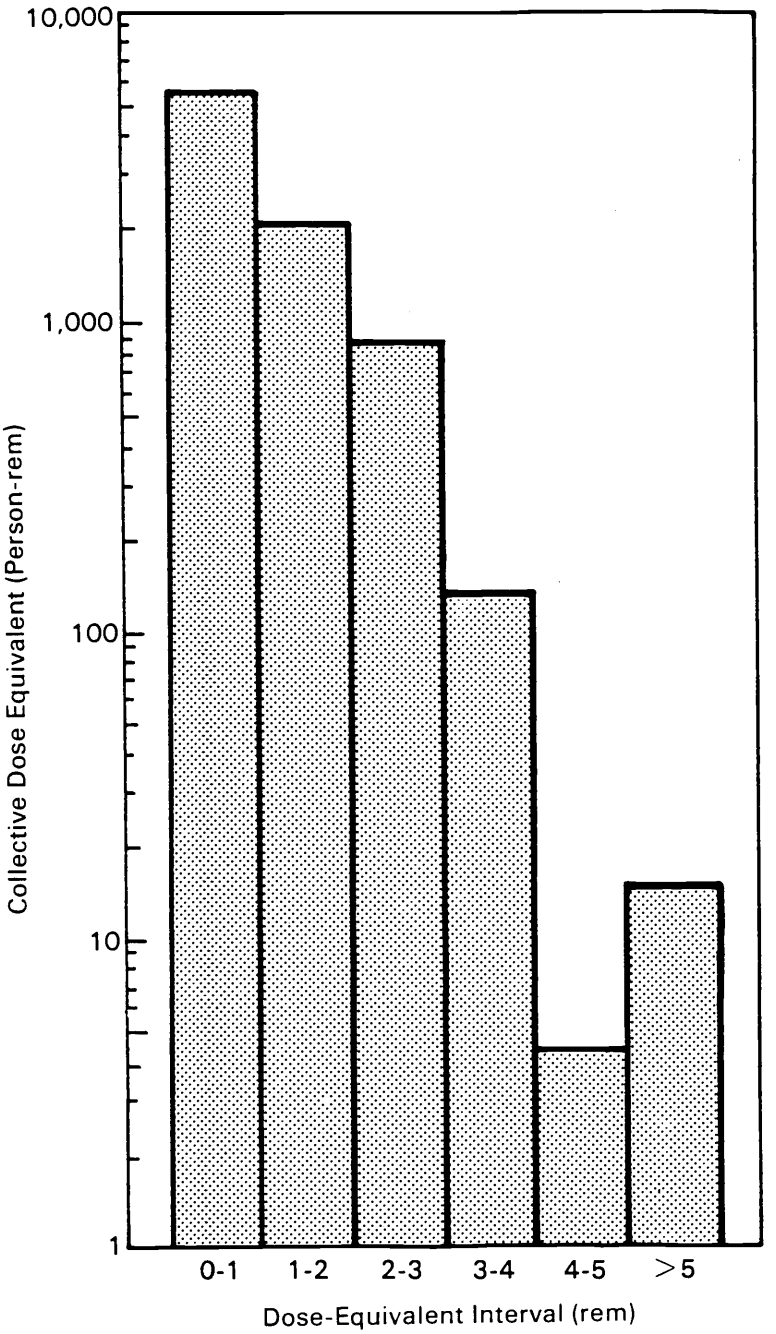

FIGURE 3. Contribution of Each Dose-Equivalent Interval to the Total Collective Dose Equivalent, 1986

TABLE 3. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees, 1965-1986

	Number of Employees Receiving Exposures in Each Dose-Equivalent Range (rem)														
Year	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	Total Monitored
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[b]	47,327	42,696	1,226	312	31	11									91,603
1985	55,939	38,085	1,366	356	51	8				1					95,806
1986	54,581	37,774	1,298	349	35	1		1					1		94,040

(a)Separation of data before 1974 is unavailable.

