1998 Report on Occupational Radiation Exposures in Canada

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Abstract

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Introduction

This series of reports provides statistics on occupational radiation exposures of monitored workers in Canada. Previous issues of the report can be obtained from the authors[1-5].

The information is based on the data in the National Dose Registry (NDR) maintained by the Radiation Protection Bureau of Health Canada[6]. The Registry is a centralized record-keeping system containing dose information on all monitored workers in Canada. It includes records from the National Dosimetry Services (NDS), as well as data submitted by nuclear power generating stations, Atomic Energy of Canada Ltd., uranium mines, and private dosimeter processing companies. About 80 percent of the records are from the NDS.

Information for input into the NDR is received in a number of different physical forms. Data from the NDS are fed directly from the dosimeter reading stations into a computer, where they are processed, reported and entered into the NDR files. Most other dose records are submitted to the Registry 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 stable 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, and more complete data on the first year.

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 reoccur 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 25 July 1998. All NDS 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 recorded by the NDS there is a minimum reporting level of 0.2 mSv. Organizations submitting their own doses may have lower reporting levels.

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 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[7]. In the report the radon progeny exposures are converted to dose equivalents (in mSv). The value used in this report is given in the specific comments section.

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 can have records under more than one job category for the same year, if he has been monitored by more than one organization. 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:

1997: Preliminary analysis

Table 1:

Table 1 gives the annual doses distributions by job category.

1996: Final Analysis

Table 2:

In Table 2, statistics are broken down by job category and province or territory.

Table 3:

Table 3 contains dose distributions broken down by age and sex. In these tables job categories have been grouped into "job sectors".

Table 4:

Table 4 contains various dose statistics broken down by job category. The table also shows the parameters of the lognormal or hybrid lognormal distribution for positive doses, as produced 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 1992-1996 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 1987-1996.

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 on job sector in the same year. For this reason the totals in Tables 2-4 may slightly differ.

Comments specific to this report

The conversion factor currently used to convert Radon progeny exposures is 10 mSv per WLM. This is based on the annual dose limits recommended by the ICRP[8] which are 50 mSv for external whole body doses and 4.8 WLM for Radon progeny exposures. A change to 5 mSv per WLM is planned for next year's report, which will be compatible with the new dose limits expected to be implemented at that time.

Job category information is no longer provided by all dosimetry companies. In a number of dose records the job category had to be inferred from earlier information on the same worker. This is expected to be a temporary problem, which will disappear when new regulatory requirements are enforced.

References

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8. ICRP publication 47, “Radiation protection of workers in mines”, Annals of the ICRP 16(1), p. 5 (1986).

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1997 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	341	179	1	0	0	0	0	521	0.14	0.41
Office staff	3052	439	10	7	0	0	0	3508	0.06	0.42
Safety officer	65	22	1	1	0	0	0	89	0.17	0.63
Industry and Research:										
Fuel processor	39	56	22	32	28	0	0	177	2.27	2.92
Industrial radiographer	1018	321	151	261	401	76	2	2230	3.34	6.15
Instructor (non-medical)	149	12	1	0	0	0	0	162	0.04	0.47
Instrument technician	1424	310	34	17	6	0	0	1791	0.15	0.71
Laboratory technician (industrial)	2914	765	59	48	12	0	0	3798	0.15	0.66
Scientist engineer (field)	728	635	46	25	6	1	0	1441	0.33	0.67
Scientist/engineer (laboratory)	4164	502	23	7	2	0	0	4698	0.05	0.42
Well logger	601	216	53	53	7	0	0	930	0.43	1.23
Medicine:										
Chiropractor	920	41	2	1	0	0	0	964	0.03	0.55
Dental assistant	8115	109	0	4	3	0	0	8231	0.01	0.56
Dental hygienist	6590	105	3	1	1	0	0	6700	0.01	0.46
Dental therapist/nurse	77	2	0	0	0	0	0	79	0.02	0.85
Dentist	6537	138	3	3	1	0	0	6682	0.01	0.44
Gynaecologist	21	8	0	0	0	0	0	29	0.14	0.51
Laboratory technician (medical)	2972	321	22	6	5	0	0	3326	0.06	0.54
Medical physicist	219	47	3	1	0	0	0	270	0.08	0.43
Medical radiation technologist	9836	1773	116	42	6	1	0	11774	0.09	0.52
Nuclear medicine technologist	417	413	314	293	25	0	0	1462	1.22	1.70
Nurse	3649	1041	38	6	4	0	0	4738	0.10	0.42
Physician	1543	402	42	15	9	0	0	2011	0.16	0.67
Radiation therapist	726	277	9	6	4	1	1	1024	0.25	0.85
Radiologist (diagnostic)	1426	326	25	12	4	0	0	1793	0.13	0.63
Radiologist (therapeutic)	125	30	0	0	0	0	0	155	0.06	0.30
Veterinarian	3804	235	18	5	0	0	0	4062	0.03	0.46
Veterinary technician	5	0	0	0	0	0	0	5	0.00	0.00
Ward aide/orderly	1489	171	12	6	0	0	0	1678	0.06	0.52

