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2004 Report on Occupational Radiation Exposures in Canada

Canada

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Abstract

The report provides statistics on occupational radiation exposures for use by regulatory authorities, organizations and private individuals. Out of a total of 147,342 monitored workers, 6 annual doses exceeded the regulatory limit of 50 mSv in 2003. Out of 60 specified job categories, 22 had a smaller annual average in 2003 than in 2002, 31 had a higher average, and 7 had the same average rounded to 0.01 mSv. Typically, the changes in average dose were small.

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Introduction

This series of reports provides statistics on occupational radiation exposures of monitored workers in Canada. The statistics are intended to assist regulatory authorities, organizations, and private individuals in comparing incurred occupational radiation exposures with national or provincial/territorial averages and trends in similar occupations. This report, as well as previous issues, can be found on the National Dose Registry's (NDR) web site[1] and downloaded, or obtained from the authors.

The information is based on the data in the NDR maintained by the Radiation Protection Bureau of Health Canada[1]. The Registry is a centralized record-keeping system containing dose information on all monitored workers in Canada. It includes data submitted by nuclear power generating stations, Atomic Energy of Canada Ltd., uranium mines, and dosimeter processing companies.

Information for input into the NDR is received either via a direct link or by mail in computer readable form.

The report provides data on the two consecutive years prior to the year in which the data are extracted from the database. The data for the second (i.e. more recent) year will be close to complete at the time of data extraction. Some changes may still occur, for which the most frequent causes are: (1) a high dose to a dosimeter is judged to be non-personal after investigation; (2) a job category of a worker is updated; or, (3) dosimeters or data are returned late. The report therefore contains preliminary data on the second year (Table 1), and more complete data on the first year (Tables 2-4).

For a description and a guide to interpretation of the data, the reader is referred to the next section "General comments". The section "Comments specific to this report" has been included to address situations that do not recur from year to year.

General comments

The statistics include doses as they exist in the database at the time they are extracted for analysis, which in the case of this report is October 15, 2004. Doses are assigned to the year in which the dosimeter was issued, even though some of the dosimeters may actually have been worn during part of the subsequent year. As the statistics are determined in the same manner each year, the annual dose figures are based on a 12-month period, though not necessarily the strict calendar year.

Dose records submitted by outside organizations such as nuclear power generating stations, uranium mines, and commercial processors, are included to the extent that they have been received. The doses are representative of the calendar year only if the fourth quarter records have been received by the time of analysis. When statistics are based on partial data, the fact is indicated in the section "Comments specific to this report".

All doses are in International System (SI) units and presented to the nearest hundredth of a millisievert (1 mSv = 100 mrem). For the external whole body doses various organizations have set recording thresholds from 0 to 0.2 mSv.

The words "dose" and "exposure" are used interchangeably in this report. Doses of different types of radiation are expressed in mSv and added to give the effective dose stated in the report. The following dose types may be included:

- External whole body gamma.
- External whole body high energy beta.
- External whole body X-ray.
- External whole body neutron.
- Internal whole body tritium, as determined by urinalysis.
- Radon progeny exposures, converted from WLM values (see below).

All types of exposure are given in one total. In Tables 3 and 4, the percentage contribution of radon progeny and tritium components are indicated for occupations related to mining and nuclear power generation, respectively. Skin doses and extremity doses are not included in the report but are recorded in the database.

In the NDR database, radon progeny exposures are expressed in Working Level Months (WLM), which are in most cases calculated by the mines on the basis of area monitoring[2]. In the report the radon progeny exposures are converted to equivalent doses (in mSv). The value used in this report is 5 mSv/WLM, in accordance with the radiation protection regulations[3] under the Nuclear Safety and Control Act.

Job category designations are based on a standard list provided by the Registry and are updated when the Registry is notified. The job category is selected by the organization from a standard list maintained by the NDR. The NDR keeps the most recent job category that an organization submits for a worker in a given year. However, a worker who has been monitored by more than one organization, can have records under more than one job category for the same year. Some organizations have their own job classifications schemes, and translate them into the Registry's standardized list prior to submission of the records.

In this report, the data are tabulated as follows:

2003: Preliminary analysis

Table 1:

Table 1 gives the annual dose distributions by job category.

2002: Final Analysis

Table 2:

Table 2 contains dose statistics by job category and province or territory.

Table 3:

Table 3 contains dose statistics by age and sex. In this table job categories have been grouped into "job sectors".

Table 4:

Table 4 contains various dose statistics by job category. The table also shows the parameters of the statistical distribution applied to the doses, as determined by maximum likelihood estimation. From that information, it is possible to calculate estimates and confidence intervals of statistics of the distribution. For a more detailed discussion the reader is referred to the Appendix.

Table 4 also includes an accumulated dose distribution over the 5 year period 1998-2002 for the workers under the given job category.

Finally, Table 4 contains a histogram that shows the trend in average annual doses over the period 1993-2002 where data is available.

It should be noted that in the tables, a worker is counted more than once if he (she) works in more than one job category, in more than one province, or in more than one job sector in the same year. For this reason the totals in Tables 2-4 may slightly differ.

Comments specific to this report

The delay in this year's annual report is due to the late reporting of doses.

A new dose distribution has been designed and used to model dose data. One can obtain dose estimates from the parameters listed in table 4 using numerical integration. In most cases it is necessary to divide the interval of integration into sections that are small enough for standard numerical integration routines to give accurate results. Details are given in the Appendix. Software has been written to calculate estimates and their confidence intervals.

A beta version will be made available. No liability is assumed for any adverse outcome from using the software. Comments and suggestions are welcome.

References

1. The National Dose Registry's web site is found at http://www.hc-sc.gc.ca/ndr .

2. ICRP publication 65, "Protection against Radon-222 at home and at work.", Annals of the ICRP 23(2), p.4 (1993).

3. Regulations of the *Nuclear Safety and Control Act*, Canada Gazette, June 21, 2000, part 2. For more information see the web site of the CNSC:

   http://www.nuclearsafety.gc.ca

   or see:

   http://laws.justice.gc.ca/en/N-28.3/index.html

4. Kumazawa, S. and Numakunai, T. "A new theoretical analysis of occupational dose distributions indicating the effect of dose limits.", Health Physics 41(3) pp. 465-475 (1981).

2003 Preliminary Analysis

Table 1
Breakdown of annual doses by job category for all of Canada

Job Category	Distribution of workers over dose intervals							Number of Workers	Avg. Dose (mSv)	Avg. of Positive Doses
	0 mSv	>0-1 mSv	>1-2 mSv	>2-5 mSv	>5-20 mSv	>20-50 mSv	>50 mSv			
Administration										
Administrator	408	211	6	0	0	0	0	625	0.12	0.35
Office staff	3294	595	15	3	1	0	0	3908	0.05	0.34
Safety officer	203	79	5	4	2	0	0	293	0.19	0.63
Industry and Research										
Aircrew	3	5	3	0	0	0	0	11	0.63	0.87
Ground transportation	30	35	8	6	3	0	0	82	0.72	1.14
Industrial radiographer	1150	518	185	341	466	47	2	2709	2.80	4.86
Instructor (non-medical)	173	37	1	3	1	0	0	215	0.18	0.92
Instrument technician	1528	601	46	28	17	0	1	2221	0.27	0.86
Laboratory technician (industrial)	2493	920	65	99	31	1	0	3609	0.26	0.84
Nuclear fuel processor	113	350	104	109	53	0	0	729	1.43	1.69
Scientist/Engineer (field)	602	556	41	22	8	1	0	1230	0.33	0.65
Scientist/Engineer (laboratory)	4922	1009	36	8	2	0	0	5977	0.05	0.31
Security	117	12	0	0	0	0	0	129	0.02	0.17
Tradesmen	119	68	3	1	1	0	0	192	0.16	0.43
Well logger	1045	652	133	64	20	0	0	1914	0.42	0.93
Medicine										
Chiropractor	995	83	4	1	0	0	0	1083	0.03	0.35
Dental assistant	12685	624	1	1	0	1	0	13312	0.01	0.23
Dental hygienist	8772	444	5	2	2	0	0	9225	0.01	0.25
Dental therapist/nurse	114	22	0	0	0	0	0	136	0.04	0.23
Dentist	7278	484	2	2	1	2	0	7769	0.02	0.34
Gynaecologist	9	2	0	0	0	0	0	11	0.03	0.19
Laboratory technician (medical)	3314	894	30	44	7	0	0	4289	0.10	0.46
Medical physicist	300	101	2	2	0	0	0	405	0.08	0.31
Medical radiation technologist	9879	3252	134	87	9	2	2	13365	0.11	0.44
Nuclear medicine technologist	321	466	340	490	82	1	0	1700	1.68	2.08
Nurse	4463	1529	66	22	5	0	0	6085	0.10	0.38
Physician	1672	752	74	27	9	0	0	2534	0.21	0.62
Radiation therapist	1158	590	23	16	6	0	1	1794	0.35	0.98
Radiologist (diagnostic)	1500	542	38	17	10	3	0	2110	0.19	0.67
Radiologist (therapeutic)	207	57	2	2	2	0	0	270	0.13	0.57
Veterinarian	2994	549	18	1	1	0	0	3563	0.05	0.31
Veterinary technician	2336	377	6	0	2	0	0	2721	0.04	0.29

Table 1 (Cont'd)
Breakdown of annual doses by job category for all of Canada

Job Category	Distribution of workers over dose intervals							Number of Workers	Avg. Dose (mSv)	Avg. of Positive Doses
	0 mSv	>0-1 mSv	>1-2 mSv	>2-5 mSv	>5-20 mSv	>20-50 mSv	>50 mSv			
Ward aid/orderly	1126	235	12	9	0	0	0	1382	0.08	0.41
Nuclear Power										
Reactor - administration	3690	468	91	77	51	0	0	4377	0.21	1.31
Reactor - chemical and radiation control	132	182	64	68	75	0	0	521	1.96	2.63
Reactor - construction	912	426	154	224	142	0	0	1858	1.19	2.34
Reactor - control technician	78	40	22	17	28	0	0	185	2.17	3.75
Reactor - electrical maintenance	599	415	133	176	85	0	0	1408	1.10	1.92
Reactor - fuel handling	24	20	20	26	37	0	0	127	3.34	4.12
Reactor - general maintenance	822	269	75	106	121	0	0	1393	1.12	2.73
Reactor - health physics	32	8	5	8	1	0	0	54	0.84	2.07
Reactor - industrial radiographer	9	33	8	24	19	0	0	93	2.82	3.12
Reactor - mechanical maintenance	480	424	190	263	272	0	0	1629	2.32	3.29
Reactor - operations	893	725	268	288	137	0	0	2311	1.14	1.85
Reactor - scientific/professional	1816	406	84	108	100	0	0	2514	0.55	1.98
Reactor - training	41	10	3	4	2	0	0	60	0.61	1.94
Reactor - visitor	4729	1092	233	317	218	0	0	6589	0.53	1.88
Uranium Mining										
Uranium mine mill maintenance	15	108	56	28	1	0	0	208	1.04	1.12
Uranium mine mill worker	35	90	75	54	6	0	0	260	1.35	1.56
Uranium mine nurse	4	9	0	0	0	0	0	13	0.21	0.30
Uranium mine office staff	52	93	0	0	0	0	0	145	0.14	0.22
Uranium mine support worker	8	66	24	38	7	0	0	143	1.64	1.74
Uranium mine surface maintenance	33	178	14	4	0	0	0	229	0.43	0.50
Uranium mine surface miner	13	17	6	2	4	0	0	42	1.19	1.72
Uranium mine surface personnel	62	94	14	12	0	0	0	182	0.47	0.72
Uranium mine surface support worker	165	193	6	1	0	0	0	365	0.16	0.29
Uranium mine underground maintenance	18	81	40	19	0	0	0	158	0.95	1.07
Uranium mine underground miner	49	60	35	80	50	0	0	274	2.57	3.13
Uranium mine underground personnel	16	38	23	20	0	0	0	97	1.06	1.27
Uranium mine visitor	81	36	2	1	0	0	0	120	0.14	0.44
Miscellaneous/Unknown										
Miscellaneous/unknown	19161	5267	464	315	138	2	0	25347	0.17	0.71

2002 Final Analysis

Table 2
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Administration													
Administrator	7	0	6	9	67	402	16	5	72	42	1	0	627
	0.02	0.00	0.06	0.36	0.06	0.18	0.00	0.04	0.11	0.19	0.00	0.00	0.16
Office staff	49	10	88	57	646	2028	245	92	403	282	13	2	3915
	0.03	0.04	0.02	0.04	0.01	0.07	0.01	0.01	0.06	0.04	0.01	0.00	0.05
Safety officer	3	1	6	6	30	103	15	8	34	15	0	0	221
	0.07	0.59	0.02	0.12	0.04	0.23	0.00	0.15	0.16	0.86	0.00	0.00	0.21
OVERALL	**59**	**11**	**100**	**72**	**743**	**2533**	**276**	**105**	**509**	**339**	**14**	**2**	**4763**
	0.03	**0.09**	**0.02**	**0.09**	**0.02**	**0.09**	**0.01**	**0.03**	**0.07**	**0.10**	**0.01**	**0.00**	**0.07**
Industry and Research													
Aircrew	0	0	0	0	1	12	0	0	0	0	0	0	13
	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.49
Ground transportation	0	0	0	0	54	107	27	17	4	3	0	0	212
	0.00	0.00	0.00	0.00	0.42	0.34	0.08	0.01	1.56	0.03	0.00	0.00	0.32
Industrial radiographer	62	0	79	112	378	672	29	196	1194	254	1	4	2981
	0.29	0.00	0.30	1.64	1.26	1.37	0.84	1.49	3.96	1.75	0.00	0.12	2.39
Instructor (non-medical)	9	2	13	8	36	61	7	20	31	22	0	0	209
	0.10	0.00	0.11	0.05	0.06	0.06	0.00	0.00	0.88	0.00	0.00	0.00	0.17
Instrument technician	82	0	188	62	453	1071	55	65	248	83	2	0	2309
	0.05	0.00	0.08	0.22	0.09	0.27	0.02	0.06	0.18	0.16	0.00	0.00	0.18
Laboratory technician (industrial)	59	7	51	62	982	1972	203	378	307	178	2	0	4201
	0.16	0.11	0.12	0.10	0.07	0.32	0.01	0.04	0.25	0.21	0.00	0.00	0.20
Nuclear fuel processor	1	0	0	0	0	690	0	0	5	0	0	0	696
	0.00	0.00	0.00	0.00	0.00	1.72	0.00	0.00	0.02	0.00	0.00	0.00	1.71
Scientist/Engineer (field)	34	0	25	24	78	773	15	93	139	102	11	0	1294
	0.08	0.00	0.08	0.31	0.03	0.29	0.02	0.04	0.24	0.26	0.19	0.00	0.24
Scientist/Engineer (laboratory)	89	3	165	18	2190	2302	129	101	1069	667	0	0	6733
	0.00	0.14	0.05	0.14	0.03	0.10	0.03	0.03	0.09	0.02	0.00	0.00	0.06
Security	0	0	0	0	0	10	0	0	0	0	0	0	10
	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05
Tradesmen	0	0	0	1	14	117	0	7	18	4	0	0	161
	0.00	0.00	0.00	0.30	0.01	0.15	0.00	0.07	0.06	0.00	0.00	0.00	0.12
Well logger	0	0	0	1	1	7	0	23	1511	13	0	0	1556
	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.12	0.40	0.11	0.00	0.00	0.39
OVERALL	**336**	**12**	**521**	**288**	**4187**	**7794**	**465**	**900**	**4526**	**1326**	**16**	**4**	**20375**
	0.10	**0.10**	**0.11**	**0.74**	**0.16**	**0.45**	**0.07**	**0.36**	**1.24**	**0.40**	**0.13**	**0.12**	**0.54**
Medicine													
Chiropractor	2	1	3	3	524	274	79	10	128	21	0	0	1045
	0.00	0.00	0.00	0.03	0.03	0.05	0.01	0.02	0.04	0.06	0.00	0.00	0.03
Dental assistant	145	36	293	170	2701	5524	825	346	1169	724	25	1	11959
	0.02	0.02	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01
Dental hygienist	49	18	200	118	2912	3801	468	146	457	343	7	2	8521
	0.01	0.06	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.00	0.00	0.01
Dental therapist/nurse	0	0	0	0	11	21	26	43	12	1	8	7	129
	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.13	0.00	0.00	0.33	0.04
Dentist	106	10	153	94	2890	2880	501	114	409	265	17	0	7439
	0.03	0.06	0.01	0.01	0.08	0.01	0.00	0.01	0.02	0.01	0.00	0.00	0.04