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

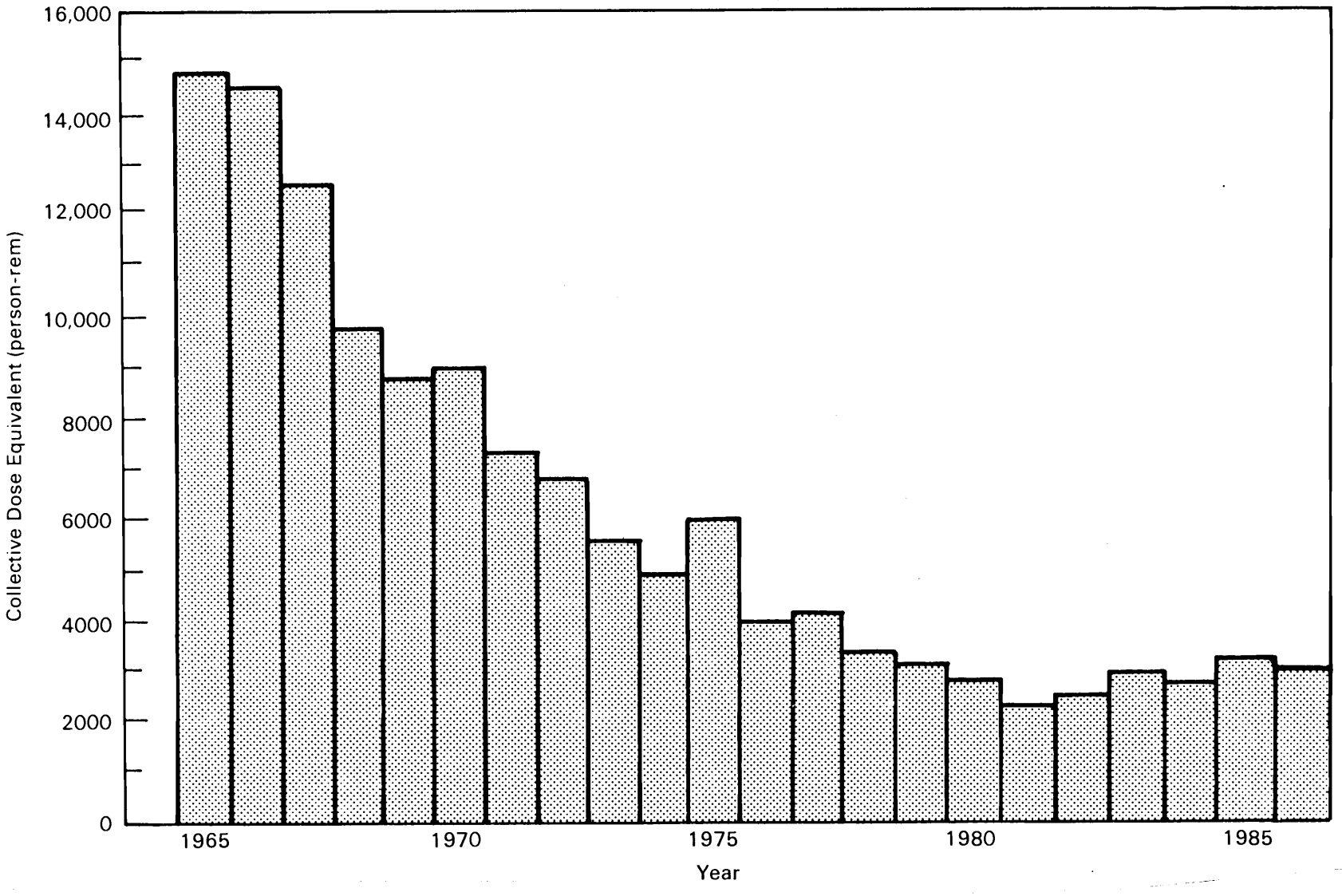

FIGURE 4. Total Collective Dose Equivalent for all DOE/DOE Contractor Employees Who Received an Exposure Greater Than 1 Rem, 1965-1986

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, construction, and irradiation facilities. 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 54 mrem. The highest average dose equivalent per individual monitored was observed at fuel fabrication facilities (205 mrem), and the lowest was observed for visitors to DOE facilities (9 mrem). The average dose equivalent per individual monitored with a measurable exposure was 179 mrem. The highest average dose equivalent for individuals monitored with a measurable exposure was observed at fuel processing facilities (314 mrem), and the lowest was observed at DOE offices (65 mrem).

