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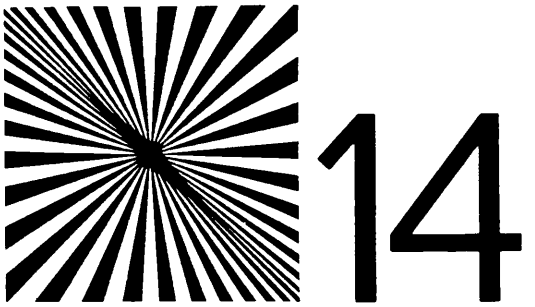

Fourteenth Annual Report Radiation Exposures For DOE and DOE Contractor Employees - 1981

March 1983

Prepared for:
U.S. Department of Energy
Assistant Secretary for Environmental Protection,
Safety, and Emergency Preparedness
Office of Nuclear Safety

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FOURTEENTH ANNUAL REPORT
RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES
1981

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 made 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 made 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, 1978, 1979, and 1980 were presented in DOE/EV-0066/10, 11, 12, and 13 respectively. A revised version of the 1979 report was issued. This report contains 1981 radiation exposure data for DOE and DOE contractors.

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 includes 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 1981.

A total of 82,873 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposures in 1981. This represents 54.9% of all DOE and DOE contractor employees and is a decrease from the number of individuals monitored in 1980. In addition to the employees, 84,343 visitors were monitored.

Of all employees monitored, 54.43% received a dose equivalent that was less than measurable, 44.04% a measurable exposure less than 1 rem, and 1.53% an exposure greater than 1 rem. The exposure received by 88.14% of the visitors to DOE facilities was less than measurable. Only 11.85% 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 6,902 person-rem. The collective dose equivalent for visitors was 579 person-rem. The total dose equivalent for employees and visitors combined was 7,481 person-rem. The average dose equivalent for all individuals (employees and visitors) monitored was 45 mrem and the average dose equivalent for all individuals who received a measurable exposure was 157 mrem. The highest average dose equivalent was observed for employees monitored at fuel processing facilities (342 mrem) and the lowest among visitors (7 mrem) to DOE facilities. These averages are significantly less than the DOE 5-rem/year radiation protection standard for whole-body exposures.

Six cases of internal depositions were reported in 1981. In all cases, the depositions were less than the annual dose-equivalent standard. Internal depositions were the result of accidental, not planned, exposures.

A total of 10,193 monitored employees terminated their employment in 1981. The average cumulative dose equivalent for terminated employees who worked one to two years was 0.32 rem; two to four years, 0.43 rem; four to six years, 0.62 rem; and longer than six years, 2.92 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.

CONTENTS

FIGURES

TABLES

FOURTEENTH ANNUAL REPORT RADIATION EXPOSURES FOR DOE AND DOE CONTRACTOR EMPLOYEES 1981

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,[b] red bone marrow, active blood-forming organs.	Year	5[c]
	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 which exceeds the limits specified in this table.

(b) 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).

(c) In special cases with the approval of the Director, Division of Operational and Environmental Safety, a worker may exceed 5 rem/year provided his/her average exposure per year since age 18 will not exceed 5 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 practicable, DOE requires the submittal of occupational radiation exposure records to a central repository. The data required includes a summary of whole-body exposure 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 is a summary of the data submitted for 1981 by DOE and DOE contractor offices. For the purpose of trend analysis, the data is compared to that reported in previous years. The data used to prepare this report is presented in Appendix A, "Distribution of Whole-Body Exposures by Facility Type for Each DOE Field Organization, 1981"; Appendix B, "Distribution of Annual Whole Body Exposures by Contractor for Each DOE Field Organization, 1981"; and Appendix C, "Distribution of Annual Whole-Body Exposures for DOE Government Employees and Visitors by DOE Field Organization, 1981."

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 the 10% 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 contractor and DOE office. A positive, measurable exposure is any recorded exposure greater than the minimum sensitivity of a personnel monitoring device. The data is 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, 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 calculated by multiplying the number of individuals in each dose range by the 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 5 rem. A total of 82,873 DOE and DOE contractor employees were monitored for whole-body ionizing radiation exposure in 1981. This represents 54.9% of all DOE and DOE contractor employees. In addition to the employees, 84,343 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, 1981

Dose-Equivalent Interval (rem)	Number of Persons			Collective Person-rem		
	Employees	Visitors	Total	Employees	Visitors	Total
<Measurable	45,109	74,338	119,447	0	0	0
Measurable to 0.10	27,074	9,710	36,784	1,354	486	1,840
0.10 to 0.25	4,582	187	4,769	802	33	835
0.25 to 0.50	2,796	63	2,859	1,049	24	1,073
0.50 to 0.75	1,309	29	1,338	818	18	836
0.75 to 1.00	739	10	749	647	9	656
1 to 2	967	5	972	1,451	7	1,458
2 to 3	263	1	264	658	2	660
3 to 4	29	0	29	101	0	101
4 to 5	5	0	5	22	0	22
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	82,873	84,343	167,216	6,902	579	7,481

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 five years is presented in Figure 1. The number of employees monitored in 1981 decreased slightly from the number reported in previous years (Figure 1).

Of the employees monitored in 1981, 54.43% received a dose equivalent that was less than measurable, 44.04% a measurable exposure less than 1 rem, and 1.53% an exposure greater than 1 rem (Figure 2). The exposure received by 88.14% of the visitors to DOE facilities was less than measurable. Only 11.85% of the visitors received an exposure between measurable and 1 rem, and 0.01% of the visitors received an exposure greater than 1 rem (Figure 2).