Table 2 (Cont'd)
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Gynaecologist	1	0	1	0	2	2	3	0	0	1	1	0	11
	0.00	0.00	0.17	0.00	0.06	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.04
Laboratory technician (medical)	33	0	120	8	1284	1816	144	55	266	236	3	2	3967
	0.04	0.00	0.03	0.05	0.13	0.12	0.03	0.08	0.19	0.06	0.23	0.00	0.12
Medical physicist	4	3	11	6	112	131	19	11	21	66	0	0	384
	0.04	0.06	0.09	0.14	0.04	0.07	0.15	0.05	0.11	0.04	0.00	0.00	0.06
Medical radiation technologist	305	50	221	394	3067	4722	674	693	1480	1492	35	10	13143
	0.07	0.19	0.10	0.11	0.09	0.12	0.04	0.06	0.12	0.10	0.04	0.05	0.10
Nuclear medicine technologist	21	6	52	42	513	616	63	25	139	189	0	0	1666
	1.50	0.84	1.81	1.40	2.01	1.76	1.37	1.77	1.63	0.79	0.00	0.00	1.68
Nurse	202	6	144	184	1235	2736	346	88	312	465	124	78	5920
	0.08	0.07	0.11	0.14	0.07	0.13	0.03	0.27	0.19	0.09	0.11	0.05	0.11
Physician	43	1	58	39	735	1063	86	30	185	196	2	5	2443
	0.19	0.00	0.10	0.27	0.22	0.22	0.12	1.16	0.12	0.20	0.00	0.00	0.22
Radiation therapist	19	5	43	39	324	808	46	80	125	281	0	0	1770
	0.38	0.30	0.13	0.11	0.15	0.10	0.10	1.46	0.10	0.11	0.00	0.00	0.18
Radiologist (diagnostic)	55	8	33	48	539	812	71	64	205	235	7	0	2077
	0.06	0.04	0.21	0.11	0.12	0.18	0.06	0.17	0.26	0.19	0.04	0.00	0.16
Radiologist (therapeutic)	1	1	5	9	71	108	9	7	20	28	0	0	259
	0.22	0.00	0.09	0.01	0.20	0.13	0.01	0.13	0.10	0.02	0.00	0.00	0.12
Veterinarian	46	54	159	74	850	861	200	181	677	551	0	10	3663
	0.05	0.19	0.06	0.13	0.02	0.06	0.02	0.05	0.09	0.05	0.00	0.00	0.06
Veterinary technician	40	7	78	48	457	554	144	77	421	404	0	3	2233
	0.01	0.05	0.04	0.06	0.01	0.05	0.01	0.03	0.08	0.04	0.00	0.00	0.04
Ward aid/orderly	14	7	17	38	819	341	84	23	53	87	9	9	1501
	0.03	0.23	0.02	0.06	0.06	0.09	0.01	0.13	0.14	0.03	0.07	0.00	0.07
OVERALL	**1086**	**213**	**1591**	**1314**	**19046**	**27070**	**3788**	**1993**	**6079**	**5585**	**238**	**127**	**68130**
	0.09	**0.15**	**0.11**	**0.13**	**0.12**	**0.11**	**0.04**	**0.15**	**0.12**	**0.10**	**0.07**	**0.05**	**0.11**
Nuclear Power													
Reactor - administration	0	0	0	354	491	3667	0	0	0	0	0	0	4512
	0.00	0.00	0.00	0.23	0.12	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Reactor - chemical and radiation control	0	0	0	28	29	412	0	0	0	0	0	0	469
	0.00	0.00	0.00	0.59	1.23	1.81	0.00	0.00	0.00	0.00	0.00	0.00	1.70
Reactor - construction	0	0	0	0	81	1759	0	0	0	0	0	0	1840
	0.00	0.00	0.00	0.00	0.24	1.70	0.00	0.00	0.00	0.00	0.00	0.00	1.64
Reactor - control technician	0	0	0	0	190	0	0	0	0	0	0	0	190
	0.00	0.00	0.00	0.00	1.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.35
Reactor - electrical maintenance	0	0	0	169	51	1222	0	0	0	0	0	0	1442
	0.00	0.00	0.00	0.39	1.42	0.90	0.00	0.00	0.00	0.00	0.00	0.00	0.86
Reactor - fuel handling	0	0	0	35	16	0	0	0	0	0	0	0	51
	0.00	0.00	0.00	4.59	2.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.99
Reactor - general maintenance	0	0	0	266	80	1171	0	0	0	0	0	0	1517
	0.00	0.00	0.00	0.63	2.43	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.77
Reactor - health physics	0	0	0	36	19	8	0	0	0	0	0	0	63
	0.00	0.00	0.00	1.12	0.07	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.69
Reactor - industrial radiographer	0	0	0	41	9	16	0	0	0	0	0	0	66
	0.00	0.00	0.00	3.36	4.33	1.00	0.00	0.00	0.00	0.00	0.00	0.00	2.92
Reactor - mechanical	0	0	0	310	178	1248	0	0	0	0	0	0	1736
	0.00	0.00	0.00	0.67	3.09	1.95	0.00	0.00	0.00	0.00	0.00	0.00	1.84

Table 2 (Cont'd)
Number of workers (top) and average whole body dose in mSv (bottom) by job category and province/territory

Job Sector and Category	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.	N.W.T.	Yukon	Canada
Reactor - operations	0	0	0	124	108	1957	0	0	0	0	0	0	2189
	0.00	0.00	0.00	0.61	1.24	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.97
Reactor - scientific/professiona	0	0	0	394	250	1877	0	0	0	0	0	0	2521
	0.00	0.00	0.00	0.72	0.40	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.54
Reactor - training	0	0	0	36	21	1	0	0	0	0	0	0	58
	0.00	0.00	0.00	0.40	0.69	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.56
Reactor - visitor	0	0	0	0	800	5820	0	0	0	0	0	0	6620
	0.00	0.00	0.00	0.00	0.00	0.77	0.00	0.00	0.00	0.00	0.00	0.00	0.67
OVERALL	**0**	**0**	**0**	**1793**	**2323**	**19158**	**0**	**0**	**0**	**0**	**0**	**0**	**23274**
	0.00	**0.00**	**0.00**	**0.70**	**0.65**	**0.84**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.81**
Uranium Mining													
Uranium mine electrician	0	0	0	0	0	0	0	4	0	0	0	0	4
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Uranium mine mill maintenance	0	0	0	0	0	0	0	182	0	0	0	0	182
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	0.00	0.00	0.00	1.24
Uranium mine mill worker	0	0	0	0	0	0	0	249	0	0	0	0	249
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.66	0.00	0.00	0.00	0.00	1.66
Uranium mine nurse	0	0	0	0	0	0	0	11	0	0	0	0	11
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.11
Uranium mine office staff	0	0	0	0	0	0	0	148	0	0	0	0	148
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.17
Uranium mine support worker	0	0	0	0	0	0	0	140	0	0	0	0	140
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.39	0.00	0.00	0.00	0.00	1.39
Uranium mine surface maintenance	0	0	0	0	0	0	0	204	0	0	0	0	204
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.50
Uranium mine surface miner	0	0	0	0	0	0	0	46	0	0	0	0	46
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	0.00	0.00	0.00	0.00	1.53
Uranium mine surface personnel	0	0	0	0	0	0	0	173	0	0	0	0	173
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.00	0.00	0.00	0.00	0.41
Uranium mine surface support	0	0	0	0	0	0	0	329	0	0	0	0	329
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.19
Uranium mine underground	0	0	0	0	0	0	0	128	0	0	0	0	128
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.73	0.00	0.00	0.00	0.00	0.73
Uranium mine underground miner	0	0	0	0	0	0	0	196	0	0	0	0	196
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.55	0.00	0.00	0.00	0.00	2.55
Uranium mine underground	0	0	0	0	0	0	0	82	0	0	0	0	82
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.00	0.00	0.00	0.75
Uranium mine visitor	0	0	0	0	0	0	0	151	0	0	0	0	151
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	0.00	0.00	0.32
OVERALL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2043**	**0**	**0**	**0**	**0**	**2043**
	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.91**	**0.00**	**0.00**	**0.00**	**0.00**	**0.91**

2002 Final Analysis

Table 3

Dose distribution broken down by job sector, age and sex.

			Sex			
Job Sector	Age	Statistic	Male	Female	Unknown	Overall
Administration	Below 25	Number of Workers	23	318	0	341
		Average dose (mSv)	0.08	0.02	0.00	0.02
	25-34	Number of Workers	102	925	0	1027
		Average dose (mSv)	0.25	0.03	0.00	0.05
	35-44	Number of Workers	265	1191	0	1456
		Average dose (mSv)	0.23	0.05	0.00	0.08
	45-54	Number of Workers	295	1111	0	1406
		Average dose (mSv)	0.24	0.05	0.00	0.09
	55 up	Number of Workers	136	386	0	522
		Average dose (mSv)	0.16	0.03	0.00	0.06
	Unknown	Number of Workers	0	1	0	1
		Average dose (mSv)	0.00	0.00	0.00	0.00
	Overall	**Number of Workers**	**821**	**3932**	**0**	**4753**
		Average dose (mSv)	**0.22**	**0.04**	**0.00**	**0.07**
Industry and Research	Below 25	Number of Workers	1259	733	0	1992
		Average dose (mSv)	1.58	0.15	0.00	1.05
	25-34	Number of Workers	4042	2057	0	6099
		Average dose (mSv)	0.87	0.09	0.00	0.61
	35-44	Number of Workers	4473	1495	0	5968
		Average dose (mSv)	0.59	0.13	0.00	0.47
	45-54	Number of Workers	3513	862	0	4375
		Average dose (mSv)	0.47	0.16	0.00	0.41
	55 up	Number of Workers	1526	221	0	1747
		Average dose (mSv)	0.39	0.14	0.00	0.36
	Unknown	Number of Workers	8	2	1	11
		Average dose (mSv)	0.11	0.00	0.00	0.08
	Overall	**Number of Workers**	**14821**	**5370**	**1**	**20192**
		Average dose (mSv)	**0.70**	**0.12**	**0.00**	**0.55**
Medicine	Below 25	Number of Workers	451	5258	0	5709
		Average dose (mSv)	0.25	0.06	0.00	0.07
	25-34	Number of Workers	3272	16164	0	19436
		Average dose (mSv)	0.23	0.08	0.00	0.11
	35-44	Number of Workers	5125	15129	0	20254
		Average dose (mSv)	0.16	0.12	0.00	0.13
	45-54	Number of Workers	4939	10451	0	15390
		Average dose (mSv)	0.12	0.11	0.00	0.11
	55 up	Number of Workers	3457	2918	0	6375
		Average dose (mSv)	0.10	0.10	0.00	0.10
	Unknown	Number of Workers	4	8	0	12
		Average dose (mSv)	0.00	0.01	0.00	0.01
	Overall	**Number of Workers**	**17248**	**49928**	**0**	**67176**
		Average dose (mSv)	**0.15**	**0.10**	**0.00**	**0.11**

Table3 (Cont'd)

Dose distribution broken down by job sector, age and sex.

			Sex			
Job Sector	Age	Statistic	Male	Female	Unknown	Overall
Nuclear Power	Below 25	Number of Workers	1061	249	0	1310
		Average dose (mSv)	0.67	0.19	0.00	0.58
		%tritium	12.46	15.88	0.00	12.68
	25-34	Number of Workers	2904	519	0	3423
		Average dose (mSv)	1.16	0.19	0.00	1.01
		%tritium	16.93	30.74	0.00	17.32
	35-44	Number of Workers	6140	897	0	7037
		Average dose (mSv)	1.10	0.29	0.00	0.99
		%tritium	16.88	18.72	0.00	16.95
	45-54	Number of Workers	6925	637	0	7562
		Average dose (mSv)	0.86	0.19	0.00	0.80
		%tritium	14.99	19.42	0.00	15.07
	55 up	Number of Workers	3181	108	0	3289
		Average dose (mSv)	0.48	0.08	0.00	0.47
		%tritium	14.47	25.00	0.00	14.53
	Unknown	Number of Workers	0	0	2	2
		Average dose (mSv)	0.00	0.00	0.00	2.44
		%tritium	0.00	0.00	3.28	3.28
	Overall	**Number of Workers**	**20211**	**2410**	**2**	**22623**
		Average dose (mSv)	**0.90**	**0.22**	**2.44**	**0.83**
		%tritium	**15.90**	**20.90**	**3.28**	**16.04**
Uranium Mining	Below 25	Number of Workers	109	26	0	135
		Average dose (mSv)	0.56	0.25	0.00	0.50
		% radon progeny	49.71	46.88	0.00	49.44
	25-34	Number of Workers	430	55	0	485
		Average dose (mSv)	1.20	0.36	0.00	1.10
		% radon progeny	46.23	43.18	0.00	46.12
	35-44	Number of Workers	589	58	0	647
		Average dose (mSv)	1.13	0.55	0.00	1.08
		% radon progeny	48.59	47.42	0.00	48.53
	45-54	Number of Workers	448	24	0	472
		Average dose (mSv)	0.89	0.46	0.00	0.87
		% radon progeny	47.03	74.55	0.00	47.77
	55 up	Number of Workers	203	7	0	210
		Average dose (mSv)	0.79	0.11	0.00	0.76
		% radon progeny	46.65	75.00	0.00	46.79
	Overall	**Number of Workers**	**1779**	**170**	**0**	**1949**
		Average dose (mSv)	**1.01**	**0.41**	**0.00**	**0.96**
		% radon progeny	**47.43**	**50.77**	**0.00**	**47.56**

2002 Final Analysis

Table 4
Dose Statistics by job category
Administrator

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	402	0.00	0.00
>0-1	219	83.84	0.38
>1-2	2	2.66	1.33
>2-5	4	11.73	2.93
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	627	98.23	0.16
			Five year period 1998 - 2002
0	675	0.00	0.00
>0-5	373	374.13	1.00
>5-25	2	16.99	8.49
>25-100	1	32.86	32.86
>100	0	0.00	0.00
Total	1051	423.98	0.40

Parameters of the distribution in 2002:

A: 0.7456
B: 0.2550
C: 0.0000
D: 1.6731
Sample size: 627

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

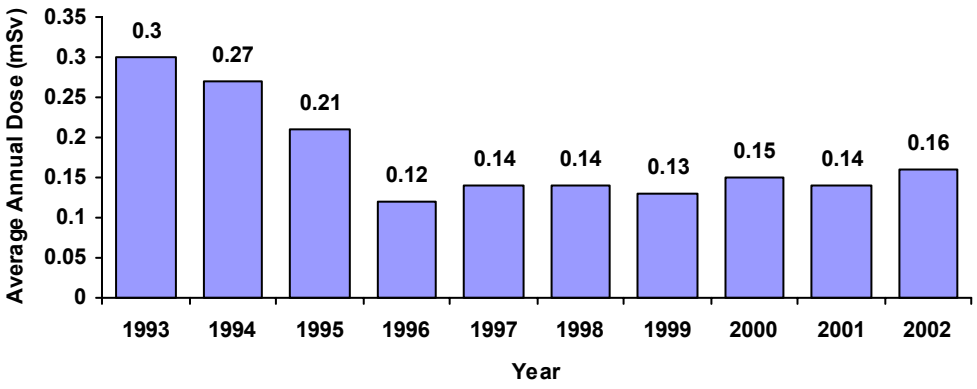


Table 4 (Cont'd)

Office staff

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	3354	0.00	0.00
>0-1	537	160.83	0.30
>1-2	18	24.45	1.36
>2-5	2	4.80	2.40
>5-20	1	5.30	5.30
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3912	195.38	0.05
			Five year period 1998 - 2002
0	5491	0.00	0.00
>0-5	1180	900.37	0.76
>5-25	17	136.74	8.04
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	6688	1037.11	0.16

Parameters of the distribution in 2002:

A: 0.5289
B: 0.2945
C: 0.0000
D: 2.1314
Sample size: 3912

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

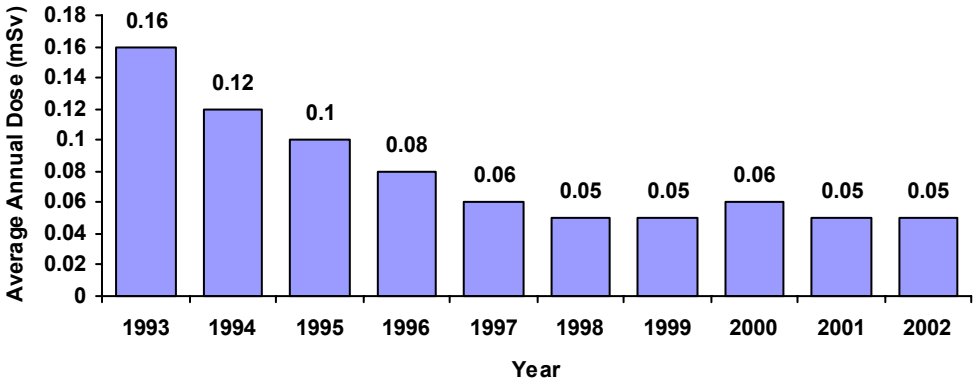


Table 4 (Cont'd)

Safety officer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	155	0.00	0.00
>0-1	57	19.52	0.34
>1-2	5	7.29	1.46
>2-5	3	9.20	3.07
>5-20	1	9.56	9.56
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	221	45.57	0.21
			Five year period 1998 - 2002
0	162	0.00	0.00
>0-5	110	80.75	0.73
>5-25	8	86.31	10.79
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	280	167.06	0.60

Parameters of the distribution in 2002:

A: 0.4754
B: 0.0381
C: 0.0000
D: 1.6130
Sample size: 221

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

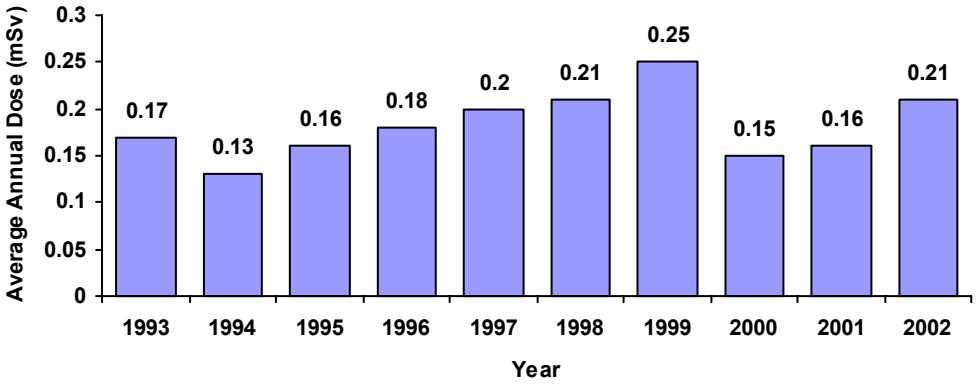


Table 4 (Cont'd)

Aircrew

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	6	0.00	0.00
>0-1	3	0.64	0.21
>1-2	4	5.71	1.43
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	13	6.35	0.49
			Five year period 1998 - 2002
0	7	0.00	0.00
>0-5	11	18.67	1.70
>5-25	1	5.53	5.53
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	19	24.20	1.27

Parameters of the distribution in 2002:

A: 0.0000
B: 0.7999
C: 0.0000
D: 0.0816
Sample size: 13

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

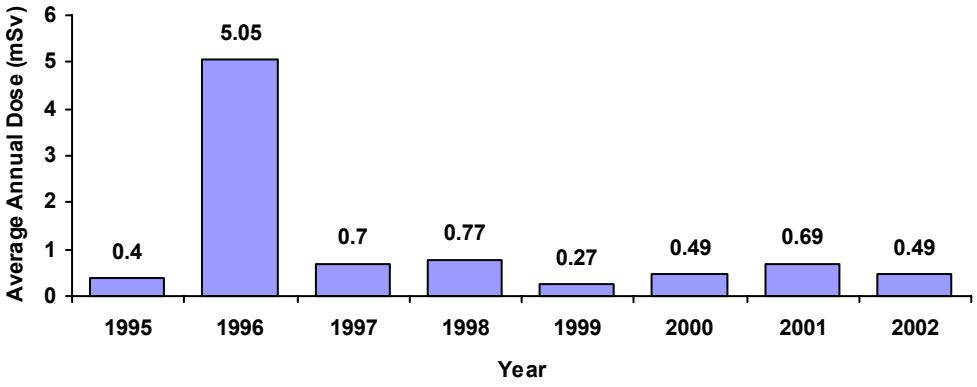


Table 4 (Cont'd)

Ground transportation

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	126	0.00	0.00
>0-1	67	24.12	0.36
>1-2	11	14.05	1.28
>2-5	6	18.10	3.02
>5-20	2	11.44	5.72
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	212	67.71	0.32
			Five year period 1998 - 2002
0	113	0.00	0.00
>0-5	96	98.57	1.03
>5-25	6	37.86	6.31
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	215	136.43	0.63

Parameters of the distribution in 2002:

A: 0.3437
B: 0.1854
C: 0.0000
D: 1.1102
Sample size: 212

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

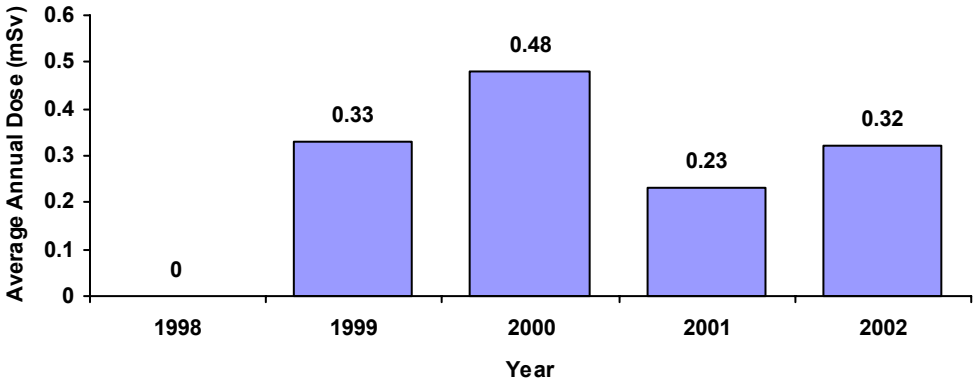


Table 4 (Cont'd)

Industrial radiographer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1239	0.00	0.00
>0-1	556	214.45	0.39
>1-2	219	327.74	1.50
>2-5	383	1253.77	3.27
>5-20	470	4624.76	9.84
>20-50	27	627.79	23.25
>50	1	67.10	67.10
Total	2895	7115.61	2.46
			Five year period 1998 - 2002
0	1772	0.00	0.00
>0-5	1340	1931.09	1.44
>5-25	944	12192.24	12.92
>25-100	496	22201.64	44.76
>100	12	2141.14	178.43
Total	4564	38466.11	8.43

Parameters of the distribution in 2002:

A: 0.1811
B: 0.0756
C: 0.0000
D: 0.2518
Sample size: 2895

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

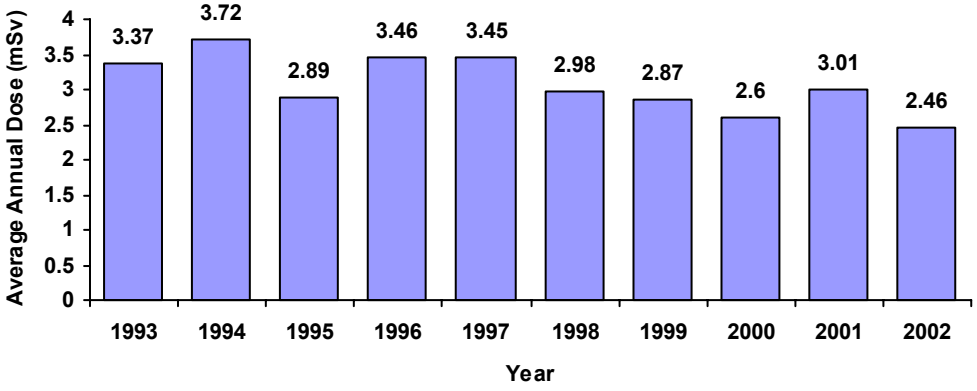


Table 4 (Cont'd)

Instructor (non-medical)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	180	0.00	0.00
>0-1	26	5.21	0.20
>1-2	2	3.11	1.56
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	1	27.15	27.15
>50	0	0.00	0.00
Total	209	35.47	0.17
			Five year period 1998 - 2002
0	284	0.00	0.00
>0-5	68	29.69	0.44
>5-25	0	0.00	0.00
>25-100	1	29.92	29.92
>100	0	0.00	0.00
Total	353	59.61	0.17

Parameters of the distribution in 2002:

A: 0.1286
B: 0.0102
C: 0.0977
D: 2.2846
Sample size: 209

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

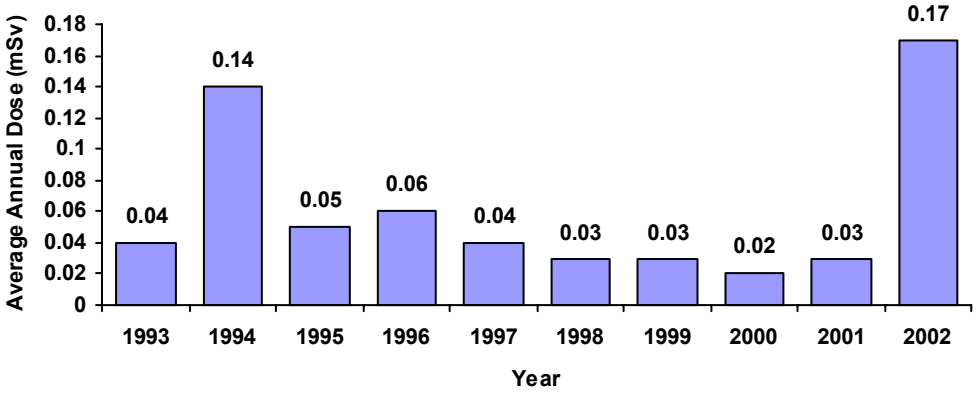


Table 4 (Cont'd)

Instrument technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1692	0.00	0.00
>0-1	530	158.92	0.30
>1-2	33	45.33	1.37
>2-5	39	131.14	3.36
>5-20	11	86.11	7.83
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	2305	421.50	0.18
			Five year period 1998 - 2002
0	2414	0.00	0.00
>0-5	1190	945.16	0.79
>5-25	90	901.83	10.02
>25-100	14	723.92	51.71
>100	1	125.54	125.54
Total	3709	2696.45	0.73

Parameters of the distribution in 2002:

A: 0.4086
B: 0.0421
C: 0.0211
D: 1.7134
Sample size: 2305

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

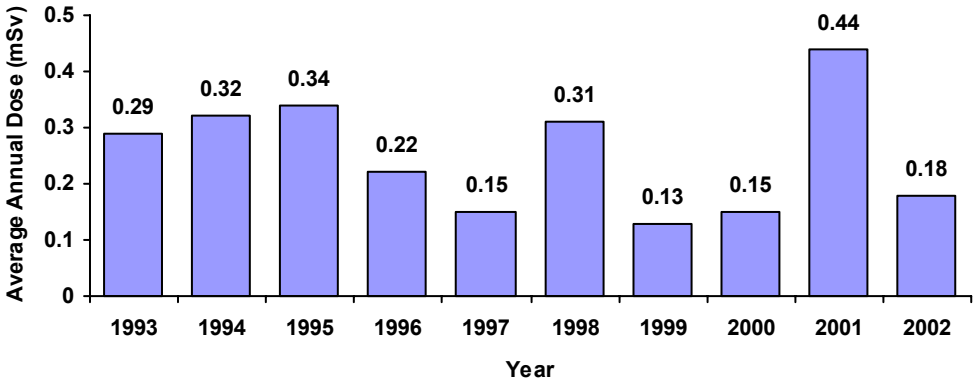


Table 4 (Cont'd)

Laboratory technician (industrial)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	3080	0.00	0.00
>0-1	929	286.13	0.31
>1-2	68	99.45	1.46
>2-5	103	310.20	3.01
>5-20	18	141.65	7.87
>20-50	1	21.80	21.80
>50	0	0.00	0.00
Total	4199	859.23	0.20
			Five year period 1998 - 2002
0	5285	0.00	0.00
>0-5	2168	1544.41	0.71
>5-25	172	1787.72	10.39
>25-100	8	330.31	41.29
>100	1	154.94	154.94
Total	7634	3817.38	0.50

Parameters of the distribution in 2002:

A: 0.3744
B: 0.0550
C: 0.0269
D: 1.6310
Sample size: 4199

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

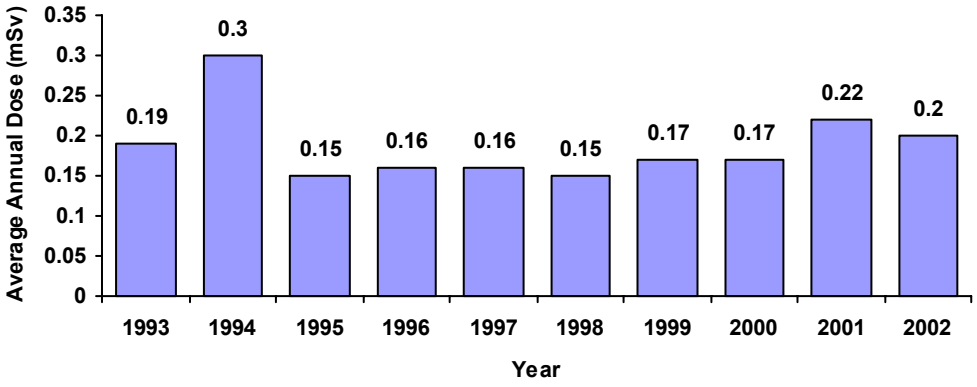


Table 4 (Cont'd)

Nuclear fuel processor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	156	0.00	0.00
>0-1	266	111.45	0.42
>1-2	101	154.93	1.53
>2-5	103	327.49	3.18
>5-20	69	522.35	7.57
>20-50	0	0.00	0.00
>50	1	71.40	71.40
Total	696	1187.62	1.71
			Five year period 1998 - 2002
0	93	0.00	0.00
>0-5	434	731.51	1.69
>5-25	227	2464.66	10.86
>25-100	20	718.04	35.90
>100	0	0.00	0.00
Total	774	3914.21	5.06

Parameters of the distribution in 2002:

A: 0.5162
B: 0.0400
C: 0.0000
D: 0.2683
Sample size: 696

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

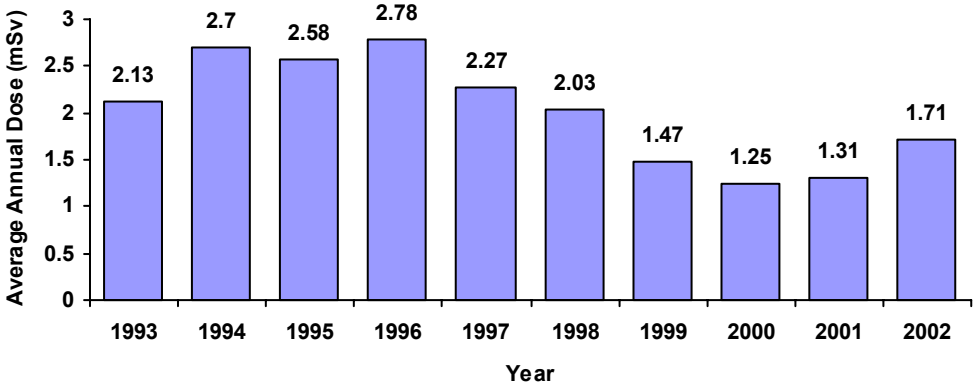


Table 4 (Cont'd)

Scientist/Engineer (field)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	669	0.00	0.00
>0-1	570	191.71	0.34
>1-2	32	43.28	1.35
>2-5	17	50.79	2.99
>5-20	3	22.05	7.35
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1291	307.83	0.24
			Five year period 1998 - 2002
0	1146	0.00	0.00
>0-5	1213	1277.86	1.05
>5-25	50	442.23	8.84
>25-100	6	182.94	30.49
>100	0	0.00	0.00
Total	2415	1903.03	0.79

Parameters of the distribution in 2002:

A: 0.7998
B: 0.0000
C: 0.0000
D: 1.6627
Sample size: 1291

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

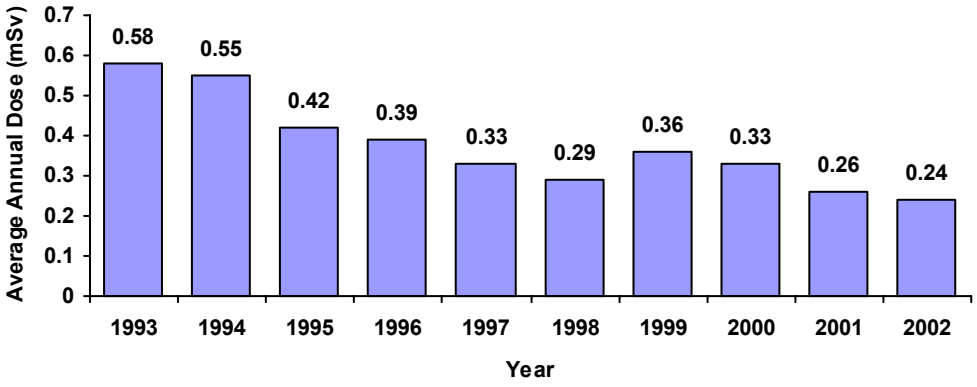


Table 4 (Cont'd)

Scientist/Engineer (laboratory)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	5425	0.00	0.00
>0-1	1250	287.67	0.23
>1-2	31	39.89	1.29
>2-5	14	44.31	3.16
>5-20	3	16.79	5.60
>20-50	1	28.40	28.40
>50	0	0.00	0.00
Total	6724	417.06	0.06
			Five year period 1998 - 2002
0	7984	0.00	0.00
>0-5	2826	1334.92	0.47
>5-25	19	167.02	8.79
>25-100	6	368.03	61.34
>100	1	153.67	153.67
Total	10836	2023.64	0.19

Parameters of the distribution in 2002:

A: 0.4370
B: 0.0000
C: 0.1158
D: 2.5546
Sample size: 6724

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

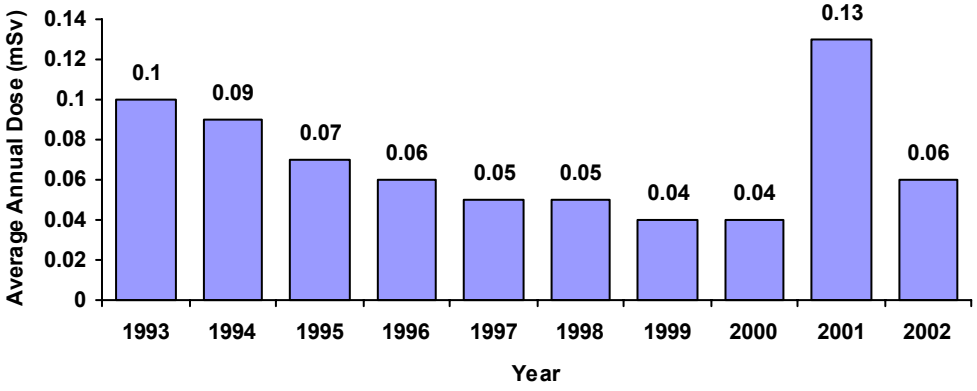


Table 4 (Cont'd)

Security

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	9	0.00	0.00
>0-1	1	0.51	0.51
>1-2	0	0.00	0.00
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	10	0.51	0.05
			Five year period 1998 - 2002
0	10	0.00	0.00
>0-5	1	0.69	0.69
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	11	0.69	0.06

Parameters of the distribution in 2002:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

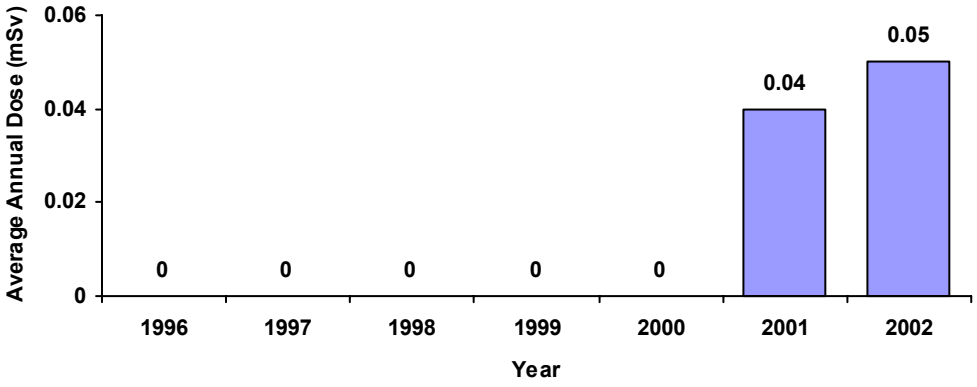


Table 4 (Cont'd)

Tradesmen

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	105	0.00	0.00
>0-1	53	14.46	0.27
>1-2	3	4.60	1.53
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	161	19.06	0.12
			Five year period 1998 - 2002
0	108	0.00	0.00
>0-5	82	65.99	0.80
>5-25	5	29.20	5.84
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	195	95.19	0.49

Parameters of the distribution in 2002:

A: 0.0000
B: 0.7593
C: 0.1308
D: 1.3693
Sample size: 161

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

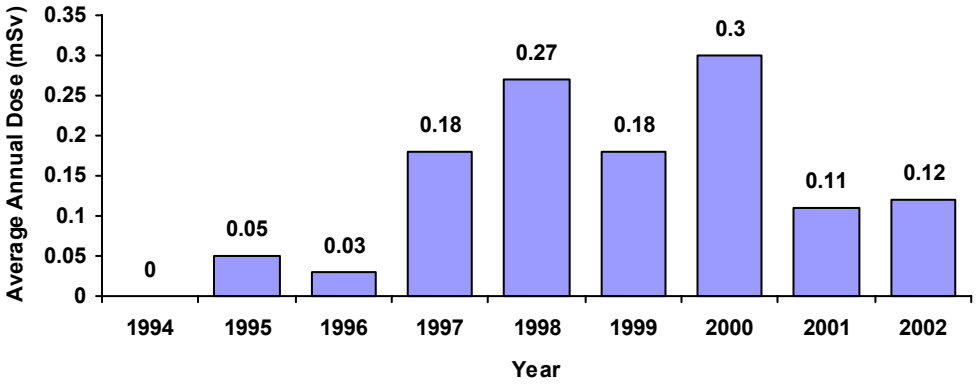


Table 4 (Cont'd)

Well logger

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	787	0.00	0.00
>0-1	598	229.06	0.38
>1-2	116	168.51	1.45
>2-5	43	122.00	2.84
>5-20	11	84.09	7.64
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1555	603.66	0.39
			Five year period 1998 - 2002
0	1071	0.00	0.00
>0-5	1372	1535.35	1.12
>5-25	122	1139.50	9.34
>25-100	8	269.34	33.67
>100	0	0.00	0.00
Total	2573	2944.19	1.14

Parameters of the distribution in 2002:

A: 0.5311
B: 0.1023
C: 0.0000
D: 1.1162
Sample size: 1555

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

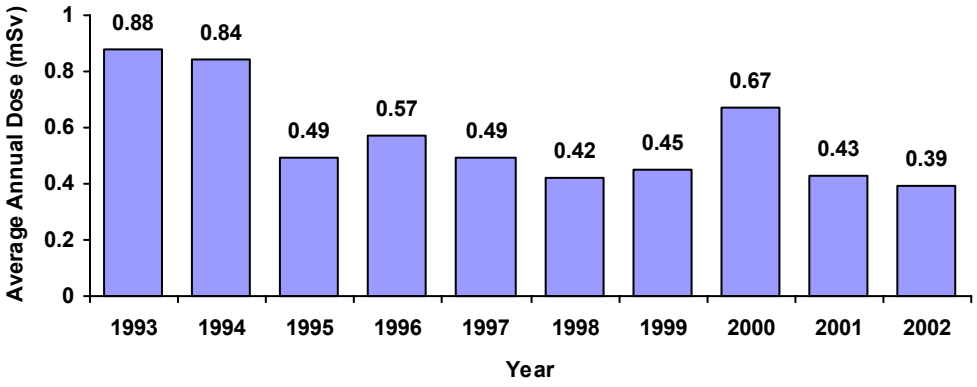


Table 4 (Cont'd)

Chiropractor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	957	0.00	0.00
>0-1	82	21.59	0.26
>1-2	3	4.04	1.35
>2-5	3	8.25	2.75
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1045	33.88	0.03
			Five year period 1998 - 2002
0	1193	0.00	0.00
>0-5	197	104.37	0.53
>5-25	5	34.33	6.87
>25-100	1	32.71	32.71
>100	0	0.00	0.00
Total	1396	171.41	0.12

Parameters of the distribution in 2002:

A: 0.0000
B: 0.3730
C: 0.0914
D: 2.1337
Sample size: 1045

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

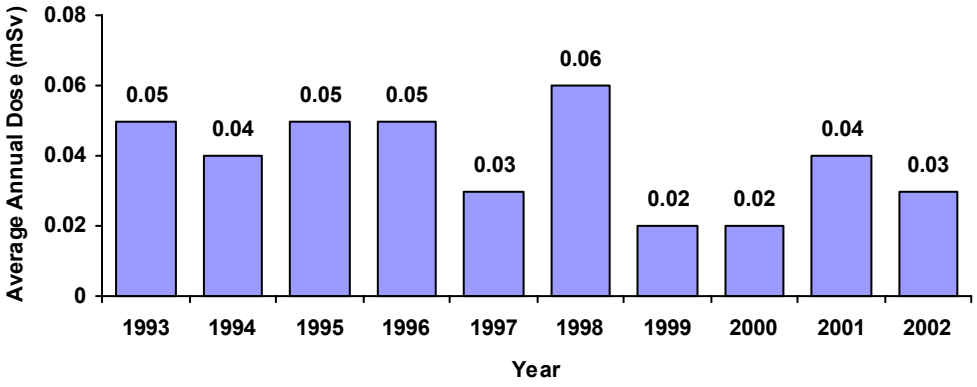


Table 4 (Cont'd)

Dental assistant

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	11523	0.00	0.00
>0-1	395	83.78	0.21
>1-2	10	14.30	1.43
>2-5	1	2.30	2.30
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	11929	100.38	0.01
			Five year period 1998 - 2002
0	17091	0.00	0.00
>0-5	1030	353.47	0.34
>5-25	5	47.30	9.46
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	18126	400.77	0.02

Parameters of the distribution in 2002:

A: 0.2547
B: 0.2835
C: 0.0873
D: 2.9614
Sample size: 11929

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

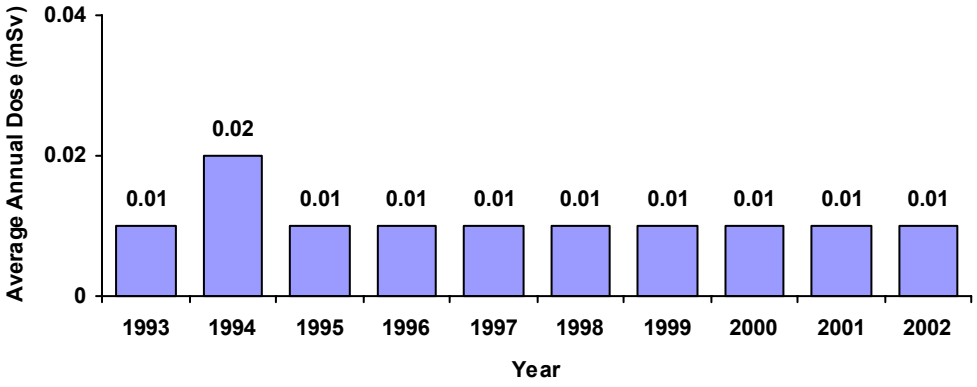


Table 4 (Cont'd)

Dental hygienist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	8233	0.00	0.00
>0-1	260	55.89	0.21
>1-2	2	2.80	1.40
>2-5	2	5.90	2.95
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	8497	64.59	0.01
			Five year period 1998 - 2002
0	10574	0.00	0.00
>0-5	755	268.68	0.36
>5-25	4	41.60	10.40
>25-100	0	0.00	0.00
>100	1	102.50	102.50
Total	11334	412.78	0.04

Parameters of the distribution in 2002:

A: 0.5403
B: 0.0000
C: 0.0467
D: 3.3100
Sample size: 8497

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

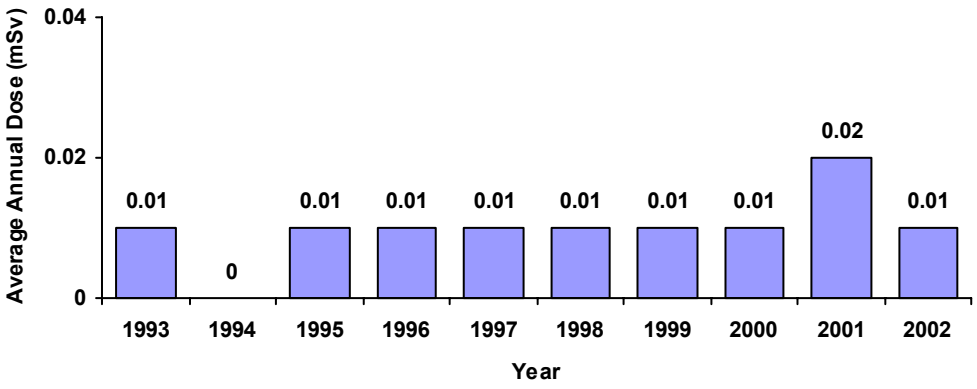


Table 4 (Cont'd)

Dental therapist/nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	114	0.00	0.00
>0-1	15	4.81	0.32
>1-2	0	0.00	0.00
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	129	4.81	0.04
			Five year period 1998 - 2002
0	160	0.00	0.00
>0-5	24	9.71	0.40
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	184	9.71	0.05

Parameters of the distribution in 2002:

A: 0.0000
B: 0.8726
C: 0.1024
D: 1.8326
Sample size: 129

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

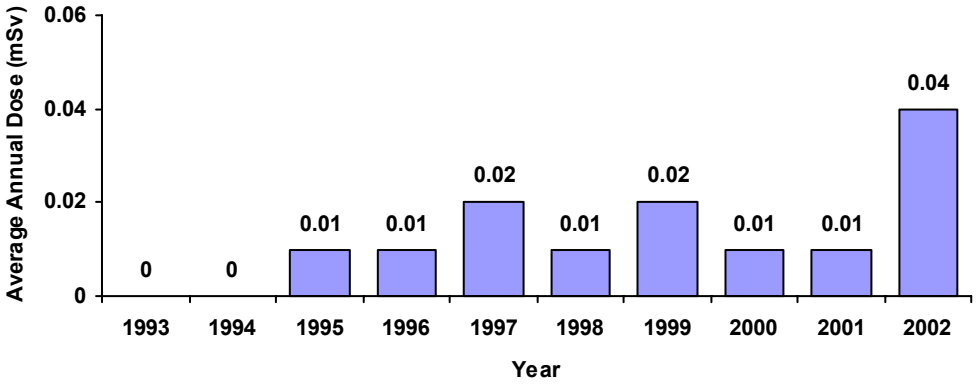


Table 4 (Cont'd)

Dentist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	7133	0.00	0.00
>0-1	275	58.13	0.21
>1-2	8	11.23	1.40
>2-5	1	3.60	3.60
>5-20	1	6.08	6.08
>20-50	0	0.00	0.00
>50	1	207.00	207.00
Total	7419	286.04	0.04
			Five year period 1998 - 2002
0	8382	0.00	0.00
>0-5	847	323.65	0.38
>5-25	2	36.79	18.40
>25-100	1	26.34	26.34
>100	1	207.00	207.00
Total	9233	593.78	0.06

Parameters of the distribution in 2002:

A: 0.2246
B: 0.0001
C: 0.1122
D: 3.0598
Sample size: 7419

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

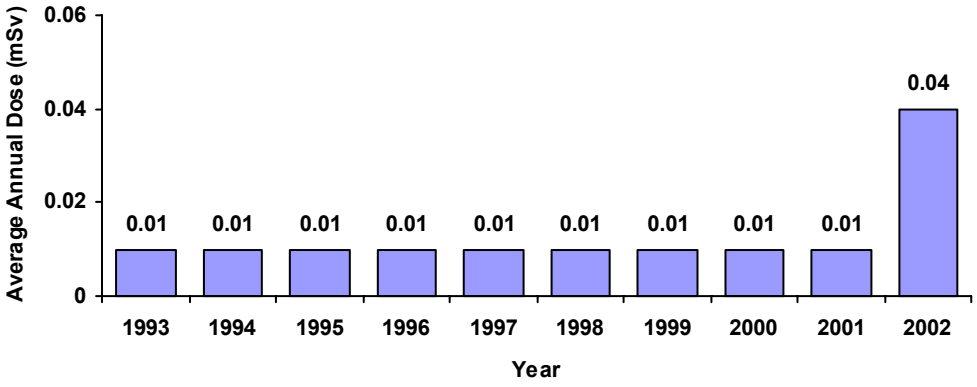


Table 4 (Cont'd)

Gynaecologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	8	0.00	0.00
>0-1	3	0.41	0.14
>1-2	0	0.00	0.00
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	11	0.41	0.04
			Five year period 1998 - 2002
0	23	0.00	0.00
>0-5	7	3.61	0.52
>5-25	0	0.00	0.00
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	30	3.61	0.12

Parameters of the distribution in 2002:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

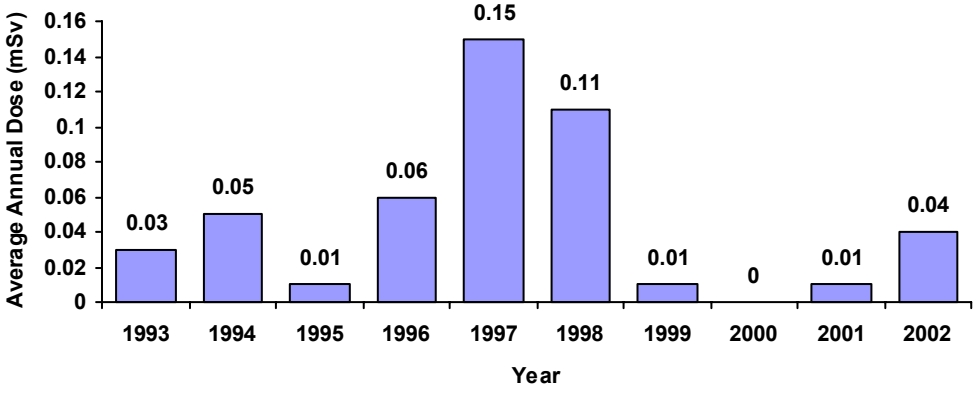


Table 4 (Cont'd)

Laboratory technician (medical)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	3168	0.00	0.00
>0-1	711	180.06	0.25
>1-2	33	47.21	1.43
>2-5	37	109.18	2.95
>5-20	17	122.59	7.21
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3966	459.04	0.12
			Five year period 1998 - 2002
0	5058	0.00	0.00
>0-5	1722	974.17	0.57
>5-25	48	423.04	8.81
>25-100	2	65.35	32.67
>100	1	197.30	197.30
Total	6831	1659.86	0.24

Parameters of the distribution in 2002:

A: 0.0780
B: 0.1085
C: 0.1523
D: 2.0366
Sample size: 3966

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

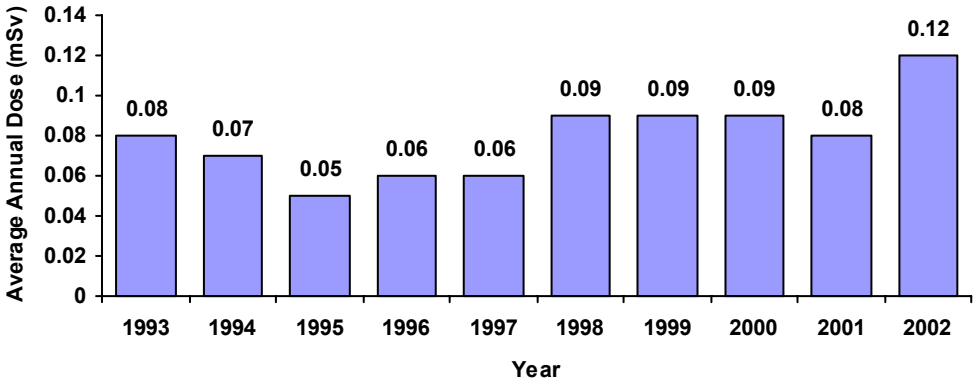


Table 4 (Cont'd)

Medical physicist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	297	0.00	0.00
>0-1	84	20.35	0.24
>1-2	1	1.10	1.10
>2-5	1	2.66	2.66
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	383	24.11	0.06
			Five year period 1998 - 2002
0	343	0.00	0.00
>0-5	164	88.23	0.54
>5-25	3	24.36	8.12
>25-100	2	91.90	45.95
>100	0	0.00	0.00
Total	512	204.49	0.40

Parameters of the distribution in 2002:

A: 0.0000
B: 0.2983
C: 0.2842
D: 2.4647
Sample size: 383

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

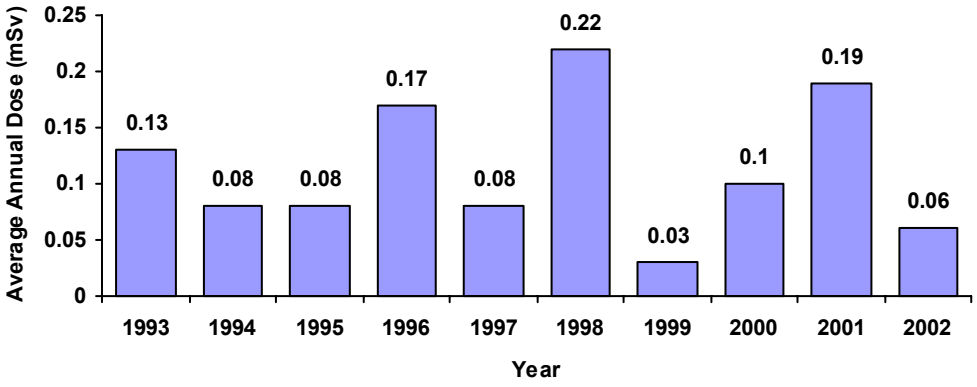


Table 4 (Cont'd)

Medical radiation technologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	9816	0.00	0.00
>0-1	2984	802.59	0.27
>1-2	138	190.57	1.38
>2-5	87	268.35	3.08
>5-20	10	84.30	8.43
>20-50	1	24.34	24.34
>50	0	0.00	0.00
Total	13036	1370.15	0.11
			Five year period 1998 - 2002
0	9582	0.00	0.00
>0-5	6146	3830.33	0.62
>5-25	137	1281.18	9.35
>25-100	3	94.68	31.56
>100	0	0.00	0.00
Total	15868	5206.19	0.33

Parameters of the distribution in 2002:

A: 0.5211
B: 0.0157
C: 0.0342
D: 2.0879
Sample size: 13036

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

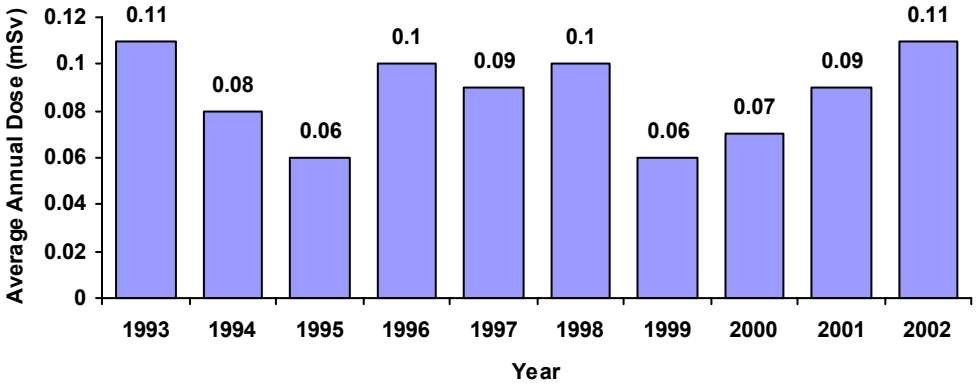


Table 4 (Cont'd)

Nuclear medicine technologist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	301	0.00	0.00
>0-1	432	217.87	0.50
>1-2	330	499.80	1.51
>2-5	528	1642.82	3.11
>5-20	63	445.80	7.08
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1654	2806.29	1.70
			Five year period 1998 - 2002
0	448	0.00	0.00
>0-5	914	1696.57	1.86
>5-25	802	8819.91	11.00
>25-100	32	1010.80	31.59
>100	0	0.00	0.00
Total	2196	11527.28	5.25

Parameters of the distribution in 2002:

A: 0.2500
B: 0.3176
C: 0.0000
D: -0.4217
Sample size: 1654

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

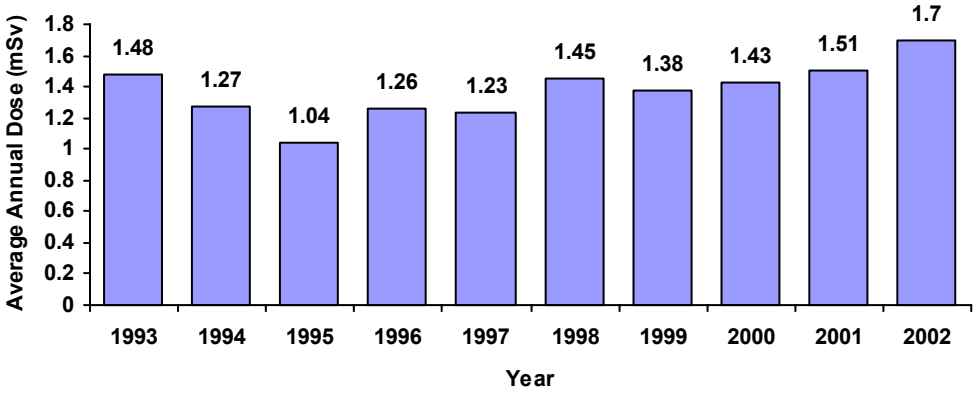


Table 4 (Cont'd)

Nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	4402	0.00	0.00
>0-1	1387	420.37	0.30
>1-2	103	137.78	1.34
>2-5	18	54.08	3.00
>5-20	7	48.84	6.98
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	5917	661.07	0.11
			Five year period 1998 - 2002
0	5705	0.00	0.00
>0-5	3193	2627.40	0.82
>5-25	53	420.91	7.94
>25-100	2	57.40	28.70
>100	0	0.00	0.00
Total	8953	3105.71	0.35

Parameters of the distribution in 2002:

A: 0.5847
B: 0.0659
C: 0.0000
D: 1.9244
Sample size: 5917

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

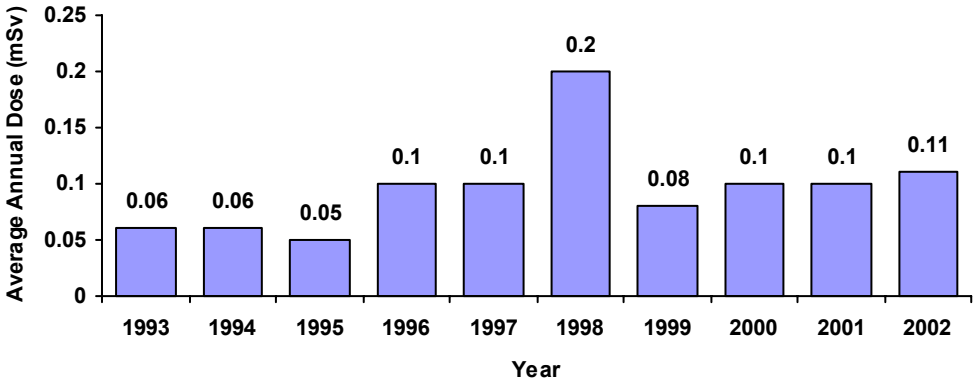


Table 4 (Cont'd)

Physician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1601	0.00	0.00
>0-1	702	220.42	0.31
>1-2	74	103.45	1.40
>2-5	38	109.64	2.89
>5-20	10	78.03	7.80
>20-50	1	22.98	22.98
>50	0	0.00	0.00
Total	2426	534.52	0.22
			Five year period 1998 - 2002
0	1869	0.00	0.00
>0-5	1391	1208.97	0.87
>5-25	79	676.78	8.57
>25-100	7	241.55	34.51
>100	0	0.00	0.00
Total	3346	2127.30	0.64

Parameters of the distribution in 2002:

A: 0.4651
B: 0.0326
C: 0.0394
D: 1.6562
Sample size: 2426

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

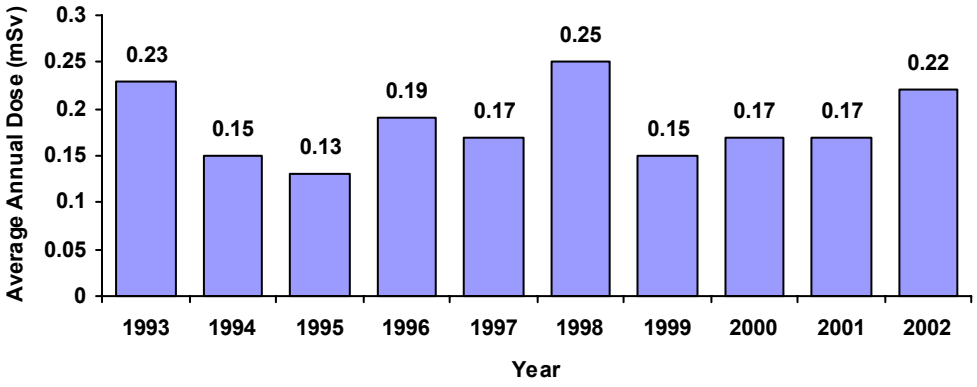


Table 4 (Cont'd)

Radiation therapist

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1146	0.00	0.00
>0-1	564	140.17	0.25
>1-2	14	19.63	1.40
>2-5	14	43.27	3.09
>5-20	2	13.41	6.70
>20-50	0	0.00	0.00
>50	1	100.83	100.83
Total	1741	317.31	0.18
			Five year period 1998 - 2002
0	997	0.00	0.00
>0-5	1034	657.45	0.64
>5-25	20	194.32	9.72
>25-100	2	81.40	40.70
>100	1	103.13	103.13
Total	2054	1036.30	0.50

Parameters of the distribution in 2002:

A: 0.3746
B: 0.0000
C: 0.1445
D: 2.2030
Sample size: 1741

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

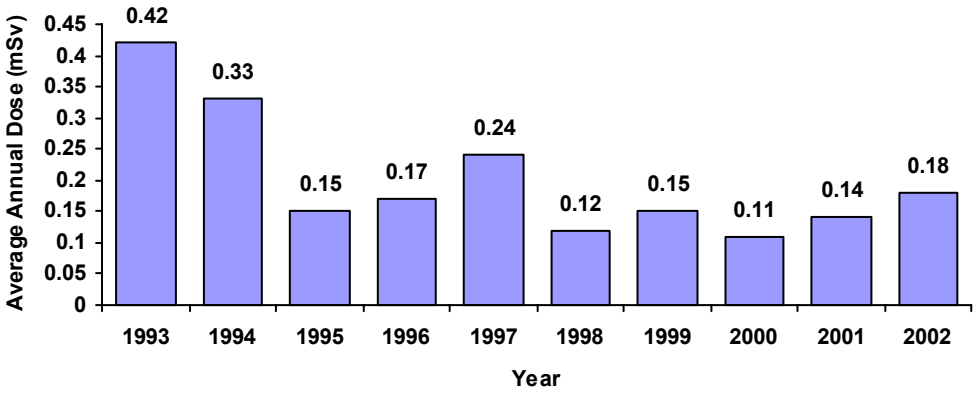


Table 4 (Cont'd)

Radiologist (diagnostic)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1507	0.00	0.00
>0-1	485	149.26	0.31
>1-2	43	61.06	1.42
>2-5	21	63.24	3.01
>5-20	7	68.67	9.81
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	2063	342.23	0.17
			Five year period 1998 - 2002
0	1441	0.00	0.00
>0-5	1100	890.99	0.81
>5-25	41	452.30	11.03
>25-100	6	208.25	34.71
>100	0	0.00	0.00
Total	2588	1551.54	0.60

Parameters of the distribution in 2002:

A: 0.5088
B: 0.0147
C: 0.0111
D: 1.7963
Sample size: 2063

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

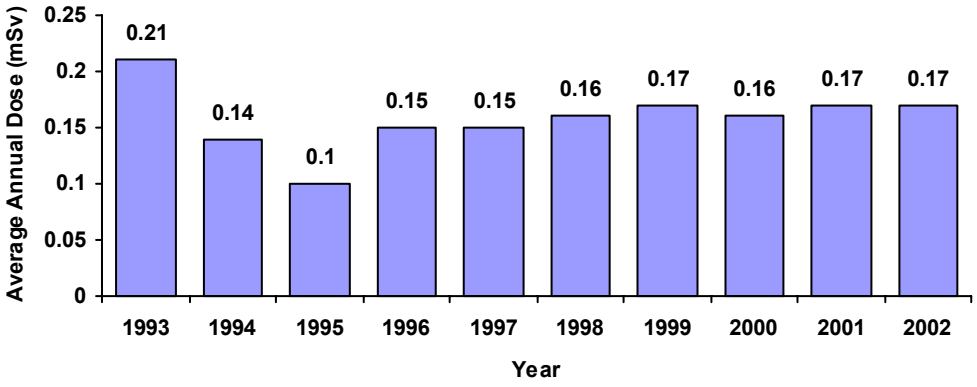


Table 4 (Cont'd)

Radiologist (therapeutic)

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	195	0.00	0.00
>0-1	58	14.27	0.25
>1-2	3	4.49	1.50
>2-5	2	5.20	2.60
>5-20	1	8.35	8.35
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	259	32.31	0.12
			Five year period 1998 - 2002
0	204	0.00	0.00
>0-5	123	73.67	0.60
>5-25	4	32.62	8.15
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	331	106.29	0.32

Parameters of the distribution in 2002:

A: 0.2266
B: 0.0833
C: 0.0791
D: 1.9371
Sample size: 259

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

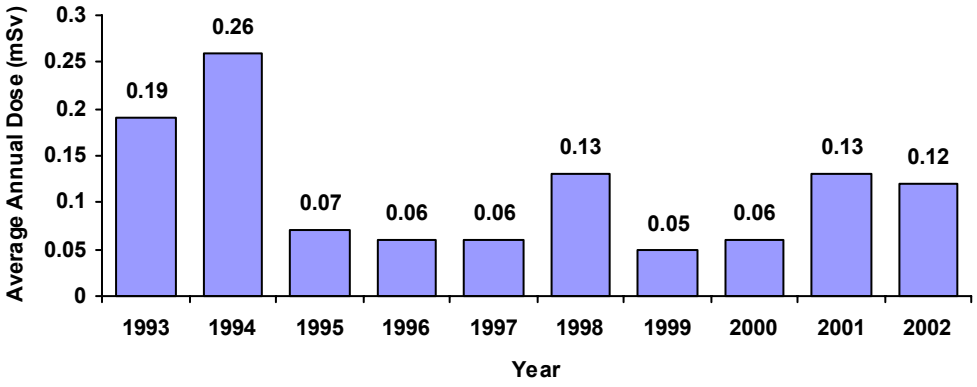


Table 4 (Cont'd)

Veterinarian

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	3075	0.00	0.00
>0-1	538	141.89	0.26
>1-2	23	31.08	1.35
>2-5	6	18.98	3.16
>5-20	1	11.35	11.35
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	3643	203.30	0.06
			Five year period 1998 - 2002
0	4563	0.00	0.00
>0-5	1183	580.25	0.49
>5-25	12	112.21	9.35
>25-100	1	34.30	34.30
>100	0	0.00	0.00
Total	5759	726.76	0.13

Parameters of the distribution in 2002:

A: 0.5760
B: 0.0190
C: 0.0000
D: 2.3353
Sample size: 3643

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

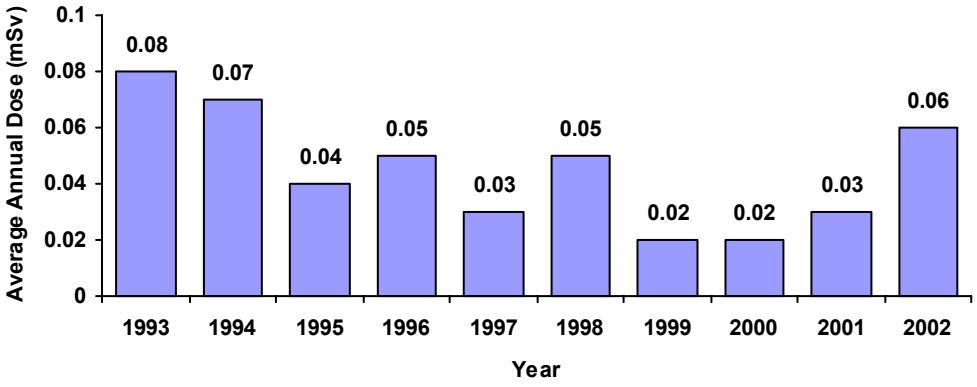


Table 4 (Cont'd)

Veterinary technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1931	0.00	0.00
>0-1	278	71.38	0.26
>1-2	17	25.05	1.47
>2-5	0	0.00	0.00
>5-20	0	0.00	0.00
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	2226	96.43	0.04
			Five year period 1998 - 2002
0	2785	0.00	0.00
>0-5	468	227.77	0.49
>5-25	1	13.20	13.20
>25-100	0	0.00	0.00
>100	0	0.00	0.00
Total	3254	240.97	0.07

Parameters of the distribution in 2002:

A: 0.0905
B: 0.5767
C: 0.0895
D: 1.9661
Sample size: 2226

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

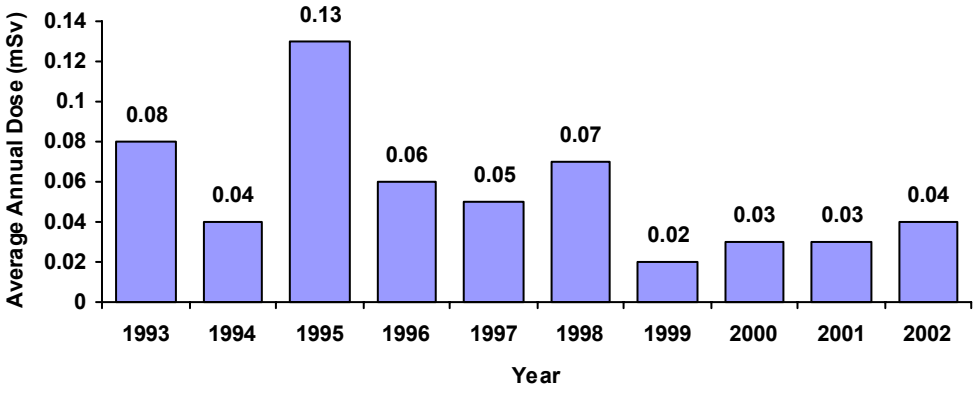


Table 4 (Cont'd)

Ward aid/orderly

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose
			Year 2002
0	1277	0.00	0.00
>0-1	206	57.07	0.28
>1-2	10	12.59	1.26
>2-5	7	23.49	3.36
>5-20	1	5.16	5.16
>20-50	0	0.00	0.00
>50	0	0.00	0.00
Total	1501	98.31	0.07
			Five year period 1998 - 2002
0	2052	0.00	0.00
>0-5	553	366.14	0.66
>5-25	18	153.76	8.54
>25-100	2	123.00	61.50
>100	0	0.00	0.00
Total	2625	642.90	0.24

Parameters of the distribution in 2002:

A: 0.4863
B: 0.0557
C: 0.0000
D: 2.1546
Sample size: 1501

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

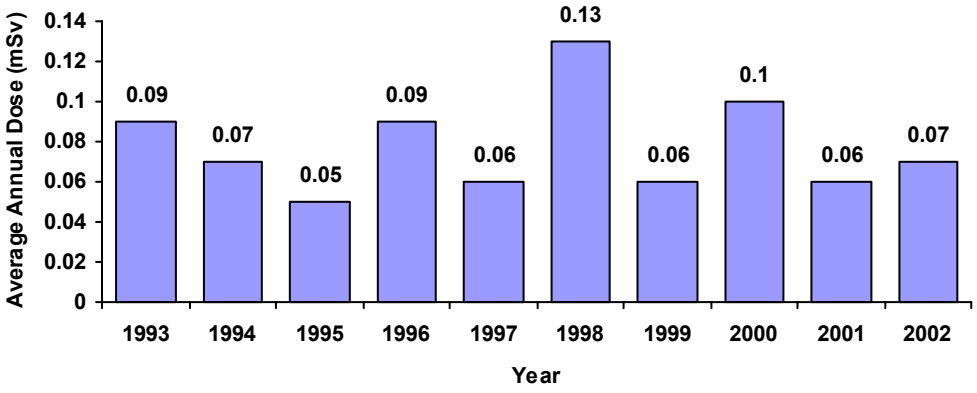


Table 4 (Cont'd)

Reactor - administration

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	3891	0.00	0.00	0
>0-1	428	114.60	0.27	44
>1-2	75	106.41	1.42	36
>2-5	81	246.45	3.04	29
>5-20	35	244.58	6.99	16
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	4510	712.04	0.16	28
				Five year period 1998 - 2002
0	5477	0.00	0.00	0
>0-5	1748	1458.22	0.83	36
>5-25	253	2540.63	10.04	33
>25-100	17	528.37	31.08	28
>100	0	0.00	0.00	0
Total	7495	4527.22	0.60	34

Parameters of the distribution in 2002:

A: 0.1656
B: 0.1206
C: 0.0000
D: 1.6000
Sample size: 4510

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

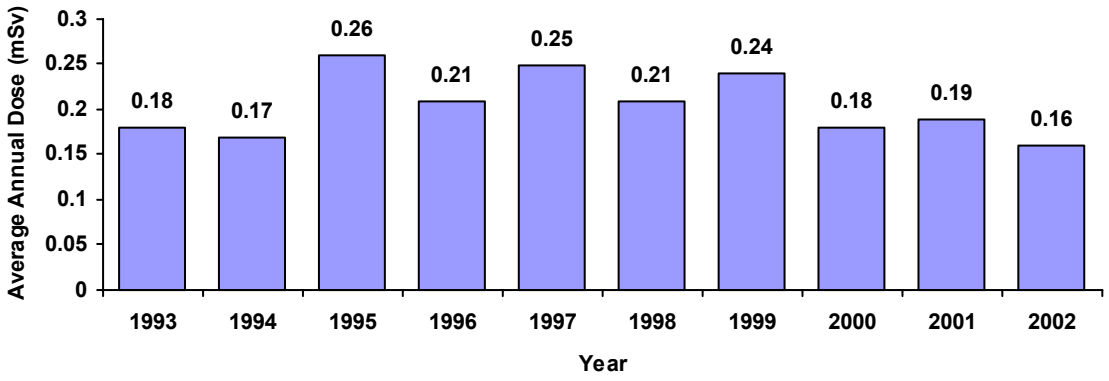


Table 4 (Cont'd)

Reactor - chemical and radiation control

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	142	0.00	0.00	0
>0-1	171	68.24	0.40	42
>1-2	49	71.51	1.46	29
>2-5	54	184.94	3.42	19
>5-20	53	474.89	8.96	18
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	469	799.58	1.70	21
				Five year period 1998 - 2002
0	142	0.00	0.00	0
>0-5	333	505.63	1.52	39
>5-25	128	1364.07	10.66	17
>25-100	30	1156.68	38.56	12
>100	0	0.00	0.00	0
Total	633	3026.38	4.78	19

Parameters of the distribution in 2002:

A: 0.3244
B: 0.0828
C: 0.0000
D: 0.2956
Sample size: 469

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

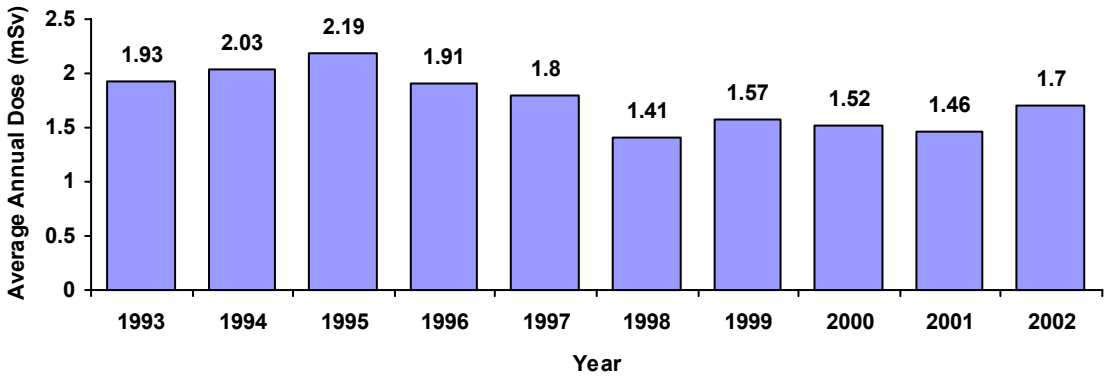


Table 4 (Cont'd)