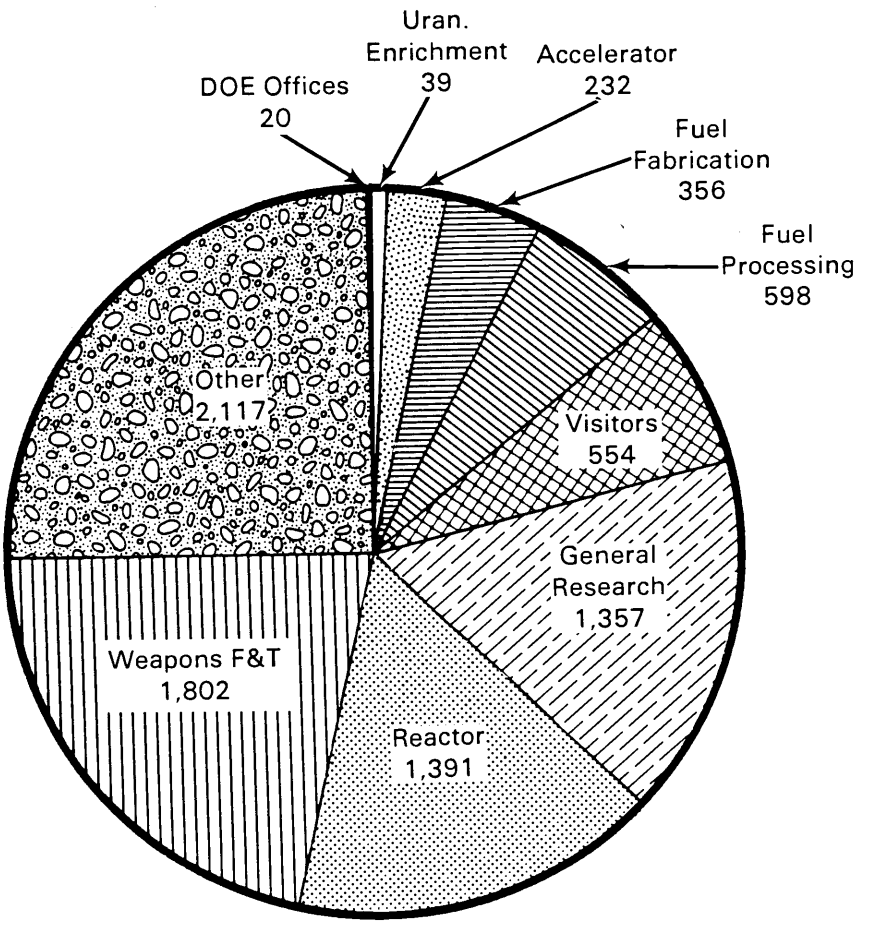

FIGURE 5. Contribution of Each Facility Type to the Total Collective Dose Equivalent, 1986

TABLE 4. Distribution of Annual Whole-Body Exposures for DOE/DOE Contractor Employees and Visitors by Facility Type, 1986(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	7,260	2,628	2,747	701	500	163	112	279	130											1,391
Fuel Fabrication	1,733	165	767	300	329	119	21	31	1											356
Fuel Processing	3,038	1,132	942	329	289	122	62	151	11											598
Uranium Enrichment	1,134	581	481	60	12															39
Weapon F&T	21,109	10,285	7,921	1,446	664	290	147	296	60											1,802
Gen. Research	30,449	24,004	4,728	701	409	165	113	215	79	35										1,357
Accelerator	4,794	2,990	1,437	186	97	39	12	26	7											232
Other	22,493	11,071	7,920	1,481	997	458	202	300	61		1		1					1		2,117
Visitors	63,463	55,670	7,251	321	126	45	28	21		1										554
DOE Offices	2,030	1,725	283	14	7	1														20
TOTAL PERSONS	157,503	110,251	34,477	5,539	3,430	1,402	697	1,319	349	36	1		1					1		
TOTAL PERSON-REM			1,724	969	1,286	876	610	1,979	873	126	5		6					11		8,465

(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, 1986[a]

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	7,260	4,632	1,391	192	300
Fuel Fabrication	1,733	1,568	356	205	227
Fuel Processing	3,038	1,906	598	197	314
Uranium Enrichment	1,134	553	39	34	71
Weapon F&T	21,109	10,824	1,802	85	166
Gen. Research	30,449	6,445	1,357	45	211
Accelerator	4,794	1,804	232	48	129
Other	22,493	11,422	2,117	94	185
Visitors	63,463	7,793	554	9	71
DOE Offices	2,030	305	20	10	65
TOTAL	157,503	47,252	8,465	54	179

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

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 1980 to 1986 for each field organization are shown in Table 8.

TABLE 6. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1986

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	30,035	15,998	2,388	79	149
Chicago	15,360	3,305	408	27	123
Idaho	17,809	2,457	685	38	279
Nevada	27,214	284	65	2	230
Oak Ridge	5,331	2,959	611	115	207
Pittsburgh Naval Reactor	2,271	1,798	143	63	80
Richland	12,443	4,991	2,321	187	465
San Francisco	25,250	1,190	108	4	91
Savannah River	18,936	11,946	1,498	79	125
Schenectady Naval Reactor	2,846	2,324	238	84	102
TOTAL(a)	157,503	47,252	8,465	54	179

(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, 1986

Field Organization	Facility Type									
	Reactor	Fuel Fab.	Fuel Proc.	Uran. Enrich.	Weapon F&T	Gen. Research	Acceler.	Other	Visitors	DOE Offices
Albuquerque					0.64	0.25		0.01	0.10	<0.01
Chicago	0.09					0.20	0.50	0.06	0.16	<0.01
Idaho	0.23		0.25			0.01		0.50	0.01	<0.01
Nevada					0.82			0.01	0.16	<0.01
Oak Ridge		0.28		0.06	0.32	0.24		0.09		
Pittsburgh Naval Reactor	0.36					0.58		0.01	0.06	
Richland	0.42	0.04				0.13		0.41	<0.01	<0.01
San Francisco					0.01	0.54	0.27	0.05	0.13	<0.01
Savannah River	0.09	0.06	0.28		0.01	0.04		0.48	0.04	0.01
Schenectady Naval Reactor	0.22					0.11		<0.01	0.66	
ALL FIELD ORGANIZATIONS COMBINED	0.16	0.04	0.07	<0.01	0.21	0.16	0.03	0.25	0.07	<0.01