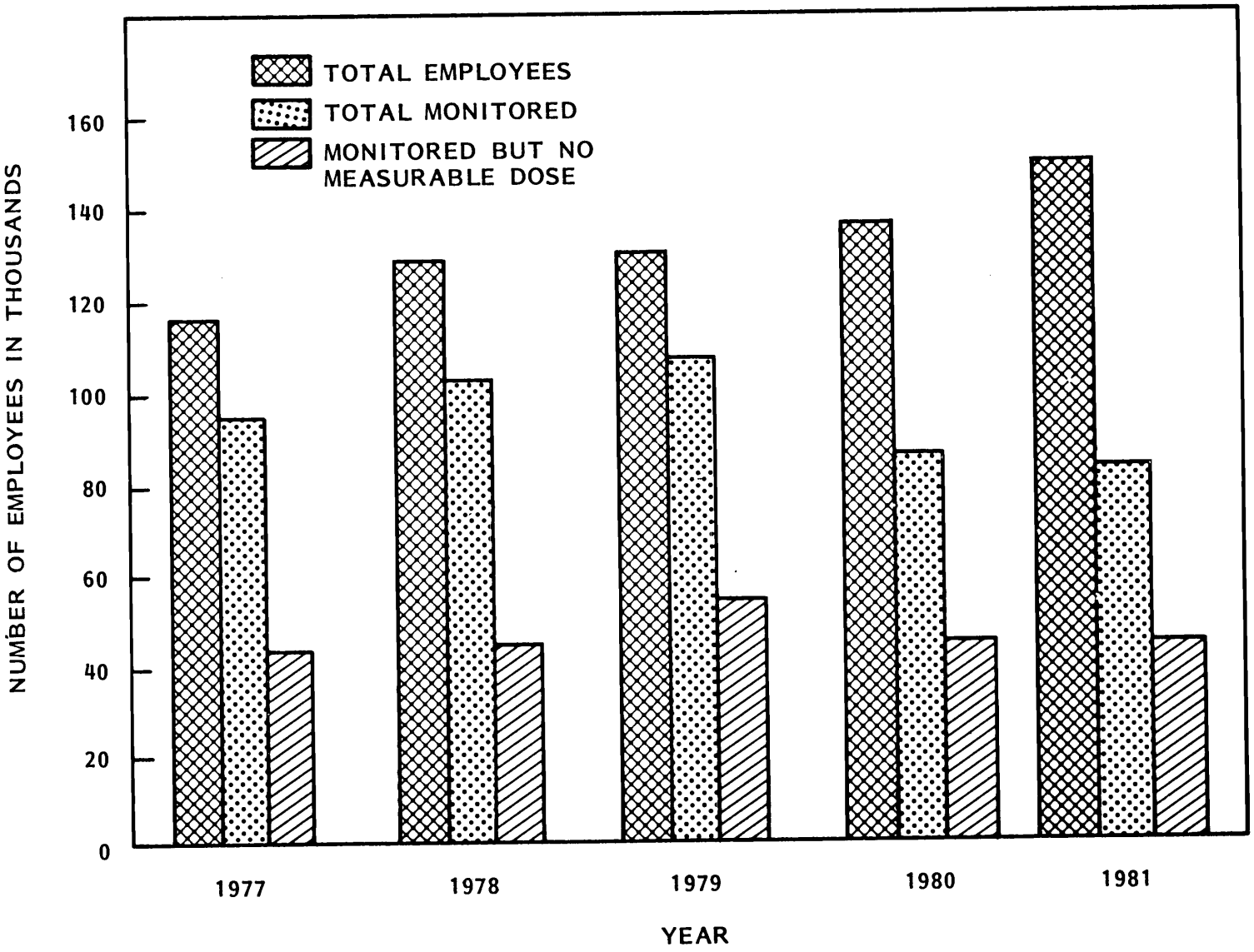

FIGURE 1. Comparison of Number of Employees, Number of Employees Monitored, and Number of Employees Monitored Who Received No Measurable Dose Equivalent

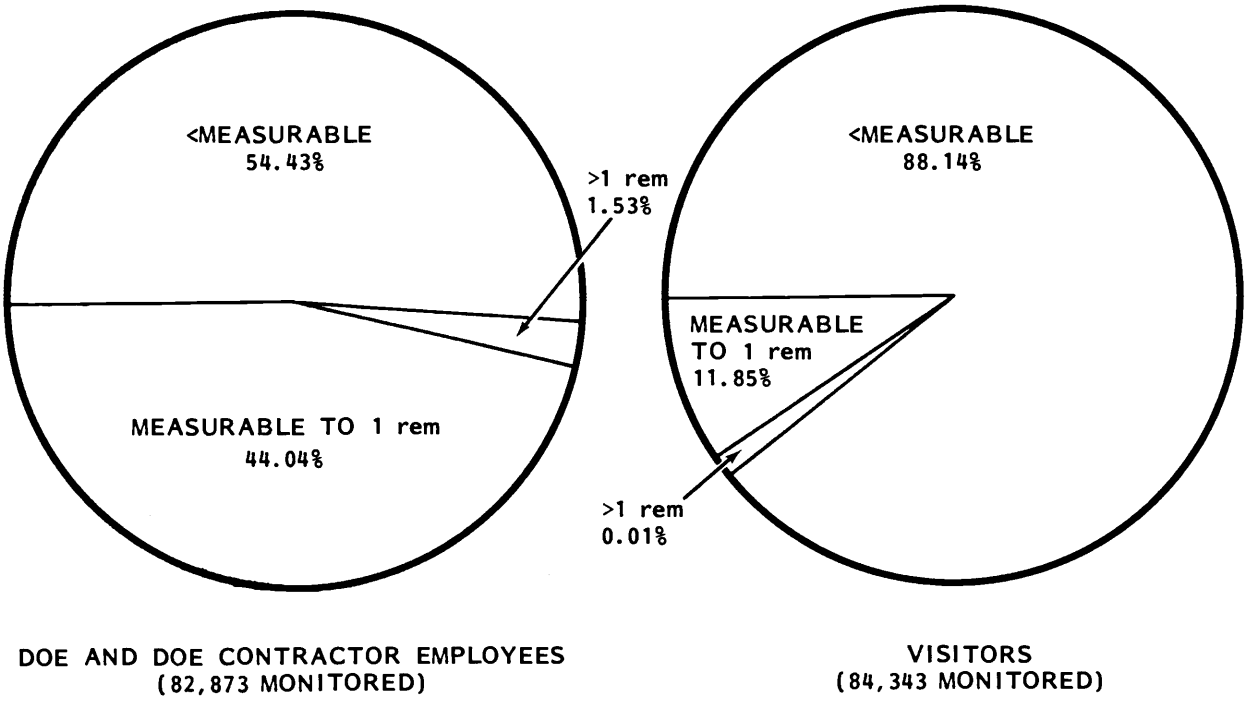

FIGURE 2. Percent of Monitored Employees and Percent of Monitored Visitors Who Received an Exposure Less Than Measurable, Measurable to 1 rem, or Greater Than 1 rem, 1981

The collective dose equivalent was 6,902 person-rem for all DOE and DOE contractor employees, and 579 person-rem for visitors to DOE facilities, for a total collective dose equivalent of 7,481 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 1965-1981 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 that shows the collective dose equivalent for all individuals from 1965 to 1981 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 prior to 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.