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			
Nuclear Power:										
Reactor - administration	3925	812	205	192	26	0	0	5160	0.25	1.03
Reactor - chemical and radiation control	110	131	46	42	42	0	0	371	1.80	2.56
Reactor - construction	648	292	100	171	139	5	0	1355	1.60	3.07
Reactor - control technician	48	35	6	15	7	0	0	111	1.32	2.33
Reactor - electrical maintenance	307	363	132	134	41	0	0	977	1.13	1.65
Reactor - fuel handling	6	5	0	9	19	0	0	39	4.76	5.62
Reactor - general maintenance	748	288	83	106	60	1	0	1286	0.81	1.93
Reactor - health physics	43	15	3	5	1	0	0	67	0.37	1.04
Reactor - industrial radiographer	3	3	3	1	1	0	0	11	1.30	1.78
Reactor - mechanical maintenance	365	331	118	238	259	0	0	1311	2.57	3.57
Reactor - operations	493	639	298	271	163	1	0	1865	1.61	2.18
Reactor - scientific/professional	1148	211	48	77	81	2	0	1567	0.74	2.76
Reactor - training	37	9	1	2	1	0	0	50	0.31	1.18
Reactor - visitor	39	7	2	1	2	0	0	51	0.36	1.55
Uranium Mining:										
Uranium mine mill maintenance	4	22	34	68	32	0	0	160	3.84	3.94
Uranium mine mill worker	5	34	40	93	56	0	0	228	3.89	3.97
Uranium mine nurse	5	1	2	0	0	0	0	8	0.40	1.07
Uranium mine office staff	29	43	19	2	0	0	0	93	0.53	0.77
Uranium mine support worker	6	26	11	27	43	6	0	119	6.18	6.51
Uranium mine surface maintenance	27	80	48	26	0	0	0	181	1.02	1.19
Uranium mine surface miner	42	98	59	41	2	0	0	242	1.16	1.41
Uranium mine surface personnel	20	27	11	7	0	0	0	65	0.80	1.16
Uranium mine surface support worker	63	102	70	25	8	0	0	268	1.15	1.50
Uranium mine underground maintenance	5	10	7	22	21	0	0	65	3.75	4.07
Uranium mine underground miner	16	35	31	38	144	30	0	294	9.11	9.63
Uranium mine underground personnel	265	116	34	25	26	1	0	467	0.96	2.23
Uranium mine visitor	156	72	13	0	0	0	0	241	0.17	0.49
Miscellaneous/Unknown										
Miscellaneous/unknown	26847	5701	615	498	261	23	1	33946	0.22	1.06