TABLE 8. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1980-1986 (person-rem)

Field Organization	1980	1981[a]	1982	1983	1984[a]	1985	1986
Albuquerque	1,700	2,024	2,285	2,332	2,738	2,900	2,388
Chicago	918	758	587	623	615	502	408
Idaho	593	302	363	353	441	420	685
Nevada	50	36	29	25	24	34	65
Oak Ridge	604	437	401	371	419	353	611
Pittsburgh Naval Reactor	186	185	194	220	180	180	143
Richland	2,256	2,093	2,272	2,458	2,399	2,548	2,321
San Francisco	240	171	289	267	195	187	108
Savannah River	1,391	1,401	1,310	1,293	1,283	1,394	1,498
Schenectady Naval Reactor	79	76	147	217	130	165	238
TOTAL	8,024	7,483	7,879	8,158	8,423	8,684	8,465

(a)The data differ slightly from those listed in previous reports because of errors reported by individual 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 critical organ in excess of 50 percent of the pertinent annual dose-equivalent standard set forth in DOE Order 5480.1, 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.

Three cases of internal body depositions were reported in 1986 which exceeded 50 percent of the pertinent annual dose-equivalent standard. Of these three cases, two occurred in 1974 and are reported now because recent revisions in the dose calculations established these cases as reportable depositions. The third case occurred in 1985 but was not reported until evaluation was completed in early 1987. There were no uptakes of radioactive material reported to have occurred in 1986.

Table 9 lists only those cases occurring since 1980 and identifies each by the first year known in which the dose-equivalent exceeded 50 percent of the annual standard. Also listed are the radionuclide(s) involved, the organ showing the highest percent of the annual standard, and the number of individuals in each dose-equivalent range. Revisions to previously reported cases are included.

TABLE 9. Dose Distributions for Cases of Internal Body Depositions, 1980-1986

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			2	2		
	^{234}U, ^{235}U, ^{238}U	Lung	1					
1981	^{238}Pu, ^{239}Pu, ^{240}Pu	Bone		1	1			
	^{238}Pu, ^{239}Pu, ^{240}Pu	Lung	1					
	^{234}U, ^{235}U, ^{238}U	Lung	3					
1982	^{238}Pu	Bone			3	1		
	^{238}Pu, ^{239}Pu, ^{240}Pu	Bone						1
1983	^{239}Pu, ^{240}Pu, ^{241}Am	Bone			1			
	^{234}U, ^{235}U	Lung	4					
1984	^{239}Pu, ^{241}Am	Lung					1	
1985	^{234}U, ^{235}U, ^{238}U	Lung	2					
	^{239}Pu, ^{241}Am	Lung	1(a)					
1986	None							

(a) Not included in the previous annual report because evaluation was completed after the report was published.

APPENDIX A

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURE BY FACILITY TYPE FOR EACH DOE FIELD ORGANIZATION, 1986

TABLE A.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
ALBUQUERQUE FIELD ORGANIZATION
1986

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	10,655	1,152	7,435	853	508	243	133	272	59									1,535
Gen. Research	10,794	8,972	1,166	200	145	68	53	130	46	14								596
Accelerator																		
Other	398	222	114	48	13	1												20
Visitors	7,645	3,252	4,341	42	9		1											229
DOE Offices	543	439	90	7	6	1												9
TOTAL	30,035	14,037	13,146	1,150	681	313	187	402	105	14								
TOTAL PERSON-REM			657	201	255	196	164	603	263	49								2,388

TABLE A.2
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
CHICAGO FIELD ORGANIZATION
1986

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	437	191	147	66	25	5	2	1										35
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	4,076	3,460	476	74	33	15	8	9	1									82
Accelerator	4,240	2,794	1,112	164	94	34	12	23	7									203
Other	171	93	58	3	3	4	1	7	2									23
Visitors	6,389	5,471	854	43	11	5	3	1		1								65
DOE Offices	47	46	1															
TOTAL	15,360	12,055	2,648	350	166	63	26	41	10	1								
TOTAL PERSON-REM			132	61	62	39	23	62	25	4								408

TABLE A.3
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
IDAHO FIELD ORGANIZATION
1986