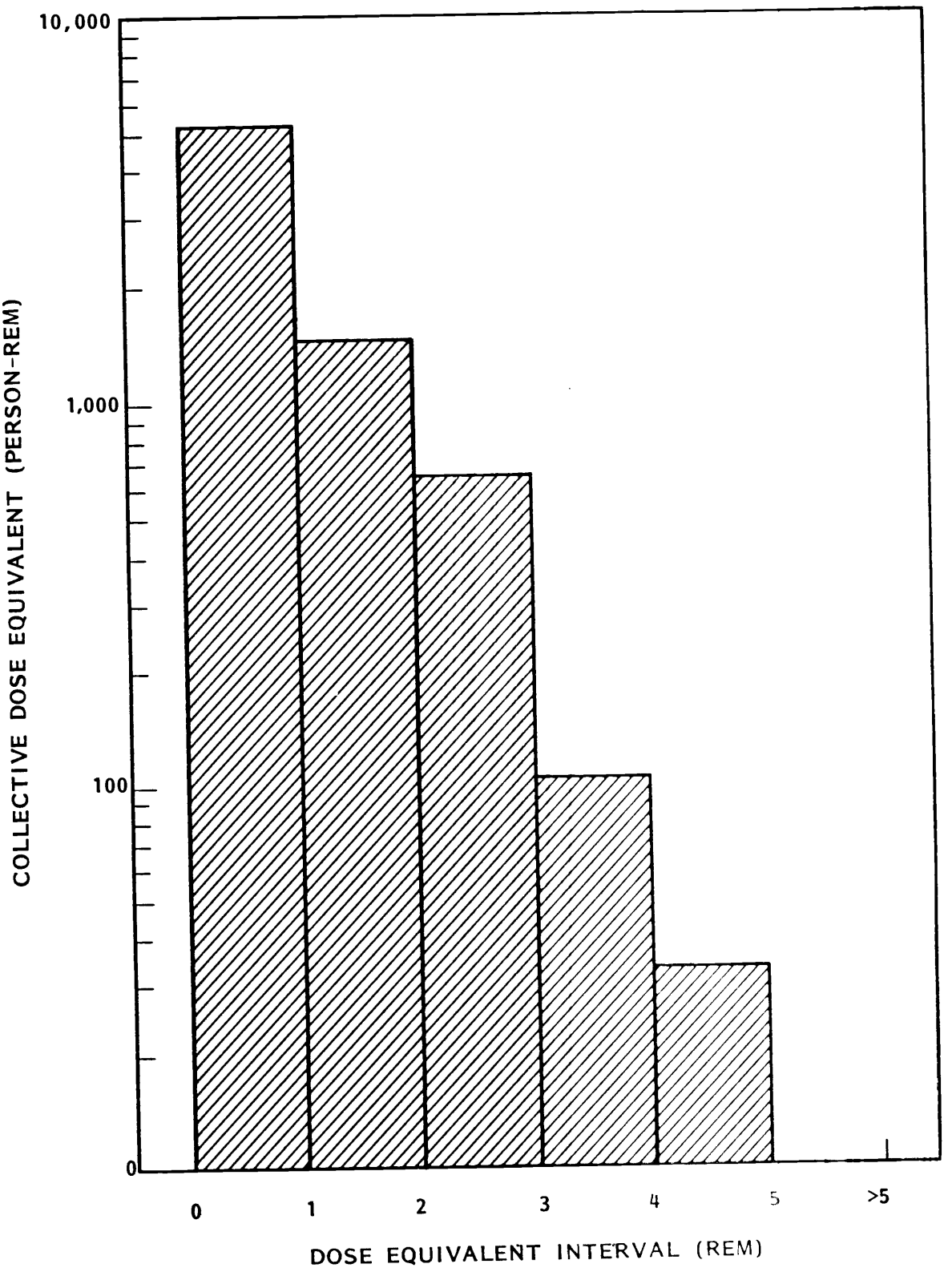

FIGURE 3. Contribution of Each Dose-Equivalent Interval to the Total Collective Dose Equivalent, 1981

TABLE 3. Distribution of Whole-Body Ionizing Radiation Exposures for DOE/DOE Contractor Employees, 1965-1981

Year	Dose Equivalent Ranges (rem) 0-1[a] <Meas.	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	45,109	36,500	967	263	29	5									82,873

(a)Separation of data prior to 1974 is unavailable.
(b)The 1979 data differs slightly from those listed in the original 1979 report because of an error in the dose-equivalent calculation by a contractor.