Reactor - construction

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	904	0.00	0.00	0
>0-1	379	135.80	0.36	22
>1-2	157	221.45	1.41	17
>2-5	184	620.31	3.37	14
>5-20	211	1926.37	9.13	5
>20-50	5	106.95	21.39	2
>50	0	0.00	0.00	0
Total	1840	3010.88	1.64	8
				Five year period 1998 - 2002
0	1453	0.00	0.00	0
>0-5	1269	1913.18	1.51	17
>5-25	660	7695.76	11.66	11
>25-100	125	4397.38	35.18	10
>100	0	0.00	0.00	0
Total	3507	14006.32	3.99	11

Parameters of the distribution in 2002:

A: 0.1685
B: 0.0940
C: 0.0000
D: 0.4382
Sample size: 1840

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

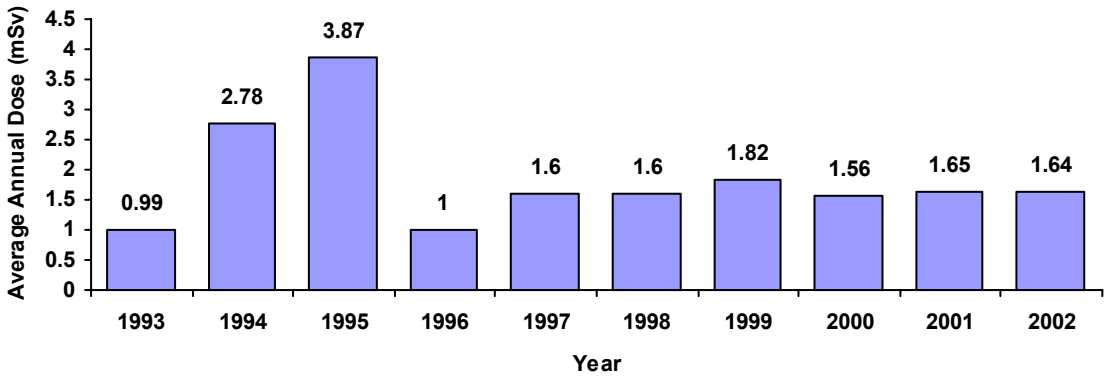


Table 4 (Cont'd)

Reactor - control technician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	83	0.00	0.00	0
>0-1	57	22.84	0.40	43
>1-2	15	20.88	1.39	24
>2-5	15	46.82	3.12	17
>5-20	20	165.76	8.29	4
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	190	256.30	1.35	12
				Five year period 1998 - 2002
0	124	0.00	0.00	0
>0-5	109	164.71	1.51	26
>5-25	56	580.34	10.36	13
>25-100	4	132.33	33.08	3
>100	0	0.00	0.00	0
Total	293	877.38	2.99	14

Parameters of the distribution in 2002:

A: 0.2084
B: 0.1081
C: 0.0000
D: 0.4602
Sample size: 190

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

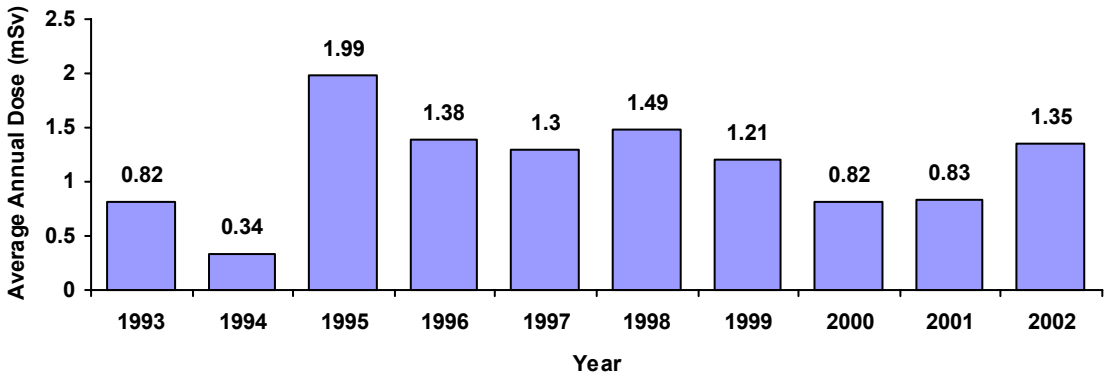


Table 4 (Cont'd)

Reactor - electrical maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	651	0.00	0.00	0
>0-1	465	173.03	0.37	36
>1-2	125	187.82	1.50	24
>2-5	139	433.80	3.12	14
>5-20	62	444.87	7.18	9
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	1442	1239.52	0.86	17
				Five year period 1998 - 2002
0	613	0.00	0.00	0
>0-5	946	1271.60	1.34	26
>5-25	303	3232.45	10.67	16
>25-100	29	880.94	30.38	11
>100	0	0.00	0.00	0
Total	1891	5384.99	2.85	17

Parameters of the distribution in 2002:

A: 0.2456
B: 0.1599
C: 0.0000
D: 0.5487
Sample size: 1442

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

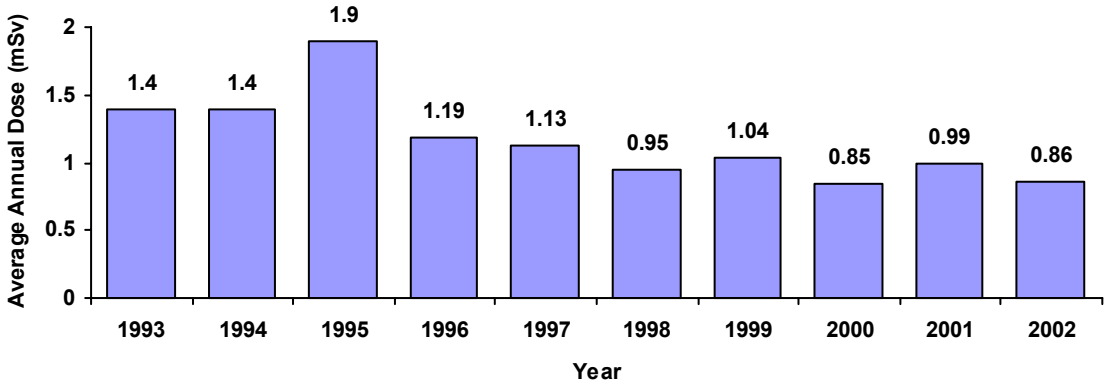


Table 4 (Cont'd)

Reactor - fuel handling

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	4	0.00	0.00	0
>0-1	10	2.65	0.26	33
>1-2	5	7.81	1.56	23
>2-5	15	50.33	3.36	17
>5-20	17	142.73	8.40	21
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	51	203.52	3.99	20
				Five year period 1998 - 2002
0	6	0.00	0.00	0
>0-5	27	45.50	1.69	15
>5-25	36	408.93	11.36	13
>25-100	19	735.81	38.73	22
>100	0	0.00	0.00	0
Total	88	1190.24	13.53	19

Parameters of the distribution in 2002:

A: 0.0000
B: 0.2203
C: 0.0461
D: -0.7254
Sample size: 51

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

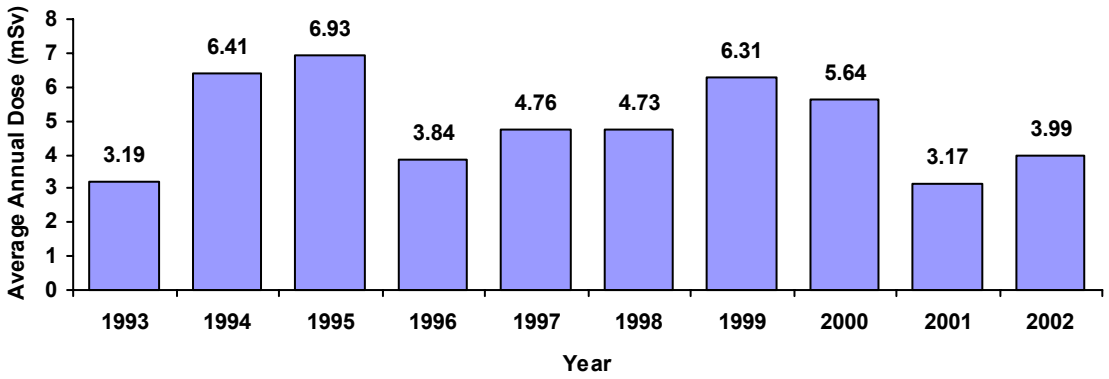


Table 4 (Cont'd)

Reactor - general maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	936	0.00	0.00	0
>0-1	318	95.73	0.30	28
>1-2	69	101.58	1.47	30
>2-5	124	409.19	3.30	18
>5-20	70	556.69	7.95	11
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	1517	1163.19	0.77	17
				Five year period 1998 - 2002
0	1456	0.00	0.00	0
>0-5	822	1018.92	1.24	23
>5-25	272	3002.50	11.04	16
>25-100	63	2228.59	35.37	12
>100	0	0.00	0.00	0
Total	2613	6250.01	2.39	16

Parameters of the distribution in 2002:

A: 0.1269
B: 0.1301
C: 0.0112
D: 0.8075
Sample size: 1517

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

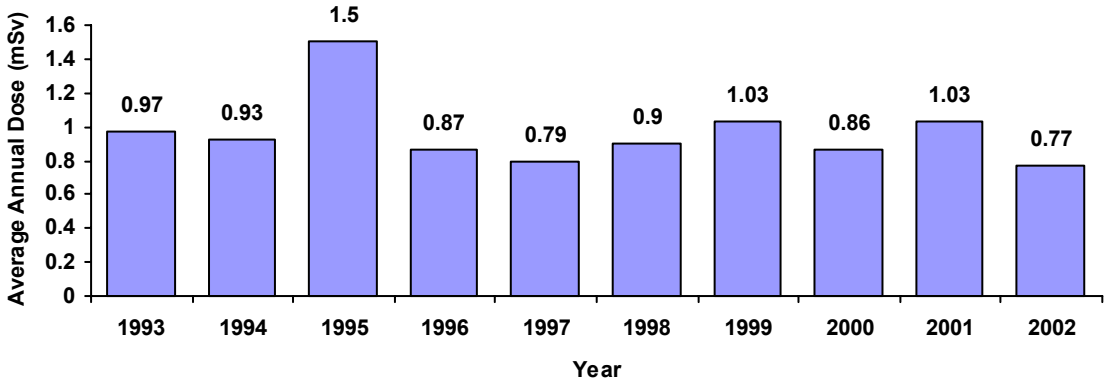


Table 4 (Cont'd)

Reactor - health physics

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	31	0.00	0.00	0
>0-1	21	6.64	0.32	16
>1-2	3	5.15	1.72	20
>2-5	8	31.84	3.98	12
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	63	43.63	0.69	14
				Five year period 1998 - 2002
0	82	0.00	0.00	0
>0-5	46	49.61	1.08	20
>5-25	11	99.81	9.07	12
>25-100	1	25.19	25.19	18
>100	0	0.00	0.00	0
Total	140	174.61	1.25	15

Parameters of the distribution in 2002:

A: 0.0653
B: 0.2733
C: 0.0000
D: 0.5241
Sample size: 63

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

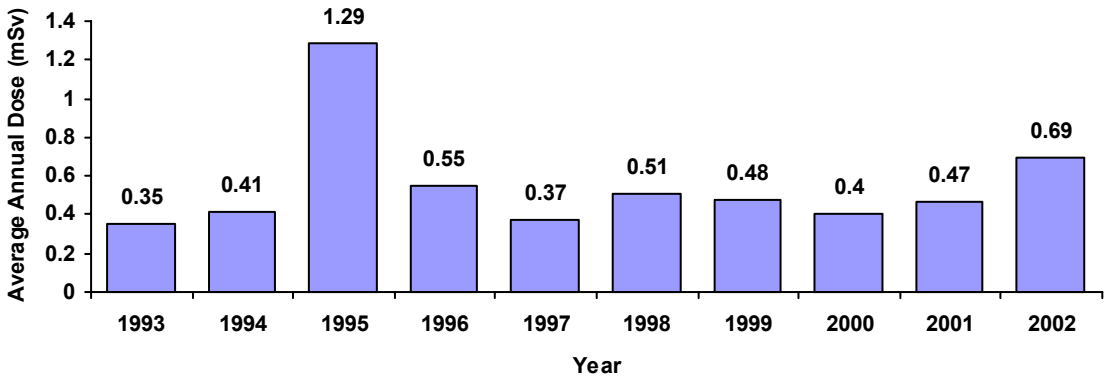


Table 4 (Cont'd)

Reactor - industrial radiographer

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	9	0.00	0.00	0
>0-1	21	5.03	0.24	22
>1-2	5	7.48	1.50	22
>2-5	14	54.41	3.89	4
>5-20	17	125.93	7.41	5
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	66	192.85	2.92	6
				Five year period 1998 - 2002
0	8	0.00	0.00	0
>0-5	63	103.90	1.65	10
>5-25	35	320.64	9.16	7
>25-100	1	26.38	26.38	14
>100	0	0.00	0.00	0
Total	107	450.92	4.21	8

Parameters of the distribution in 2002:

A: 0.0000
B: 0.2129
C: 0.0402
D: -0.3442
Sample size: 66

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

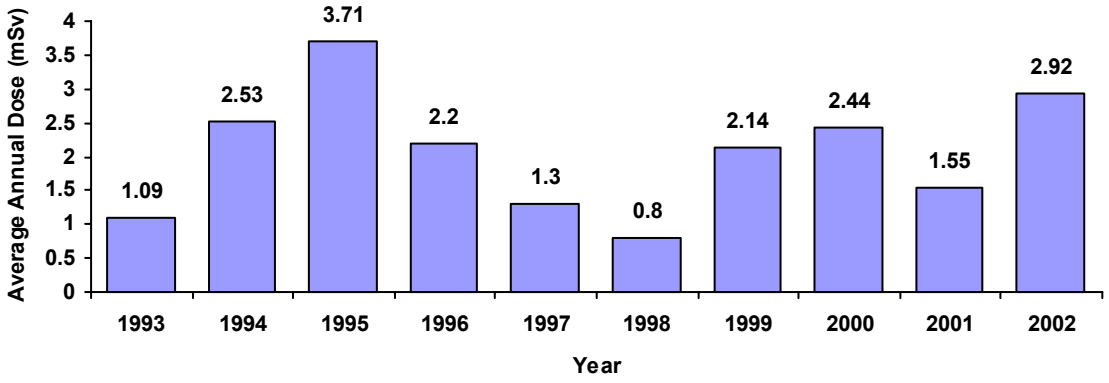


Table 4 (Cont'd)

Reactor - mechanical maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	627	0.00	0.00	0
>0-1	463	159.12	0.34	36
>1-2	147	217.50	1.48	27
>2-5	261	857.22	3.28	15
>5-20	237	1963.88	8.29	8
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	1735	3197.72	1.84	13
				Five year period 1998 - 2002
0	772	0.00	0.00	0
>0-5	1189	1719.18	1.45	21
>5-25	659	8017.80	12.17	14
>25-100	153	5406.33	35.34	12
>100	0	0.00	0.00	0
Total	2773	15143.31	5.46	14

Parameters of the distribution in 2002:

A: 0.1469
B: 0.1365
C: 0.0089
D: 0.1854
Sample size: 1735

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

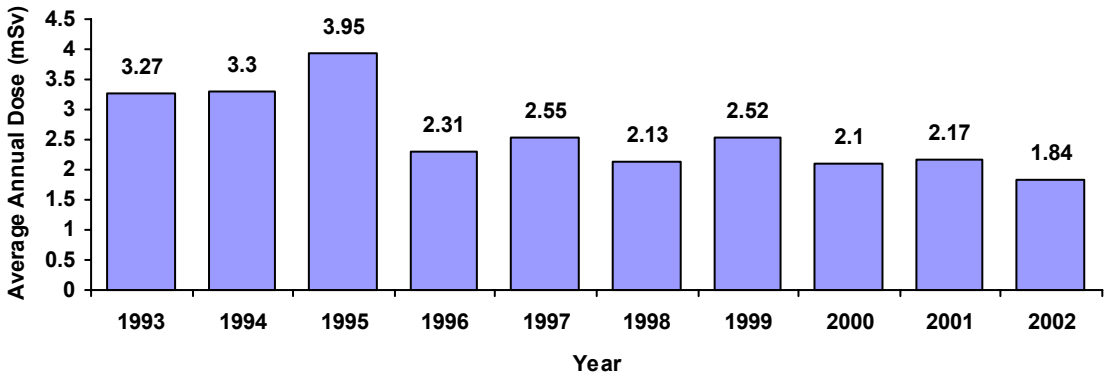


Table 4 (Cont'd)

Reactor - operations

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	834	0.00	0.00	0
>0-1	828	295.42	0.36	48
>1-2	215	312.83	1.46	42
>2-5	205	658.03	3.21	34
>5-20	107	860.70	8.04	18
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	2189	2126.98	0.97	31
				Five year period 1998 - 2002
0	520	0.00	0.00	0
>0-5	1443	2243.95	1.56	48
>5-25	516	5138.34	9.96	35
>25-100	94	4044.02	43.02	15
>100	0	0.00	0.00	0
Total	2573	11426.31	4.44	31

Parameters of the distribution in 2002:

A: 0.3265
B: 0.1075
C: 0.0000
D: 0.5784
Sample size: 2189

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

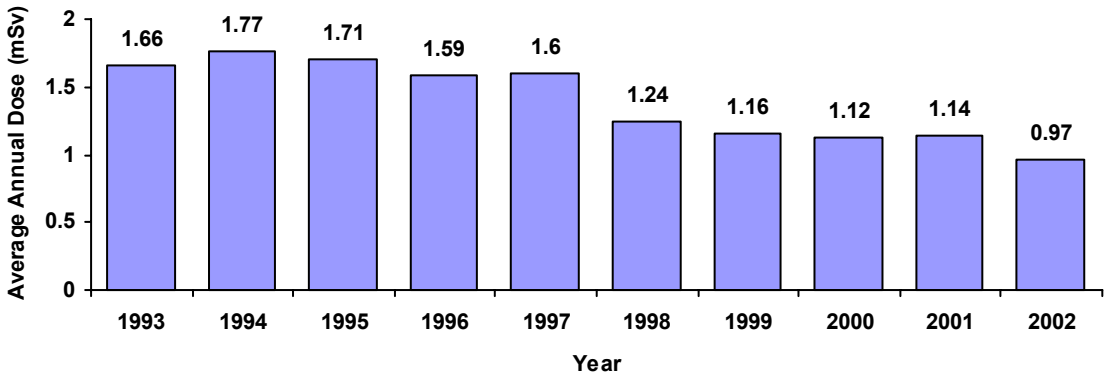


Table 4 (Cont'd)