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	2,315	1,632	374	118	110	38	15	28										159
Fuel Fabrication																		
Fuel Processing	1,661	1,005	391	84	89	36	16	30	10									174
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	45	35	6		1	1		2										4
Accelerator																		
Other	2,923	1,903	512	171	131	76	42	73	13		1		1					342
Visitors	10,734	10,662	66	6														4
DOE Offices	131	115	16															1
TOTAL	17,809	15,352	1,365	379	331	151	73	133	23		1		1					
TOTAL PERSON-REM			68	66	124	94	64	200	58		4		6					685

TABLE A.4
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
NEVADA FIELD ORGANIZATION
1986

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	9,014	8,792	124	47	24	10	4	12	1									54
Gen. Research																		
Accelerator																		
Other	1,862	1,851	8	3														1
Visitors	15,573	15,524	25	15	4	2	1	2										11
DOE Offices	765	763	2															
TOTAL	27,214	26,930	159	65	28	12	5	14	1									
TOTAL PERSON-REM			8	11	11	8	4	21	2									65

TABLE A.5
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
OAK RIDGE FIELD ORGANIZATION
1986

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	583	15	100	168	204	87	9											173
Fuel Processing																		
Uran. Enrichment	1,134	581	481	60	12													39
Weapon F&T	1,016	133	168	529	128	36	10	12										198
Gen. Research	1,197	643	237	137	112	26	21	21										144
Accelerator																		
Other	1,343	942	304	31	40	16	6	4										57
Visitors	58	58																
DOE Offices																		
TOTAL	5,331	2,372	1,290	925	496	165	46	37										
TOTAL PERSON-REM			65	162	186	103	40	55										611

TABLE A.6
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1986

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	640	52	491	64	25	7		1										51
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,305	260	893	114	27	8	3											82
Accelerator																		
Other	46	21	25															1
Visitors	280	140	134	4	1	1												8
DOE Offices																		
TOTAL	2,271	473	1,543	182	53	16	3	1										
TOTAL PERSON-REM			77	32	20	10	3	1										143

TABLE A.7
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
RICHLAND FIELD ORGANIZATION
1986

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	1,905	575	391	177	189	101	94	248	130									964
Fuel Fabrication	220	27	62	30	35	23	12	30	1									94
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,729	1,099	347	87	47	32	21	43	32	21								307
Accelerator																		
Other	6,249	3,490	1,226	470	498	239	100	180	46									952
Visitors	2,148	2,081	65	2														4
DOE Offices	192	180	10	2														1
TOTAL	12,443	7,452	2,101	768	769	395	227	501	209	21								
TOTAL PERSON-REM			105	134	288	247	199	752	523	74								2,321

TABLE A.8
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SAN FRANCISCO FIELD ORGANIZATION
1986

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	131	122	5	2	2													1
Gen. Research	9,446	8,844	509	51	26	8	4	4										59
Accelerator	554	196	325	22	3	5		3										29
Other	83	66	6	5	1	3	2											5
Visitors	14,959	14,762	176	16	4	1												14
DOE Offices	77	70	7															
TOTAL	25,250	24,060	1,028	96	36	17	6	7										
TOTAL PERSON-REM			51	17	13	11	5	11										108

TABLE A.9
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SAVANNAH RIVER FIELD ORGANIZATION
1986

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	1,071	134	557	230	137	11	1	1										129
Fuel Fabrication	930	123	605	102	90	9		1										89
Fuel Processing	1,377	127	551	245	200	86	46	121	1									423
Uran. Enrichment																		
Weapon F&T	293	86	189	15	2	1												13
Gen. Research	872	232	575	31	18	7	3	6										57
Accelerator																		
Other	9,384	2,467	5,649	750	311	119	51	36									1	715
Visitors	4,734	3,709	969	40	10	6												63
DOE Offices	275	112	157	5	1													9
TOTAL	18,936	6,990	9,252	1,418	769	239	101	165	1								1	
TOTAL PERSON-REM			463	248	288	149	88	248	3								11	1,498

TABLE A.10
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE
SCHENECTADY NAVAL REACTOR FIELD ORGANIZATION
1986

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	892	44	787	46	14	1												53
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	977	451	519	7														27
Accelerator																		
Other	34	16	18															1
Visitors	943	11	621	153	87	30	23	18										156
DOE Offices																		
TOTAL	2,846	522	1,945	206	101	31	23	18										
TOTAL PERSON-REM			97	36	38	19	20	27										238

APPENDIX B

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL FOR EACH DOE FIELD ORGANIZATION, 1986

TABLE B.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
ALBUQUERQUE FIELD ORGANIZATION
1986