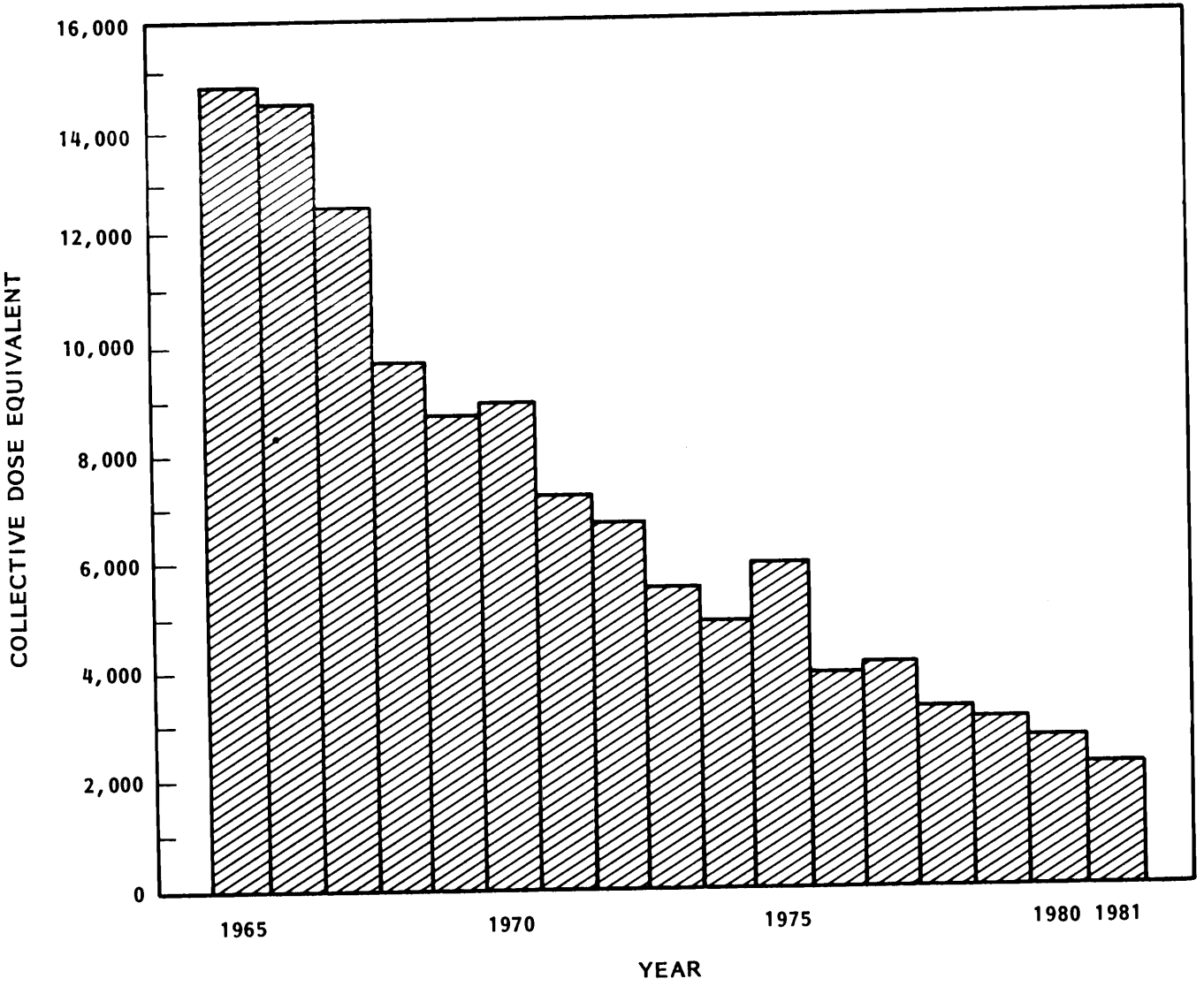

FIGURE 4. Total Collective Dose Equivalent for All DOE/DOE Contractor Employees Who Received an Exposure Greater Than 1 rem, 1965-1981

DISTRIBUTION BY FACILITY TYPE

The number of individuals and the distribution of the annual whole-body exposures in each of 10 facility categories was reported to the central repository. For the purpose of 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 include radioactive waste handling and construction. "General Research" was a close second. As would be expected, the smallest contribution was from DOE offices. A summary of the data submitted 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 45 mrem. The highest average dose equivalent per individual monitored was observed at fuel processing facilities (342 mrem) and the lowest was observed for visitors to DOE facilities (7 mrem). The average dose equivalent per individual monitored with a measurable exposure was 157 mrem. The highest average dose equivalent for all monitored employees was observed at fuel processing facilities (412 mrem) and the lowest was observed for visitors (58 mrem).

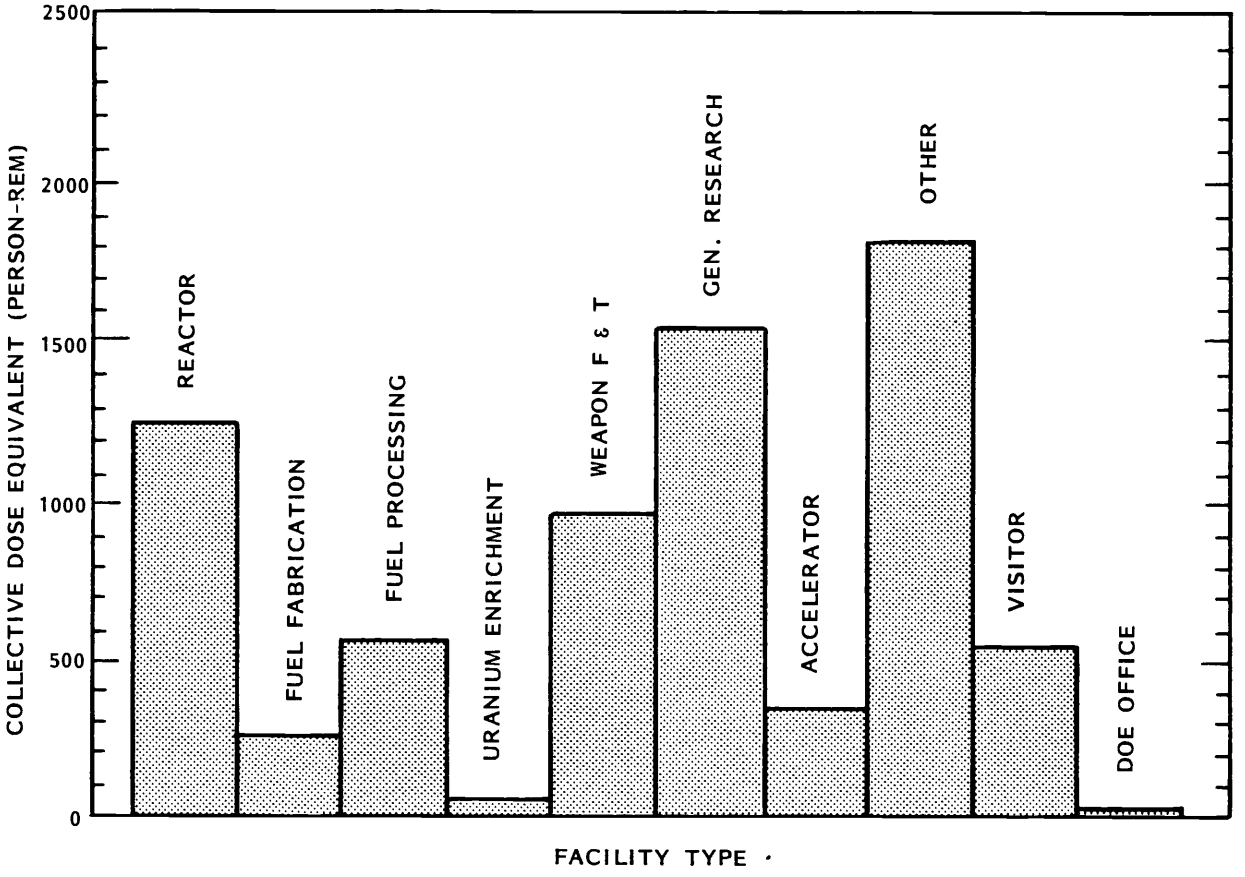

FIGURE 5. Contribution of Each Facility Type to the Total Collective Dose Equivalent, 1981

TABLE 4. Distribution of Annual Whole-Body Exposures for All Employees, 1981

Facility Type	Total Monitored	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	10-11	11-12	>12	
Reactor	7,352	2,631	2,805	749	512	232	115	207	99	2										1,274
Fuel Fab	1,337	255	576	178	173	76	42	35	2											267
Fuel Proc	1,729	293	594	219	243	137	95	106	42											592
Uran Enrch	2,000	1,162	722	90	24	2														62
Weapon F&T	18,062	10,485	6,158	607	376	209	100	118	9											973
Gen Research	31,604	20,661	8,789	1,039	537	208	129	165	49	22	5									1,535
Accelerator	3,591	2,066	906	292	144	73	44	53	12	1										348
Other	15,011	6,015	5,912	1,382	779	372	214	283	50	4										1,813
Visitors	84,343	74,338	9,710	187	63	29	10	5	1											579
DOE Offices	2,187	1,541	612	26	8															38
TOTAL	167,216	119,447	36,784	4,769	2,859	1,338	749	972	264	29	5									7,481
TOTAL PERSON-REM			1,840	835	1,073	836	656	1,458	660	101	22									7,481