Reactor - scientific/professional

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	1828	0.00	0.00	0
>0-1	394	112.04	0.28	27
>1-2	92	132.33	1.44	18
>2-5	122	394.37	3.23	14
>5-20	83	720.47	8.68	9
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	2519	1359.21	0.54	12
				Five year period 1998 - 2002
0	2854	0.00	0.00	0
>0-5	1002	992.75	0.99	19
>5-25	256	2862.11	11.18	12
>25-100	33	1166.29	35.34	10
>100	0	0.00	0.00	0
Total	4145	5021.15	1.21	13

Parameters of the distribution in 2002:

A: 0.1535
B: 0.0954
C: 0.0000
D: 1.0937
Sample size: 2519

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

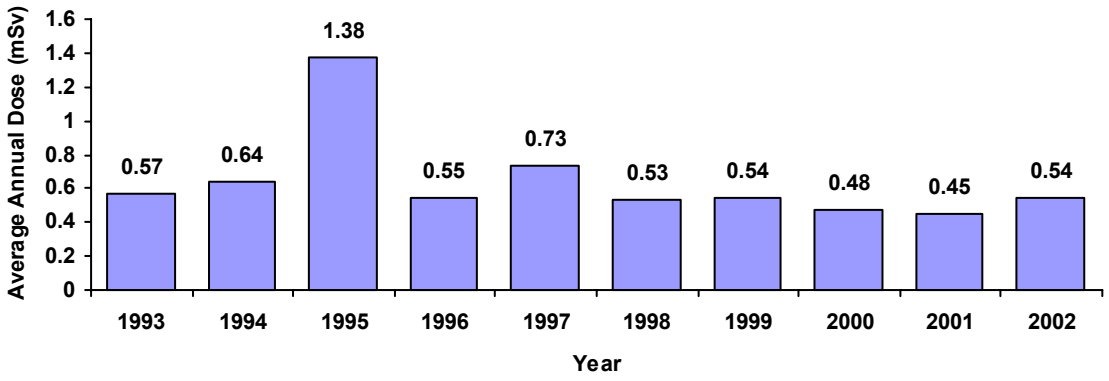


Table 4 (Cont'd)

Reactor - training

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	41	0.00	0.00	0
>0-1	6	1.50	0.25	77
>1-2	4	5.28	1.32	25
>2-5	5	14.19	2.84	5
>5-20	2	11.29	5.64	7
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	58	32.26	0.56	12
				Five year period 1998 - 2002
0	123	0.00	0.00	0
>0-5	35	41.94	1.20	18
>5-25	8	92.94	11.62	11
>25-100	2	72.24	36.12	8
>100	0	0.00	0.00	0
Total	168	207.12	1.23	11

Parameters of the distribution in 2002:

A: 0.0000
B: 0.2650
C: 0.0000
D: 0.6975
Sample size: 58

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

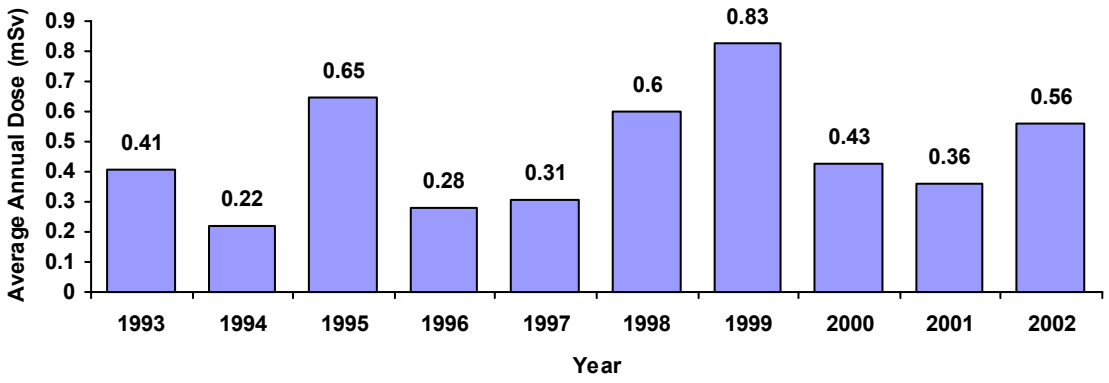


Table 4 (Cont'd)

Reactor - visitor

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Tritium
				Year 2002
0	4439	0.00	0.00	0
>0-1	1171	402.46	0.34	34
>1-2	337	492.75	1.46	25
>2-5	395	1279.34	3.24	19
>5-20	256	2201.72	8.60	8
>20-50	4	83.83	20.96	2
>50	0	0.00	0.00	0
Total	6602	4460.10	0.68	15
				Five year period 1998 - 2002
0	8564	0.00	0.00	0
>0-5	2322	2673.17	1.15	22
>5-25	545	5577.60	10.23	12
>25-100	33	1277.45	38.71	7
>100	0	0.00	0.00	0
Total	11464	9528.22	0.83	14

Parameters of the distribution in 2002:

A: 0.1785
B: 0.0970
C: 0.0000
D: 0.9412
Sample size: 6602

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

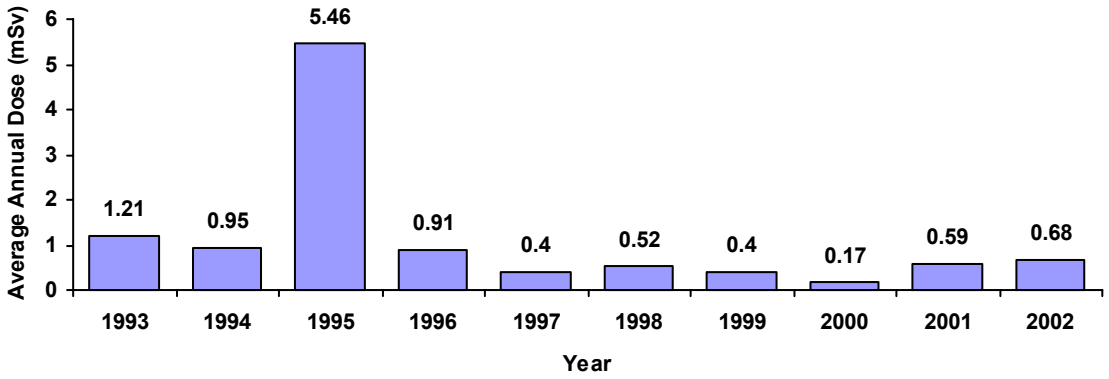


Table 4 (Cont'd)

Uranium mine electrician

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	4	0.00	0.00	0
>0-1	0	0.00	0.00	0
>1-2	0	0.00	0.00	0
>2-5	0	0.00	0.00	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	4	0.00	0.00	0
				Five year period 1998 - 2002
0	7	0.00	0.00	0
>0-5	14	6.95	0.50	100
>5-25	0	0.00	0.00	0
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	21	6.95	0.33	100

Parameters of the distribution in 2002:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

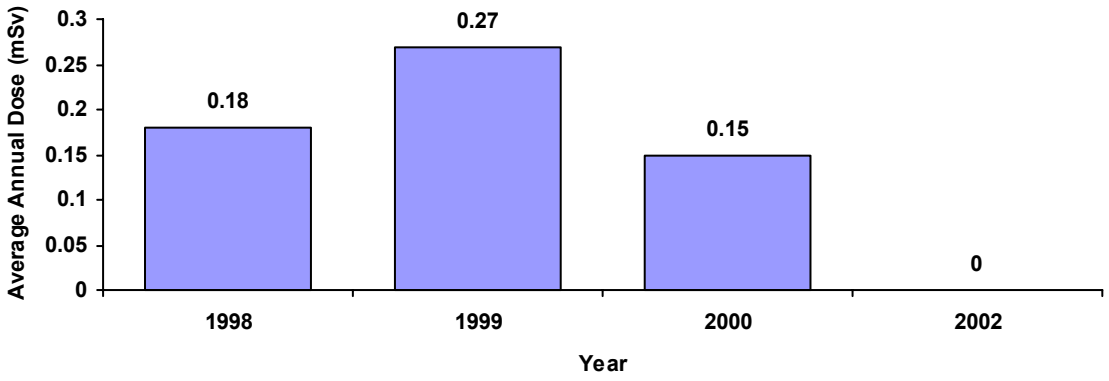


Table 4 (Cont'd)

Uranium mine mill maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	6	0.00	0.00	0
>0-1	88	47.35	0.54	79
>1-2	54	78.15	1.45	51
>2-5	32	88.05	2.75	51
>5-20	2	12.75	6.38	55
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	182	226.30	1.24	57
				Five year period 1998 - 2002
0	21	0.00	0.00	0
>0-5	169	325.30	1.92	71
>5-25	107	1128.95	10.55	46
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	297	1454.25	4.90	51

Parameters of the distribution in 2002:

A: 0.7536
B: 0.2886
C: 0.0000
D: -0.2222
Sample size: 182

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

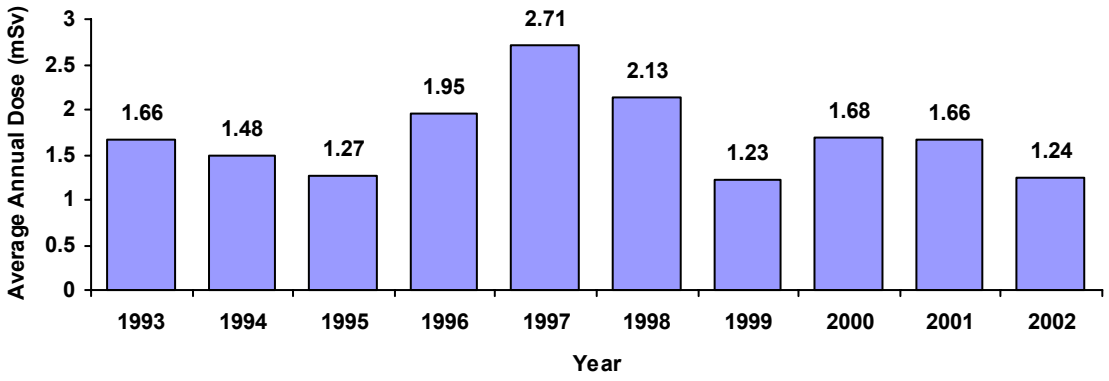


Table 4 (Cont'd)

Uranium mine mill worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	41	0.00	0.00	0
>0-1	68	36.05	0.53	60
>1-2	65	96.25	1.48	58
>2-5	62	189.70	3.06	50
>5-20	13	90.25	6.94	44
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	249	412.25	1.66	51
				Five year period 1998 - 2002
0	40	0.00	0.00	0
>0-5	225	395.70	1.76	60
>5-25	166	1893.65	11.41	51
>25-100	8	218.95	27.37	28
>100	0	0.00	0.00	0
Total	439	2508.30	5.71	50

Parameters of the distribution in 2002:

A: 0.3675
B: 0.2662
C: 0.0000
D: -0.3305
Sample size: 249

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

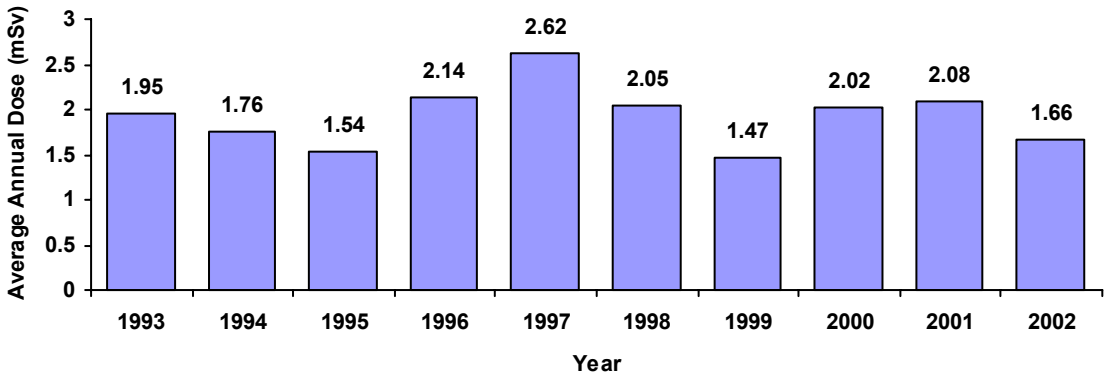


Table 4 (Cont'd)

Uranium mine nurse

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	6	0.00	0.00	0
>0-1	5	1.25	0.25	68
>1-2	0	0.00	0.00	0
>2-5	0	0.00	0.00	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	11	1.25	0.11	68
				Five year period 1998 - 2002
0	22	0.00	0.00	0
>0-5	18	10.50	0.58	57
>5-25	0	0.00	0.00	0
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	40	10.50	0.26	57

Parameters of the distribution in 2002:

A: N/A
B: N/A
C: N/A
D: N/A
Sample size: N/A

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

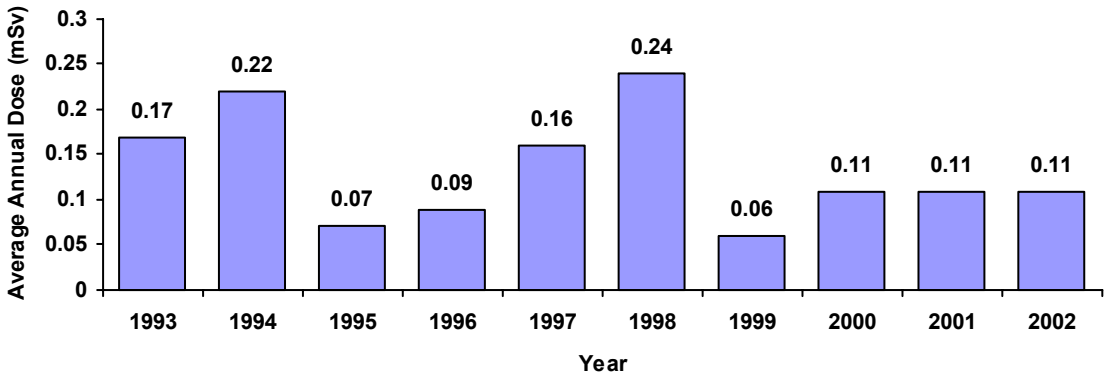


Table 4 (Cont'd)

Uranium mine office staff

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	69	0.00	0.00	0
>0-1	77	19.30	0.25	65
>1-2	1	1.25	1.25	4
>2-5	1	4.40	4.40	14
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	148	24.95	0.17	53
				Five year period 1998 - 2002
0	140	0.00	0.00	0
>0-5	238	160.55	0.67	64
>5-25	1	5.10	5.10	25
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	379	165.65	0.44	63

Parameters of the distribution in 2002:

A: 0.0384
B: 0.1296
C: 0.3718
D: 2.3266
Sample size: 148

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

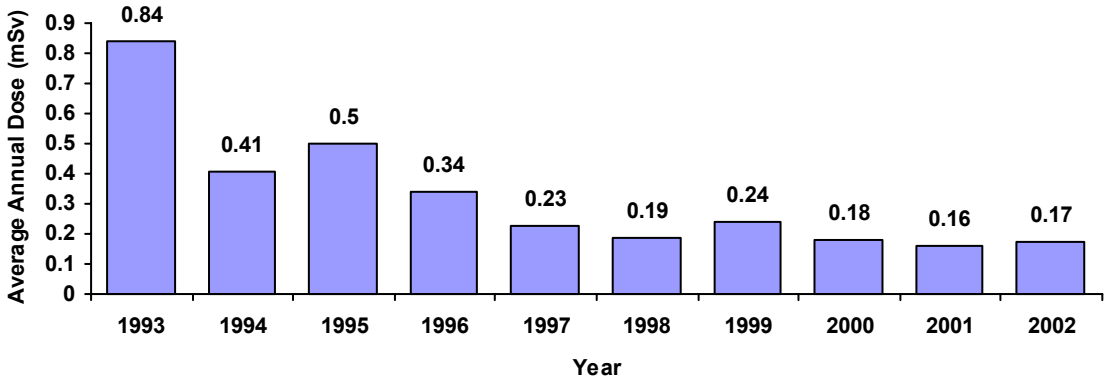


Table 4 (Cont'd)

Uranium mine support worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	27	0.00	0.00	0
>0-1	48	19.15	0.40	46
>1-2	21	31.00	1.48	34
>2-5	39	116.30	2.98	33
>5-20	5	27.90	5.58	38
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	140	194.35	1.39	35
				Five year period 1998 - 2002
0	97	0.00	0.00	0
>0-5	604	663.85	1.10	70
>5-25	110	1061.15	9.65	47
>25-100	6	182.35	30.39	32
>100	0	0.00	0.00	0
Total	817	1907.35	2.33	54

Parameters of the distribution in 2002:

A: 0.0000
B: 0.4674
C: 0.0248
D: -0.3881
Sample size: 140

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

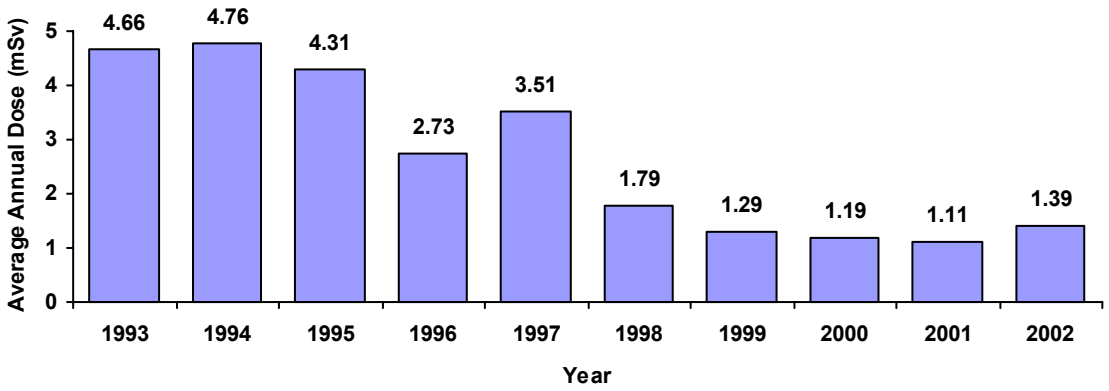


Table 4 (Cont'd)

Uranium mine surface maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	28	0.00	0.00	0
>0-1	151	64.10	0.42	76
>1-2	22	30.00	1.36	56
>2-5	3	7.75	2.58	11
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	204	101.85	0.50	65
				Five year period 1998 - 2002
0	117	0.00	0.00	0
>0-5	343	392.20	1.14	64
>5-25	37	263.10	7.11	34
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	497	655.30	1.32	52

Parameters of the distribution in 2002:

A: 0.8028
B: 0.4953
C: 0.0000
D: 0.6375
Sample size: 204

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

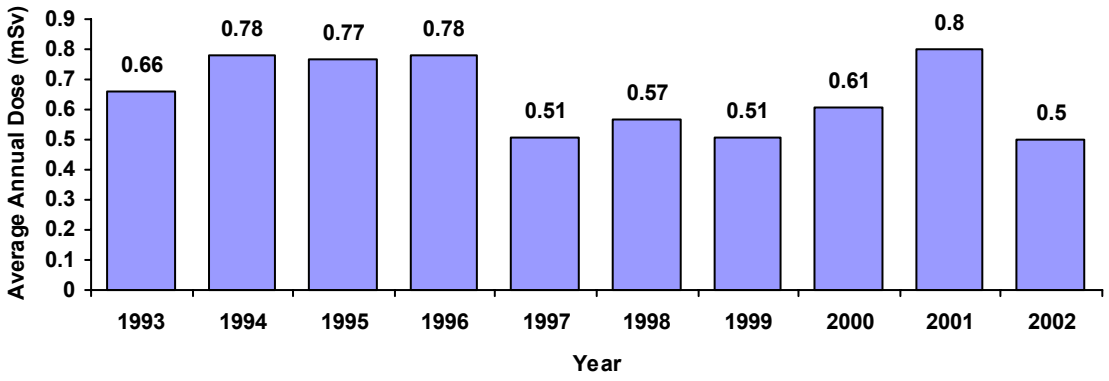


Table 4 (Cont'd)

Uranium mine surface miner

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	13	0.00	0.00	0
>0-1	12	6.00	0.50	52
>1-2	8	12.75	1.59	33
>2-5	9	26.65	2.96	19
>5-20	4	24.95	6.24	15
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	46	70.35	1.53	23
				Five year period 1998 - 2002
0	24	0.00	0.00	0
>0-5	120	140.05	1.17	38
>5-25	34	297.80	8.76	43
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	178	437.85	2.46	41

Parameters of the distribution in 2002:

A: 0.1759
B: 0.2975
C: 0.0000
D: -0.2210
Sample size: 46

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

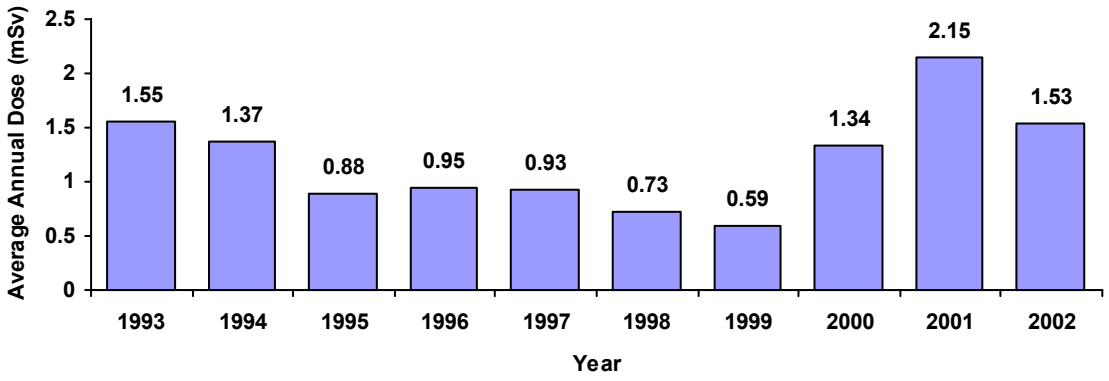


Table 4 (Cont'd)

Uranium mine surface personnel

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	41	0.00	0.00	0
>0-1	106	33.35	0.31	63
>1-2	23	31.00	1.35	79
>2-5	3	6.75	2.25	50
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	173	71.10	0.41	69
				Five year period 1998 - 2002
0	105	0.00	0.00	0
>0-5	282	261.40	0.93	65
>5-25	29	215.00	7.41	70
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	416	476.40	1.15	67

Parameters of the distribution in 2002:

A: 0.0000
B: 0.9000
C: 0.1074
D: 0.3403
Sample size: 173

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

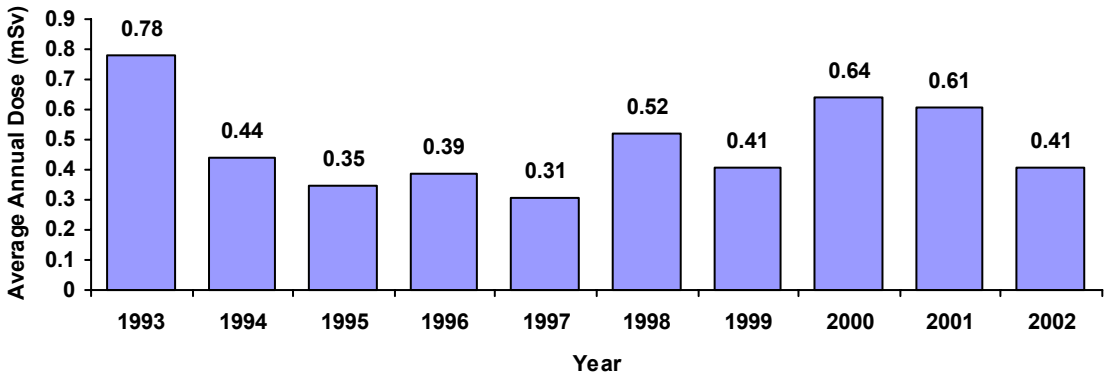


Table 4 (Cont'd)

Uranium mine surface support worker

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	150	0.00	0.00	0
>0-1	167	45.25	0.27	63
>1-2	11	14.95	1.36	48
>2-5	1	2.20	2.20	0
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	329	62.40	0.19	57
				Five year period 1998 - 2002
0	347	0.00	0.00	0
>0-5	473	385.15	0.81	48
>5-25	24	166.10	6.92	43
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	844	551.25	0.65	47

Parameters of the distribution in 2002:

A: 0.0000
B: 0.6558
C: 0.2507
D: 1.4852
Sample size: 329

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

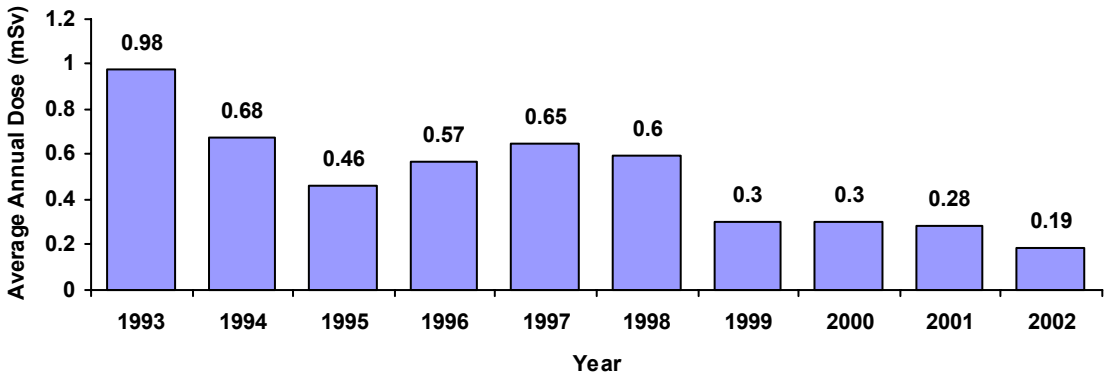


Table 4 (Cont'd)

Uranium mine underground maintenance

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	10	0.00	0.00	0
>0-1	79	27.70	0.35	67
>1-2	30	42.05	1.40	46
>2-5	9	23.95	2.66	50
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	128	93.70	0.73	53
				Five year period 1998 - 2002
0	30	0.00	0.00	0
>0-5	327	410.80	1.26	72
>5-25	31	213.75	6.90	66
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	388	624.55	1.61	70

Parameters of the distribution in 2002:

A: 0.0373
B: 0.7363
C: 0.1052
D: -0.0481
Sample size: 128

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

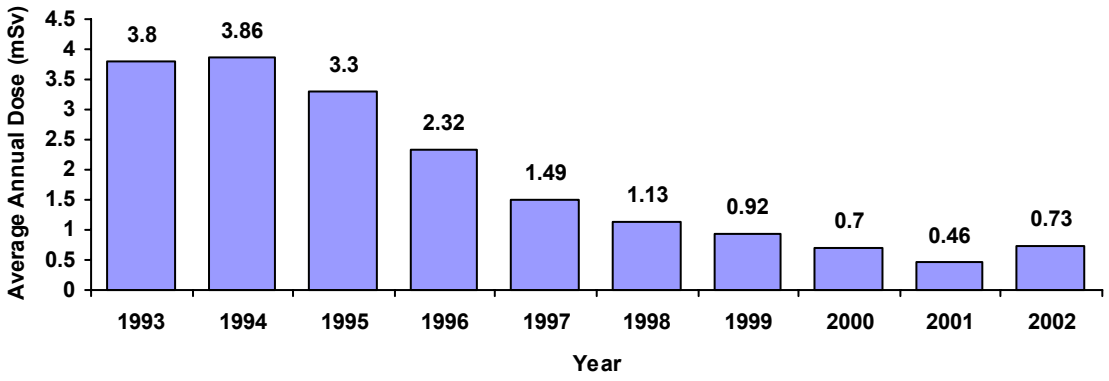


Table 4 (Cont'd)

Uranium mine underground miner

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	11	0.00	0.00	0
>0-1	46	18.60	0.40	61
>1-2	30	42.50	1.42	54
>2-5	81	252.53	3.12	41
>5-20	28	186.40	6.66	35
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	196	500.03	2.55	41
				Five year period 1998 - 2002
0	25	0.00	0.00	0
>0-5	384	650.32	1.69	65
>5-25	187	2036.71	10.89	50
>25-100	33	1170.15	35.46	23
>100	0	0.00	0.00	0
Total	629	3857.18	6.13	45

Parameters of the distribution in 2002:

A: 0.1465
B: 0.3168
C: 0.0491
D: -0.7488
Sample size: 196

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

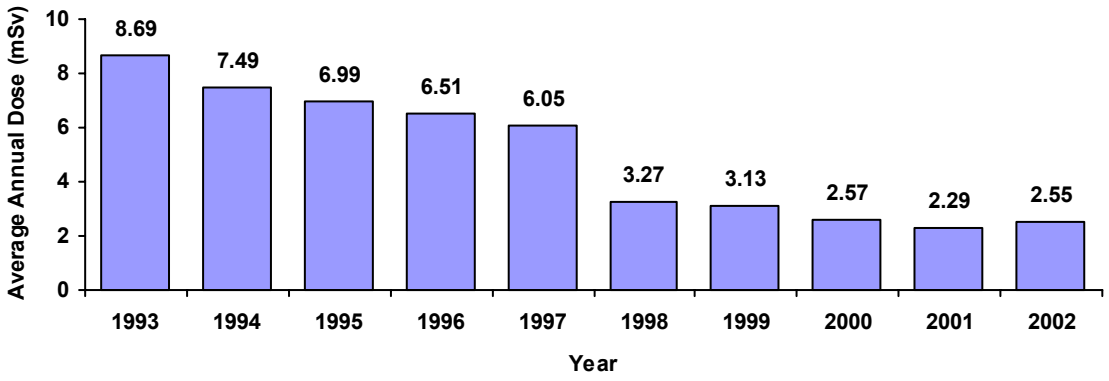


Table 4 (Cont'd)

Uranium mine underground personnel

Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	17	0.00	0.00	0
>0-1	45	24.35	0.54	73
>1-2	14	20.77	1.48	52
>2-5	6	16.25	2.71	43
>5-20	0	0.00	0.00	0
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	82	61.37	0.75	58
				Five year period 1998 - 2002
0	88	0.00	0.00	0
>0-5	217	292.25	1.35	71
>5-25	30	234.87	7.83	61
>25-100	1	25.10	25.10	15
>100	0	0.00	0.00	0
Total	336	552.22	1.64	65

Parameters of the distribution in 2002:

A: 0.4352
B: 0.5583
C: 0.0000
D: 0.0045
Sample size: 82

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002

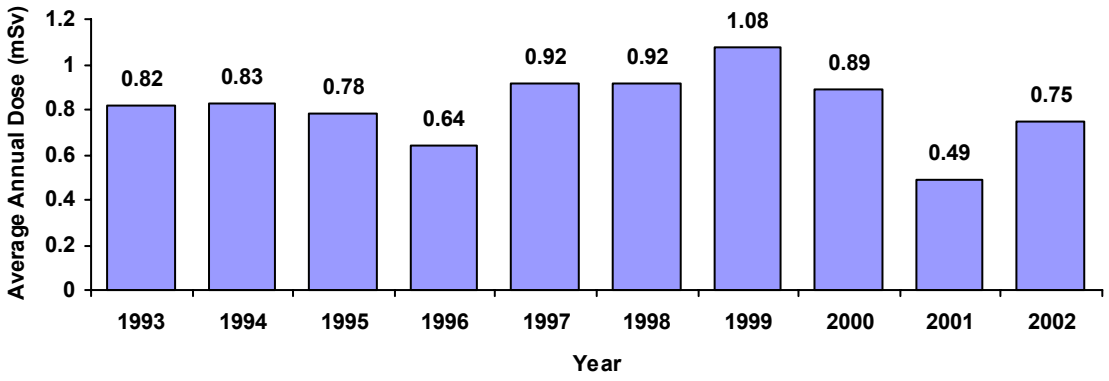


Table 4 (Cont'd)

Uranium mine visitor

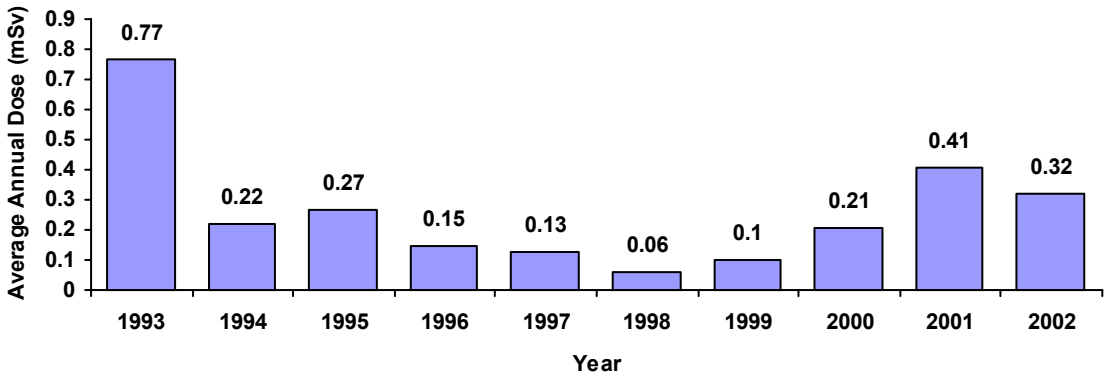
Dose Interval (mSv)	Number of Workers	Collective Dose	Average Dose	% Radon
				Year 2002
0	62	0.00	0.00	0
>0-1	71	17.45	0.25	34
>1-2	16	23.35	1.46	18
>2-5	1	2.05	2.05	12
>5-20	1	5.80	5.80	7
>20-50	0	0.00	0.00	0
>50	0	0.00	0.00	0
Total	151	48.65	0.32	22
				Five year period 1998 - 2002
0	372	0.00	0.00	0
>0-5	516	160.80	0.31	52
>5-25	5	39.00	7.80	23
>25-100	0	0.00	0.00	0
>100	0	0.00	0.00	0
Total	893	199.80	0.22	46

Parameters of the distribution in 2002:

A: 0.2013
B: 0.4240
C: 0.0000
D: 0.7979
Sample size: 151

(See Appendix for explanation)

Histogram of average annual doses over ten year period 1993 - 2002



Appendix
The new three component normal (TCN) distribution

The appendix explains how the data can be fitted to a statistical distribution, so that: (1) the sample of doses can be described by 5 quantities (the parameters of the distribution and sample size); and, (2) from these quantities, any dose statistic can be estimated, including any statistic not listed in this report, such as the 9-th decile.

Statistical distributions are defined by a probability density function, which is interpreted as follows:

The probability that a dose value lies between a and b equals

$$\int_a^b f(x)dx \quad ,$$

where f represents the probability density function and x assumes possible values of a random variable X which in our case represents the occupational dose.

The probability density function also contains a number of parameters, which determine the shape of the function. The distribution is defined by the mathematical formula for the density function, with the parameters as yet unspecified. Only when the parameters have been specified is the statistical model for the occupational dose defined. Parameters are adjusted to fit the data.

The TCN distribution has been designed to provide good fits especially to low dose distributions. Its probability density function is defined as:

$$f(x:A,B,C,D) =$$

$$\phi(A*\log(x) + B*x - C/x + D) *$$

$$(A/x + B + C/x^2) =$$

$$\phi(z) * (dz/dx)$$

where $\phi(t)$ denotes the standard normal probability density function $\exp(-t^2/2)/\sqrt{(2\pi)}$, and A, B, C and D are parameters of the distribution. In other words, the random variable:

$$Z = A*\log(X) + B*X - C/X + D$$

follows a standard normal distribution.

The parameters A, B and C are restricted to values >=0 and cannot all three be 0; there are no restrictions on the parameter D.

Special cases of this distribution arise when B and C are fixed to 0, and when just C is fixed to 0, while A>0; they are reparametrized versions of respectively the lognormal and hybrid lognormal distributions[4], which were used in previous reports.

If the parameters for the probability density function f are known, one can estimate any dose statistic. For example, the mean dose is estimated as

$$\int_0^\infty xf(x)dx$$

(since the dose values x are between 0 and infinity).

The variance of the dose is estimated as:

$$\int_0^\infty (x-mean)^2 f(x)dx$$

and the standard deviation as the square root thereof.

The probability that a dose exceeds, for example, 50 mSv, is estimated as:

$$\int_{50}^\infty f(x)dx \quad .$$

The 95-th percentile is estimated as that dose value v for which:

$$\int_{v}^{\infty} f(x)dx = 95/100 .$$

The fraction of the collective dose due to doses exceeding 15 mSv is estimated as:

$$\frac{\int_{15}^{\infty} xf(x)dx}{\int_{0}^{\infty} xf(x)dx} .$$

The parameters are determined from the actual dose data. They are chosen to give the best "fit" with the sample of observed data, for which purpose there exists a variety of methods. The parameters in Table 4 have been estimated with a form of the Maximum Likelihood method. With this method, dose statistics can be estimated with the formulas given above, with the tabulated parameter values substituted for A, B, C and D. Instead of single dose values, small dose intervals and their frequencies (i.e. number of doses within the intervals) are used to determine the parameters. Doses recorded as 0 are assumed to have small positive values within the lowest dose interval. The resulting models will be valid for complete sets of workers' doses, not just doses recorded as positive as in previous reports.