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
Albuquerque Misc. Subcontractors																	
Employees	1	1,362	61	7	1												82
Visitors																	
Total	1	1,362	61	7	1												82
Allied Bendix Aerospace																	
Employees	146	27															1
Visitors																	
Total	146	27															1
General Electric Co. —Pinellas																	
Employees	252	56	3		1												4
Visitors																	
Total	252	56	3		1												4
Inhalation Toxicology																	
Employees	290	29	4	1													3
Visitors	137																
Total	427	29	4	1													3
Jacobs—Weston Team																	
Employees	136	101	46	11	1												18
Visitors																	
Total	136	101	46	11	1												18
Los Alamos National Lab																	
Employees	4,516	621	131	109	54	46	125	44	14								515
Visitors	1,228	225	32	8													20
Total	5,744	846	163	117	54	46	125	44	14								535

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
ALBUQUERQUE FIELD ORGANIZATION
1986

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	
Mason & Hanger (Amarillo, TX)																	
Employees	729	165	94	52	23	14	16										95
Visitors	643	44															2
Total	1,372	209	94	52	23	14	16										97
Mason & Hanger (Los Alamos, NM)																	
Employees	348	18															1
Visitors																	
Total	348	18															1
Monsanto Research Co. (Mound)																	
Employees	23	1,789	75	10	2		1										109
Visitors	662	846															42
Total	685	2,635	75	10	2		1										151
Pan-Am World Services, Inc.																	
Employees	1,551	220	34	21	9	3											33
Visitors																	
Total	1,551	220	34	21	9	3											33
Rockwell International																	
Employees		4,035	622	441	216	119	255	59									1,245
Visitors		3,136	7														158
Total		7,171	629	441	216	119	255	59									1,403

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
ALBUQUERQUE FIELD ORGANIZATION
1986

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	
Ross Aviation, Inc.																	
Employees	85	6															
Visitors																	
Total	85	6															
Sandia National Laboratory																	
Employees	2,267	278	31	14	5	4	5	2									44
Visitors	582	90	3	1		1											6
Total	2,849	368	34	15	5	5	5	2									50
TOTAL ALBUQUERQUE	13,596	13,048	1,143	675	312	187	402	105	14								2,379

TABLE B.2
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
CHICAGO FIELD ORGANIZATION
1986

Contractor	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
Ames Laboratory (Iowa St.)																	
Employees	64	1															
Visitors																	
Total	64	1															
Argonne National Lab.																	
Employees	1,927	329	115	35	15	3	6										71
Visitors	1,658	112	1														6
Total	3,585	441	116	35	15	3	6										76
Brookhaven National Lab.																	
Employees	1,046	475	120	92	33	18	25	8									173
Visitors	263	402	24	9	4	3	1		1								38
Total	1,309	877	144	101	37	21	26	8	1								211
Chicago Misc. Subcontractors																	
Employees	108	85	6	7	6	1	9	2									31
Visitors	149	6	3	2	1												2
Total	257	91	9	9	7	1	9	2									33
Fermi National Lab.																	
Employees	1,715	678	54	17	2	1											52
Visitors	1,347	320	15														19
Total	3,062	998	69	17	2	1											70

TABLE B.2 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
CHICAGO FIELD ORGANIZATION
1986

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	
Massachusetts Institute of Technology																	
Employees	250	97	11	4	2												10
Visitors	1,912	12															1
Total	2,162	109	11	4	2												10
Princeton University																	
Employees	1,353	117	1														6
Visitors	111	2															
Total	1,464	119	1														6
TOTAL CHICAGO	11,903	2,636	350	166	63	26	41	10	1								407

TABLE B.3
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
IDAHO FIELD ORGANIZATION
1986

	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
American Protective Service																	
Employees	382	58															3
Visitors																	
Total	382	58															3
EG&G Idaho, Inc.																	
Employees	1,626	360	133	119	41	15	25										162
Visitors	10,623																
Total	12,249	360	133	119	41	15	25										162
MK-Ferguson Company																	
Employees	335	113	32	51	29	20	62	12		1		1					200
Visitors																	
Total	335	113	32	51	29	20	62	12		1		1					200
MK-Ferguson Subcontractors																	
Employees	414	80	18	12	7	10	15	2									52
Visitors	36	65	6														4
Total	450	145	24	12	7	10	15	2									57
Rockwell Rocketdyne Idaho																	
Employees	300	71	5	1													5
Visitors		1															
Total	300	72	5	1													5

TABLE B.3 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
IDAHO FIELD ORGANIZATION
1986

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	
UNC-GEO Technical Services																	
Employees	215	19	7														2
Visitors																	
Total	215	19	7														2
West Valley Nuclear																	
Employees	384	192	94	62	38	12	4										90
Visitors																	
Total	384	192	94	62	38	12	4										90
Westinghouse Idaho Nuclear																	
Employees	869	371	84	86	36	16	27	9									165
Visitors																	
Total	869	371	84	86	36	16	27	9									165
TOTAL IDAHO	15,184	1,330	379	331	151	73	133	23		1		1					683

TABLE B.4
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
NEVADA FIELD ORGANIZATION
1986