TABLE 5. Collective Dose Equivalent for DOE/DOE Contractor Employers and Visitors by Facility Type, 1981

Facility Type	No. Individuals Monitored	No. Individuals With Measurable Exposure	Total No. Person-rem	Average Dose Equivalent (mrem) Per Individual Monitored	Average Dose Equivalent (mrem) Per Individual Monitored With Measurable Exposures
Reactor	7,352	4,721	1,274	173	270
Fuel Fab.	1,337	1,082	267	200	247
Fuel Proc.	1,729	1,436	592	342	412
Uran. Enrich.	2,000	838	62	31	74
Weapon F&T	18,062	7,577	973	54	128
Gen. Research	31,604	10,943	1,535	49	140
Accelerator	3,591	1,525	348	97	228
Other	15,011	8,996	1,813	121	202
Visitors	84,343	10,005	579	7	58
DOE Offices	2,187	646	38	17	59
TOTAL	167,216	47,769	7,481	45	157

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 what fraction of the collective dose equivalent is attributed to each facility type. Trends in collective dose equivalent from 1976 to 1981 can be observed for each field organization in Table 8.

TABLE 6. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1981

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 Exposures
Albuquerque	31,682	18,926	2,024	64	107
Chicago	15,113	4,348	758	50	174
Idaho	31,772	1,775	302	10	170
Nevada	25,704	321	34	1	106
Oak Ridge	5,387	2,230	437	81	196
Pittsburgh Naval Reactor	2,615	2,037	185	71	91
Richland	9,677	7,861	2,093	216	266
San Francisco	29,520	2,119	171	6	81
Savannah River	13,588	6,879	1,401	103	204
Schenectady Naval Reactor	2,144	1,273	76	35	60
TOTAL[a]	167,216	47,769	7,481	45	157

(a)Note: Energy Tech Centers: report 14 persons monitored all 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, 1981

Field Organization	Facility Type									
	Reactor	Fuel Fab.	Fuel Proc.	Uran. Enrich.	Weapon F&T	Gen. Research	Acceler.	Other	Visitor	DOE Office
Albuquerque					0.44	0.35		<0.01	0.20	0.01
Chicago	0.20					0.19	0.45	0.07	0.09	
Idaho	0.41							0.57		0.02
Nevada					0.47				0.53	
Oak Ridge		0.25		0.14	0.12	0.43		0.04	0.02	
Pittsburgh Naval Reactor	0.39					0.54		0.01	0.05	0.01
Richland	0.33	0.02				0.08		0.55	0.02	<0.01
San Francisco					<0.01	0.58	0.05	0.26	0.11	
Savannah River	0.13	0.09	0.42		0.01	0.07		0.27	0.01	<0.01
Schenectady Naval Reactor	0.61					0.30		0.01	0.07	0.01
TOTAL	0.17	0.04	0.08	0.01	0.13	0.20	0.05	0.24	0.08	<0.01

TABLE 8. Collective Dose Equivalent for DOE/DOE Contractor Employees and Visitors by Field Organization, 1976-1981[a]

Field Organization	1976	1977	1978	1979[b]	1980	1981
Albuquerque	1,437	2,300	2,399	1,873	1,700	2,024
Chicago	1,354	1,373	1,167	1,061	918	758
Idaho	790	929	899	876	593	302
Nevada	25	49	47	55	50	34
Oak Ridge	1,351	1,300	1,566	1,332	604	437
Pittsburgh Naval Reactor	1,609	653	252	196	186	185
Richland	2,265	3,197	2,596	2,571	2,256	2,093
San Francisco	285	334	307	264	240	171
Savannah River	1,278	1,298	1,289	1,343	1,391	1,401
Schenectady Naval Reactor	203	148	111	114	79	76
TOTAL	10,597	11,581	10,635	9,693	8,024	7,481

(a) Throughout this report, minor variations in collective dose-equivalent values may occur due to computer rounding.
(b) The 1979 data differ slightly from those listed in the 1979 report because of an error in the dose-equivalent calculation by a contractor.

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% 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.

Of 10 reported internal deposition cases for 1981, six are considered new and are included in Table 9. The four remaining cases are not included for the following reasons: in two cases, the current burden has decreased from the measured level of previous years. These instances are judged as continued tracking of a previous uptake. In two other cases, the reported current burden was slightly higher than was previously measured, indicating either a re-evaluation of the burden, or a possible new uptake.

TABLE 9. Dose Distributions for Cases of Internal Body Depositions, 1977-1981

Year	Radionuclide	Critical Organ	Dose Equivalent Interval (rem) 7.5-10	10-15	15-25	25-50	50-100	100-200
1977	^{238}Pu	Lung	1		1	1		
1978	^{239}Pu, ^{240}Pu, ^{241}Pu	Lung	1					
	^{125}I	Thyroid	1					
1979	^{234}U, ^{235}U, ^{238}U	Lung	2					
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					

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

(b) One individual exceeded 100% 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.

SUMMARY OF WORKER TERMINATIONS

A total of 10,193 monitored workers terminated their employment with DOE or DOE contractors in 1981. 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 1981 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 2.92 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 1981

Length of Employment	Number of Terminated Employees	Total Cumulative Dose Equivalent (Person-rem)	Average Cumulative Dose Equivalent Per Terminated Employee (rem)
1-90 days	2,368	1118.52	0.47
90-180 days	1,044	266.91	0.26
180-365 days	1,042	366.29	0.35
1-2 years	1,228	388.31	0.32
2-4 years	1,385	594.68	0.43
4-6 years	753	466.29	0.62
>6 years	2,373	6935.83	2.92

APPENDIX A

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY FACILITY TYPE FOR EACH DOE FIELD ORGANIZATION, 1981

TABLE A.1
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
ALBUQUERQUE FIELD ORGANIZATION
1981

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	8,117	1,091	5,823	487	309	186	96	116	9									889
Gen. Research	10,382	6,391	3,152	318	173	77	58	95	38	21	5							711
Accelerator																		
Other	72	45	18	5	4													3
Visitors	12,388	4,837	7,472	48	21	5	4	1										398
DOE Offices	777	392	367	13	5													23
TOTAL	31,682	12,756	16,832	871	512	268	158	212	47	21	5							2,024
TOTAL PERSON-REM			842	152	192	168	138	318	118	73	23							2,024

TABLE A.2
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
CHICAGO FIELD ORGANIZATION
1981