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	
EG&G, Inc. (Las Vegas)																	
Employees	1,365	21	1	1													2
Visitors	71																
Total	1,436	21	1	1													2
Fenix & Scisson, Inc.																	
Employees	336	10	2	2													2
Visitors	399																
Total	735	10	2	2													2
Holmes & Narver, Inc.																	
Employees	566	9	1	3	2		1	1									7
Visitors	222																
Total	788	9	1	3	2		1	1									7
Nevada Misc. Contractors																	
Employees	2,525	11	5														1
Visitors	2,553	2															
Total	5,078	13	5														1
Reynolds Elec. & Eng. Co.																	
Employees	5,414	77	41	18	8	4	11										43
Visitors	5,728																
Total	11,142	77	41	18	8	4	11										43

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
NEVADA FIELD ORGANIZATION
1986

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	
Wackenhut Services, Inc.-NV																	
Employees	411																
Visitors	119																
Total	530																
Westinghouse Electric																	
Employees	26	4															
Visitors	38																
Total	64	4															
TOTAL NEVADA	19,773	134	50	24	10	4	12	1									55

TABLE B.5
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
OAK RIDGE FIELD ORGANIZATION
1986

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	
CEER, Puerto Rico																	
Employees	73																
Visitors	12																
Total	85																
Martin Marietta/ORGDP																	
Employees	282	27	3														2
Visitors	31																
Total	313	27	3														2
Martin Marietta/ORNL																	
Employees	45	72	136	112	26	21	21										136
Visitors																	
Total	45	72	136	112	26	21	21										136
Martin Marietta/Paducah																	
Employees	18	10	33	10													10
Visitors																	
Total	18	10	33	10													10
Martin Marietta/ Portsmouth																	
Employees	281	444	24	2													27
Visitors																	
Total	281	444	24	2													27
Martin Marietta/Y-12																	
Employees	133	168	529	128	36	10	12										198
Visitors																	
Total	133	168	529	128	36	10	12										198

TABLE B.5 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
OAK RIDGE FIELD ORGANIZATION
1986

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	
Morrison-Knudsen																	
Employees	36																
Visitors	15																
Total	51																
Oak Ridge Assoc. Univ.																	
Employees	564	165	1														8
Visitors																	
Total	564	165	1														8
Oak Ridge Misc. Subcontractors																	
Employees	284	196	5	4	1												13
Visitors																	
Total	284	196	5	4	1												13
RMI Company																	
Employees	583	108	26	36	15	6	4										44
Visitors																	
Total	583	108	26	36	15	6	4										44
Westinghouse Materials Co. of Ohio																	
Employees	15	100	168	204	87	9											173
Visitors																	
Total	15	100	168	204	87	9											173
TOTAL OAK RIDGE	2,372	1,290	925	496	165	46	37										611

TABLE B.6
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1986

	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/BAPL																	
Employees	236	649	24	22	8	3											53
Visitors	109	130	4	1	1												8
Total	345	779	28	23	9	3											61
Westinghouse Electric/NRF																	
Employees	68	715	154	30	7		1										80
Visitors	31	4															
Total	99	719	154	30	7		1										80
Westinghouse (BAPL) Subcontractors																	
Employees	21	25															1
Visitors																	
Total	21	25															1
TOTAL PITTSBURGH	465	1,523	182	53	16	3	1										142

TABLE B.7
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
RICHLAND FIELD ORGANIZATION
1986

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	
Boeing Comp. Services																	
Employees	14	3															
Visitors																	
Total	14	3															
General Electric Co./ Shippingport																	
Employees	120	67	36	27	28	12	15										70
Visitors	2	1															
Total	122	68	36	27	28	12	15										70
Hanford Environ. Health Found.																	
Employees	9	1	1														
Visitors	1																
Total	10	1	1														
Kaisers Engineers Hanford—Arch./Eng.																	
Employees	222	64	7	5													6
Visitors	1																
Total	223	64	7	5													6
Kaiser Engineers Hanford—Cost Const.																	
Employees	630	172	129	219	147	51	67	8									370
Visitors	17																
Total	647	172	129	219	147	51	67	8									370

TABLE B.7 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
RICHLAND FIELD ORGANIZATION
1986

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	758	213	52	18	17	10	39	31	21								255
Visitors	251	24	1														1
Total	1,009	237	53	18	17	10	39	31	21								257
Rockwell Hanford Oper.																	
Employees	2,303	871	293	245	63	37	98	38									500
Visitors	879	21	1														1
Total	3,182	892	294	245	63	37	98	38									502
United Nuclear Ind. Inc.																	
Employees	628	463	207	224	124	106	278	131									1,058
Visitors	145	12															1
Total	773	475	207	224	124	106	278	131									1,059
Westinghouse Hanford Co.																	
Employees	507	172	39	31	16	11	4	1									55
Visitors	159	7															
Total	666	179	39	31	16	11	4	1									56
TOTAL RICHLAND	6,646	2,091	766	769	395	227	501	209	21								2,320

TABLE B.8
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
SAN FRANCISCO FIELD ORGANIZATION
1986

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 Rocketdyne/ETEC																	
Employees	5		2	1	3	2											4
Visitors	134	23															1
Total	139	23	2	1	3	2											6
Stanford Linear Accel. Center																	
Employees	193	26	3	2	2												4
Visitors																	
Total	193	26	3	2	2												4
University of California/LBE																	
Employees	87	12			1		3										6
Visitors																	
Total	87	12			1		3										6
University of California/LBL																	
Employees	3	370	29	2	2												26
Visitors		27	1														2
Total	3	397	30	2	2												27
University of California/LEHR																	
Employees	61	6	3														1
Visitors																	
Total	61	6	3														1

TABLE B.8 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
SAN FRANCISCO FIELD ORGANIZATION
1986

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/LLNL																	
Employees	8,720	426	41	25	8	4	4										52
Visitors	13,508	122	11	4													10
Total	22,228	548	52	29	8	4	4										62
University of California/LR																	
Employees	37																
Visitors																	
Total	37																
University of California/NTS																	
Employees	122	5	2	2													1
Visitors	1,120	4	4		1												2
Total	1,242	9	6	2	1												3
TOTAL SAN FRANCISCO	23,990	1,021	96	36	17	6	7										108

TABLE B.9
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
SAVANNAH RIVER FIELD ORGANIZATION
1986

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	
E. I. Du Pont/Production																	
Employees	1,958	5,102	839	574	168	77	144	1									1,008
Visitors	3,709	969	40	10	6												63
Total	5,667	6,071	879	584	174	77	144	1									1,071
E. I. Du Pont/ Construction																	
Employees	1,163	2,931	533	183	65	24	21									1	413
Visitors																	
Total	1,163	2,931	533	183	65	24	21									1	413
Savannah River Ecol. Lab.																	
Employees	40	60	1	1													4
Visitors																	
Total	40	60	1	1													4
Southern Bell Tel.																	
Employees	8	33															2
Visitors																	
Total	8	33															2
TOTAL SAVANNAH RIVER	6,878	9,095	1,413	768	239	101	165	1								1	1,489

TABLE B.10
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
SCHENECTADY NAVAL REACTOR FIELD ORGANIZATION
1986

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	
General Electric/ KAPL-Kesselring																	
Employees	37	639	36	12	1												43
Visitors	1	523	152	87	30	23	18										151
Total	38	1,162	188	99	31	23	18										195
General Electric/ KAPL-Knolls																	
Employees	442	511	7														27
Visitors	3	22															1
Total	445	533	7														28
General Electric/ KAPL-Knolls Subcontractors																	
Employees	16	18															1
Visitors																	
Total	16	18															1
General Electric/ KAPL-Windsor																	
Employees	6	145	10	2													10
Visitors	7	76	1														4
Total	13	221	11	2													14
TOTAL SCHENECTADY	512	1,934	206	101	31	23	18										237

TABLE B.11
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES TO PERSONNEL
MORGANTOWN ENERGY TECHNOLOGY CENTERS
1986

	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, 1986

TABLE C.1
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1986
Dose-Equivalent Ranges (rem)

Organization	< 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
Albuquerque Operations	258	3		1													1
Amarillo Area Office	37																
Dayton Area Office		27															1
Kansas City Area Office	16	1															
Los Alamos Area Office	118	3	4	4													2
Pinellas Area Office	2	8															
Rocky Flats Area Office		51	3	1	1												4
UMTRA Project Office	10	5															
SUBTOTAL	441	98	7	6	1												9
Chicago Operations	46	1															
Environmental Meas. Lab.	27	6															
New Brunswick Lab.	79	5															
SUBTOTAL	152	12															1
Idaho Operations Office	168	35															2
SUBTOTAL	168	35															2
Nevada Operations	7,157	25	15	4	2	1	2										11
SUBTOTAL	7,157	25	15	4	2	1	2										11
Pittsburgh Naval Reactors	8	20															1
SUBTOTAL	8	20															1

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1986
Dose-Equivalent Ranges (rem)

Organization	< 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
Richland Operations	806	10	2														1
SUBTOTAL	806	10	2														1
San Francisco Operations	70	7															
SUBTOTAL	70	7															
Savannah River Forest Station	11	34															2
Savannah River Operations	101	123	5	1													7
SUBTOTAL	112	157	5	1													9
Schenectady Naval Reactors	10	11															1
SUBTOTAL	10	11															1
Energy Technology Centers	6																
SUBTOTAL	6																
TOTAL DOE	8,930	375	29	11	3	1	2										34