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	1,034	490	223	123	92	58	40	8										150
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	4,453	2,994	1,235	135	46	19	11	10	3									147
Accelerator	3,415	1,947	861	286	141	72	44	51	12	1								339
Other	750	558	136	19	15	6	1	4	9	2								56
Visitors	5,425	4,746	553	87	23	10	3	2	1									66
DOE Offices	36	30	6															
TOTAL	15,113	10,765	3,014	650	317	165	99	75	25	3								758
TOTAL PERSON-REM			151	114	119	103	87	112	62	10								758

TABLE A.3
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
IDAHO FIELD ORGANIZATION
1981

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	2,597	1,572	753	166	72	16	13	4		1								125
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research																		
Accelerator																		
Other	1,515	840	364	123	78	52	26	32										172
Visitors	27,445	27,441	4															
DOE Offices	215	144	68		3													5
TOTAL	31,772	29,997	1,189	289	153	68	39	36		1								302
TOTAL PERSON-REM			60	51	57	43	34	54		3								302

TABLE A.4
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
NEVADA FIELD ORGANIZATION
1981

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	9,342	9,162	148	26	4	1		1										16
Gen. Research																		
Accelerator																		
Other	343	342	1															
Visitors	15,282	15,147	93	26	10	4	1	1										18
DOE Offices	737	732	5															
TOTAL	25,704	25,383	247	52	14	5	1	2										34
TOTAL PERSON-REM			13	9	5	3	1	3										34

TABLE A.5
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
OAK RIDGE FIELD ORGANIZATION
1981

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	790	190	369	98	86	27	13	7										107
Fuel Processing																		
Uran. Enrichment	2,000	1,162	722	90	24	2												62
Weapon F&T	328	96	89	66	53	19	4	1										53
Gen. Research	878	481	67	110	103	51	18	42	5	1								188
Accelerator																		
Other	808	725	27	27	28	1												17
Visitors	583	503	66	6	3	3	1	1										10
DOE Offices																		
TOTAL	5,387	3,157	1,340	397	297	103	36	51	5	1								437
TOTAL PERSON-REM			67	70	111	64	32	77	13	3								437

TABLE A.6
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1981

Facility Type	Total Monitored	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	
Reactor	905	160	586	100	44	15												73
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,381	267	939	99	59	8	9											99
Accelerator																		
Other	27	9	17	1														1
Visitors	259	132	120		1	5	1											10
DOE Offices	43	10	29	4														2
TOTAL	2,615	578	1,691	204	104	28	10											185
TOTAL PERSON-REM			84	36	39	17	9											185

TABLE A.7
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
RICHLAND FIELD ORGANIZATION
1981

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	868	39	199	111	106	69	50	194	99	1								698
Fuel Fabrication	113		26	35	34	9	2	6	1									39
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	1,790	232	1,222	206	81	19	17	10	3									177
Accelerator																		
Other	5,186	504	2,929	669	435	234	154	220	39	2								1,142
Visitors	1,655	1,027	614	10	3	1												34
DOE Offices	65	14	44	7														3
TOTAL	9,677	1,816	5,034	1,038	659	332	223	430	142	3								2,093
TOTAL PERSON-REM			252	182	247	207	195	645	355	10								2,093

TABLE A.8
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SAN FRANCISCO FIELD ORGANIZATION
1981

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	108	98	6	3	1													1
Gen. Research	10,680	9,346	1,197	95	24	10	7	1										99
Accelerator	176	119	45	6	3	1		2										8
Other	816	418	311	61	12	4	5	5										45
Visitors	17,677	17,361	305	9	2													18
DOE Offices	63	59	4															
TOTAL	29,520	27,401	1,868	174	42	15	12	8										171
TOTAL PERSON-REM			93	30	16	9	11	12										171

TABLE A.9
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SAVANNAH RIVER FIELD ORGANIZATION
1981

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	1,130	251	408	199	186	73	12	1										183
Fuel Fabrication	434	65	181	45	53	40	27	22	1									121
Fuel Processing	1,729	293	594	219	243	137	95	106	42									592
Uran. Enrichment																		
Weapon F&T	167	38	92	25	9	3												14
Gen. Research	1,171	482	524	74	51	24	9	7										92
Accelerator																		
Other	5,473	2,563	2,099	477	207	75	28	22	2									375
Visitors	3,251	2,864	385	1		1												20
DOE Offices	233	153	78	2														4
TOTAL	13,588	6,709	4,361	1,042	749	353	171	158	45									1,401
TOTAL PERSON-REM			218	182	281	221	150	237	112									1,401

TABLE A.10
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY FACILITY TYPE
SCHENECTADY NAVAL REACTORS FIELD ORGANIZATION
1981

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	818	119	636	50	12	1												46
Fuel Fabrication																		
Fuel Processing																		
Uran. Enrichment																		
Weapon F&T																		
Gen. Research	909	454	453	2														23
Accelerator																		
Other	21	11	10															1
Visitors	378	280	98															5
DOE Offices	18	7	11															1
TOTAL	2,144	871	1,208	52	12	1												76
TOTAL PERSON-REM			61	9	5	1												76

APPENDIX B

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES BY CONTRACTOR FOR EACH DOE FIELD ORGANIZATION, 1981

TABLE B.1
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1981

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		687	4														35
Visitors																	
Total		687	4														35
General Electric Co.																	
Employees	230	133	12	6													11
Visitors	16	2															
Total	246	135	12	6													11
Inhalation Toxicology																	
Employees	283	64	4	5	3	2	1										11
Visitors	282	2															
Total	565	66	4	5	3	2	1										11
Mason & Hanger-Silas (Amarillo, TX)																	
Employees	355	258	101	78	60	15	49	8									204
Visitors	865	142															7
Total	1,220	400	101	78	60	15	49	8									211
Mason & Hanger-Silas (Los Alamos, NM)																	
Employees	51	30															2
Visitors																	
Total	51	30															2
Monsanto Research Co.																	
Employees	336	1,112	75	30	8	3	3										92
Visitors	793	103															5
Total	1,129	1,215	75	30	8	3	3										97

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1981

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
Rockwell International																	
Employees		3,603	287	195	118	78	63	1									543
Visitors		6,608															330
Total		10,211	287	195	118	78	63	1									873
Ross Aviation, Inc.																	
Employees	40	17	1														1
Visitors																	
Total	40	17	1														1
Sandia Laboratories, (Albuquerque, NM)																	
Employees	2,195	369	41	22	2	2	3	2	1								50
Visitors	1,918	181	15	11	2												17
Total	4,113	550	56	33	4	2	3	2	1								67
Sandia Laboratories, (Livermore, CA)																	
Employees	1,053	36	3	1													3
Visitors	162																
Total	1,215	36	3	1													3
Teledyne Isotopes																	
Employees	5	1	4	4													2
Visitors																	
Total	5	1	4	4													2
The Bendix Corp.																	
Employees	170	30	8				1										4
Visitors																	
Total	170	30	8				1										4

TABLE B.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
ALBUQUERQUE FIELD ORGANIZATION
1981

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
The Zia Company																	
Employees	791	579	46	18	8	2	2										54
Visitors																	
Total	791	579	46	18	8	2	2										54
University of California																	
Employees	2,018	2,074	224	127	64	52	89	36	20	5							592
Visitors	801	434	33	10	3	4	1										38
Total	2,819	2,508	257	137	67	56	90	36	20	5							630
TOTAL ALBUQUERQUE	12,364	16,465	858	507	268	158	212	47	21	5							2,001

TABLE B.2
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1981

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
Ames Laboratory																	
Employees	59	42	5	2													4
Visitors	92	2															
Total	151	44	5	2													4
Argonne National Lab.																	
Employees	2,053	400	148	108	72	42	9	3									189
Visitors	562	102	4	2													7
Total	2,615	502	152	110	72	42	9	3									196
Brookhaven National Lab.																	
Employees	471	984	212	93	39	38	38	9	1								262
Visitors	146	209	57	15	10	2	1	1									38
Total	617	1,193	269	108	49	40	39	10	1								300
Chicago Misc.																	
Employees	433	231	57	13	7	4	8	11	2								81
Visitors	355	24	1	1			1										3
Total	788	255	58	14	7	4	9	11	2								84
Fermi National Accel.																	
Employees	1,356	427	111	64	28	10	13										111
Visitors	2,224	187	25	5		1											16
Total	3,580	614	136	69	28	11	13										127
Massachusetts Inst.																	
Employees	287	97	25	9	7	2	5	1									29
Visitors	1,356	29															1
Total	1,643	126	25	9	7	2	5	1									30

TABLE B.2 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
CHICAGO FIELD ORGANIZATION
1981

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
Princeton University																	
Employees	1,253	266	2														14
Visitors																	
Total	1,253	266	2														14
TOTAL CHICAGO	10,647	3,000	647	312	163	99	75	25	3								754

TABLE B.3
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1981

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
Arrington Const.																	
Employees	1	1															
Visitors																	
Total	1	1															
Bendix Field Eng.																	
Employees	98	11	11	1													3
Visitors																	
Total	98	11	11	1													3
Biggers Const.																	
Employees	2	1	3	3													2
Visitors																	
Total	2	1	3	3													2
Bingham Mechanical																	
Employees	2	6															
Visitors																	
Total	2	6															
C-L Electric Company																	
Employees	2	3															
Visitors																	
Total	2	3															
EG&G, Idaho, Inc.																	
Employees	1,309	606	139	62	13	12	2	1									103
Visitors	20,716	2															
Total	22,025	608	139	62	13	12	2	1									103

TABLE B.3 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1981

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	
Exxon Nuclear Co.																	
Employees	627	199	95	75	51	25	28										150
Visitors	6,725	2															
Total	7,352	201	95	75	51	25	28										151
Idaho Miscellaneous																	
Employees	290	176	26	7	4	1	1										21
Visitors																	
Total	290	176	26	7	4	1	1										21
Jones-Boecon																	
Employees		2															
Visitors																	
Total		2															
Lehigh Design Co.																	
Employees	21	3															
Visitors																	
Total	21	3															
Morrison-Knudsen																	
Employees	53	99	15	2		1	4										15
Visitors																	
Total	53	99	15	2		1	4										15
Ormond Const.																	
Employees	7	7															
Visitors																	
Total	7	7															

TABLE B.3 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
IDAHO FIELD ORGANIZATION
1981

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	
Waters Asbestos																	
Employees		3					1										2
Visitors																	
Total		3					1										2
TOTAL IDAHO	29,853	1,121	289	150	68	39	36		1								297

TABLE B.4
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1981

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	45																
Visitors	5																
Total	50																
CER Geonuclear																	
Employees	1																
Visitors																	
Total	1																
Defense Nuclear Agency																	
Employees	406	1															
Visitors	4,930	12	3														1
Total	5,336	13	3														1
EG&G, Inc. (Las Vegas, NV)																	
Employees	1,153	33	2														2
Visitors	223	6	1														
Total	1,376	39	3														2
Environmental Protec.																	
Employees	173																
Visitors	63																
Total	236																
Fenix & Scisson, Inc.																	
Employees	296	22	6														2
Visitors	209																
Total	505	22	6														2

TABLE B.4 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
NEVADA FIELD ORGANIZATION
1981

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	
Holmes & Narver, Inc.																	
Employees	511	7	2														1
Visitors	325																
Total	836	7	2														1
Nevada Misc.																	
Employees	636	3	1														
Visitors	447																
Total	1,083	3	1														
Reynolds Electrical																	
Employees	5,816	78	15	4	1		1										10
Visitors	3,980																
Total	9,796	78	15	4	1		1										10
U.S. Department of Interior																	
Employees	118	2															
Visitors	13																
Total	131	2															
Wackenhut Services																	
Employees	251	2															
Visitors	12																
Total	263	2															
Westinghouse Electric																	
Employees	98	1															
Visitors	57																
Total	155	1															
TOTAL NEVADA	19,768	167	30	4	1		1										17

TABLE B.5
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1981

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	
Goodyear Atomic Corp.																	41
Employees	662	532	45	15	1												
Visitors																	41
Total	662	532	45	15	1												
National Lead Co.																	102
Employees	156	329	83	86	27	13	7										
Visitors																	102
Total	156	329	83	86	27	13	7										
Oak Ridge Assoc. Univ.																	3
Employees	465	20	5	2													
Visitors																	3
Total	465	20	5	2													
Puerto Rico Nuclear Ctr.																	
Employees	64	7															
Visitors																	
Total	64	7															
RMI Company																	5
Employees	34	40	15														
Visitors																	5
Total	34	40	15														
Rust Engineering Co.																	17
Employees	725	27	27	28	1												
Visitors																	17
Total	725	27	27	28	1												

TABLE B.5 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
OAK RIDGE FIELD ORGANIZATION
1981

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	
Union Carbide Corp./ORGDP																	
Employees	283	109	19	3	1												11
Visitors																	
Total	283	109	19	3	1												11
Union Carbide Corp./Y-12																	
Employees	93	79	68	54	13	3	4										53
Visitors																	
Total	93	79	68	54	13	3	4										53
Union Carbide Corp./ORNL																	
Employees	15	47	103	97	50	18	39	5	1								178
Visitors	439	59	6	3	3	1	1										9
Total	454	106	109	100	53	19	40	5	1								188
Union Carbide Corp./Paducah																	
Employees	217	81	26	6													11
Visitors																	
Total	217	81	26	6													11
Woven Structures, Inc.																	
Employees	4	10		3	7	1											7
Visitors																	
Total	4	10		3	7	1											7
TOTAL OAK RIDGE	3,157	1,340	397	297	103	36	51	5	1								436

TABLE B.6
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
PITTSBURGH NAVAL REACTOR FIELD ORGANIZATION
1981

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	
Duquesne Light Co.																	
Employees	1	228	62	15	4												30
Visitors	13	59		1	5	1											7
Total	14	287	62	16	9	1											38
Westinghouse Electric/BAPL																	
Employees	246	774	32	15	8	9											63
Visitors	93	55															3
Total	339	829	32	15	8	9											66
Westinghouse Electric/NRF																	
Employees	180	523	105	73	11												79
Visitors	26	6															
Total	206	529	105	73	11												79
Westinghouse Plant Appa.																	
Employees	9	17	1														1
Visitors																	
Total	9	17	1														1
TOTAL PITTSBURGH	568	1,662	200	104	28	10											183

TABLE B.7
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1981

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
Pacific Northwest Laboratory																	
Employees	180	765	107	32	3	9	5	1									89
Visitors	72	35		2	1												3
Total	252	800	107	34	4	9	5	1									92
BCS Richland Inc.																	
Employees		8															
Visitors	1	1															
Total	1	9															
Braun Hanford Co.																	
Employees	59	128	15	4													11
Visitors																	
Total	59	128	15	4													11
Hanford Eng. Dev. Lab.																	
Employees	86	843	128	52	16	8	5	2									114
Visitors	47	26															1
Total	133	869	128	52	16	8	5	2									115
Hanford Environ. Health Found.																	
Employees		4															
Visitors																	
Total		4															
J. A. Jones Const. Co.																	
Employees	156	587	151	177	156	110	167	36	2								663
Visitors	8	2															
Total	164	589	151	177	156	110	167	36	2								664

TABLE B.7 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
RICHLAND FIELD ORGANIZATION
1981

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
Rockwell Hanford Oper.																	
Employees	255	1,816	474	251	78	44	53	3									442
Visitors	572	443	6														23
Total	827	2,259	480	251	78	44	53	3									465
United Nuclear Ind. Inc.																	
Employees	39	225	146	140	78	52	200	100	1								737
Visitors	126	68	4	1													4
Total	165	293	150	141	78	52	200	100	1								742
TOTAL RICHLAND	1,601	4,951	1,031	659	332	223	430	142	3								2,088

TABLE B.8
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1981

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
Rockwell International Energy Systems Group																	
Employees	418	311	61	12	4	5	5										45
Visitors	341	76		1													4
Total	759	387	61	13	4	5	5										49
Stanford Linear Accel. Ctr.																	
Employees	119	44	6	2													4
Visitors																	
Total	119	44	6	2													4
University of California/LBL																	
Employees	1,445	433	39	4		1											31
Visitors																	
Total	1,445	433	39	4		1											31
University of California/LLNL																	
Employees	7,718	752	49	19	9	5	1										65
Visitors	16,098	224	9	1													13
Total	23,816	976	58	20	9	5	1										78
University of California/LEHR																	
Employees	83	8	2	1													1
Visitors																	
Total	83	8	2	1													1
University of California/LNM																	
Employees	78	4	5	1	2	1	2										7
Visitors																	
Total	78	4	5	1	2	1	2										7

TABLE B.8 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAN FRANCISCO FIELD ORGANIZATION
1981

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
University of California/MC																	
Employees	22	1															
Visitors																	
Total	22	1															
University of California/NTS																	
Employees	98	6	3	1													1
Visitors	922	5															
Total	1,020	11	3	1													1
TOTAL SAN FRANCISCO	27,342	1,864	174	42	15	12	8										171

TABLE B.9
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SAVANNAH RIVER FIELD ORGANIZATION
1981

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/SRP-Opns. Energy Systems Group																	
Employees	2,506	2,760	697	588	310	155	147	45									1,143
Visitors	2,864	385	1		1												20
Total	5,370	3,145	698	588	311	155	147	45									1,163
E. I. Du Pont/SRP-Const.																	
Employees	1,090	1,113	341	161	42	16	11										232
Visitors																	
Total	1,090	1,113	341	161	42	16	11										232
Savannah River Ecol Lab																	
Employees	46	16	1														1
Visitors																	
Total	46	16	1														1
Southern Bell Tel.																	
Employees	35	4															
Visitors																	
Total	35	4															
U. S. Forest Service																	
Employees	15	5															
Visitors																	
Total	15	5															
TOTAL SAVANNAH RIVER	6,556	4,283	1,040	749	353	171	158	45									1,397

TABLE B.10
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES BY CONTRACTOR
SCHENECTADY NAVAL REACTORS FIELD ORGANIZATION
1981

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
General Electric Company																	
Employees	573	1,089	52	12	1												69
Visitors	280	98															5
Total	853	1,187	52	12	1												74
General Electric/MAO																	
Employees	11	10															1
Visitors																	
Total	11	10															1
TOTAL SCHENECTADY	864	1,197	52	12	1												74

APPENDIX C

DISTRIBUTION OF ANNUAL WHOLE-BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION, 1981

TABLE C.1
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION
1981

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	162	187	1														10
Amarillo Area Office	22	15	3														1
Dayton Area Office	5	15															1
Kansas City Area Office	14																
Los Alamos Area Office	183	97	7	3													7
Pinellas Area Office	5	3															
Rocky Flats Area Office		50	2	2													4
Sandia Area Office	1																
TOTAL	392	367	13	5													23
Chicago Operations	30	6															
Environmental Meas. Lab.	29	6	1	1													1
New Brunswick Lab.	59	2	2	4	2												3
TOTAL	118	14	3	5	2												4
Idaho Operations	144	68		3													5
TOTAL	144	68		3													5
Morgantown Energy TE	14																
TOTAL	14																

TABLE C.1 (Continued)
DISTRIBUTION OF ANNUAL WHOLE BODY EXPOSURES FOR DOE GOVERNMENT EMPLOYEES AND VISITORS BY DOE FIELD ORGANIZATION—1981

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	
Nevada Operations	5,615	80	22	10	4	1	1										16
TOTAL	5,615	80	22	10	4	1	1										16
Pittsburgh Naval Reactors	10	29	4														2
TOTAL	10	29	4														2
Richland Operations	215	83	7														5
TOTAL	215	83	7														5
San Francisco Operations	59	4															
TOTAL	59	4															
Savannah River Operations	153	78	2														4
TOTAL	153	78	2														4
Schenectady Naval Reactor	7	9															
West Milton Field Office		2															
TOTAL	7	11															1