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	2	0	6	4	44	257	22	2	19	20	0	0	376
	0.10	0.00	0.07	0.00	0.02	0.14	0.01	0.00	5.25	0.03	0.00	0.00	0.37
Office staff	39	6	80	65	673	2133	234	67	181	284	10	2	3774
	0.01	0.00	0.02	0.02	0.03	0.11	0.03	0.01	0.04	0.03	0.04	0.00	0.07
Safety officer	2	1	12	2	19	36	8	3	3	11	0	0	97
	0.00	0.20	0.07	0.25	0.00	0.23	0.10	0.13	1.33	0.00	0.00	0.00	0.15
OVERALL	**43**	**7**	**98**	**71**	**736**	**2426**	**264**	**72**	**203**	**315**	**10**	**2**	**4247**
	0.01	**0.03**	**0.02**	**0.02**	**0.03**	**0.11**	**0.03**	**0.02**	**0.54**	**0.03**	**0.04**	**0.00**	**0.10**
Industry and Research													
Fuel processor	0	0	0	0	1	178	1	0	3	2	0	0	185
	0.00	0.00	0.00	0.00	0.30	2.89	0.00	0.00	0.13	0.00	0.00	0.00	2.79
Industrial radiographer	49	0	80	102	344	596	42	148	726	214	0	3	2304
	0.69	0.00	1.66	1.73	2.22	1.97	0.59	2.62	5.89	2.78	0.00	0.00	3.28
Instructor (non-medical)	9	0	25	3	13	65	8	5	17	21	1	0	167
	0.06	0.00	0.04	0.07	0.06	0.05	0.04	0.00	0.01	0.03	1.20	0.00	0.05
Instrument technician	105	1	73	53	415	779	55	25	177	160	0	0	1843
	0.04	0.20	0.16	0.12	0.09	0.35	0.05	0.05	0.06	0.22	0.00	0.00	0.21
Laboratory technician	52	10	92	29	722	1727	235	225	600	301	0	0	3993
(industrial)	0.31	0.12	0.09	0.14	0.11	0.19	0.04	0.06	0.06	0.39	0.00	0.00	0.15
Scientist engineer (field)	5	0	45	34	99	915	18	90	149	107	0	0	1462
	0.00	0.00	0.22	0.30	0.39	0.43	0.32	0.09	0.48	0.21	0.00	0.00	0.38
Scientist/engineer (laboratory)	134	2	151	18	1536	1694	145	167	220	905	0	0	4972
	0.04	0.00	0.09	0.02	0.03	0.06	0.01	0.05	0.05	0.09	0.00	0.00	0.06
Well logger	0	0	1	0	0	4	1	23	992	15	0	0	1036
	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.07	0.58	0.25	0.00	0.00	0.56
OVERALL	**354**	**13**	**467**	**239**	**3130**	**5958**	**505**	**683**	**2884**	**1725**	**1**	**3**	**15962**
	0.17	**0.11**	**0.38**	**0.83**	**0.31**	**0.47**	**0.09**	**0.61**	**1.73**	**0.50**	**1.20**	**0.00**	**0.66**
Medicine													
Chiropractor	0	0	2	2	382	360	63	13	157	33	0	0	1012
	0.00	0.00	0.00	0.00	0.03	0.07	0.00	0.04	0.03	0.32	0.00	0.00	0.05
Dental assistant	79	14	186	129	1545	3665	501	279	391	551	13	11	7364
	0.02	0.00	0.01	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.01
Dental hygienist	46	27	185	85	2120	2918	454	187	220	365	11	7	6625
	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.02	0.01	0.02	0.00	0.01
Dental therapist/nurse	0	0	0	0	4	5	5	24	0	8	3	0	49
	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
Dentist	97	11	148	88	2276	2884	534	125	171	293	10	8	6645
	0.01	0.00	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.01
Gynaecologist	1	0	3	0	12	14	6	0	1	2	0	0	39
	0.00	0.00	0.00	0.00	0.03	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.08
Laboratory technician	38	2	159	4	1106	1455	200	147	288	319	0	0	3718
(medical)	0.02	0.00	0.03	0.45	0.05	0.08	0.03	0.02	0.05	0.06	0.00	0.00	0.06
Medical physicist	2	0	11	8	77	95	15	11	10	52	1	0	282
	0.30	0.00	1.16	0.14	0.08	0.16	0.11	0.04	0.60	0.07	0.00	0.00	0.17
Medical radiation technologist	310	72	331	360	2764	4482	678	665	1251	1332	20	8	12273
	0.05	0.03	0.12	0.08	0.08	0.12	0.04	0.14	0.09	0.09	0.13	0.29	0.10
Nuclear medicine technologist	19	4	45	30	506	577	62	30	102	153	0	0	1528
	2.26	0.63	1.13	1.26	1.60	1.16	0.96	1.27	0.93	0.62	0.00	0.00	1.24

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
Medicine (cont'd**)**													
Nurse	222	29	215	138	1120	2593	186	89	153	283	127	68	5223
	0.04	0.01	0.05	0.05	0.08	0.12	0.02	0.14	0.13	0.07	0.00	0.00	0.09
Physician	43	5	82	31	685	864	51	47	156	198	9	3	2174
	0.09	0.00	0.05	0.40	0.13	0.24	0.10	0.46	0.25	0.12	0.02	0.07	0.18
Radiation therapist	11	0	30	27	239	440	57	51	67	144	1	0	1067
	0.48	0.00	0.04	0.08	0.24	0.11	0.06	0.10	0.07	0.37	0.00	0.00	0.17
Radiologist (diagnostic)	46	7	61	52	534	683	60	47	130	221	2	0	1843
	0.09	0.00	0.35	0.08	0.14	0.16	0.08	0.07	0.11	0.11	0.00	0.00	0.14
Radiologist (therapeutic)	2	0	1	12	46	58	18	4	14	15	0	0	170
	0.00	0.00	0.70	0.02	0.09	0.07	0.00	0.00	0.05	0.02	0.00	0.00	0.06
Veterinarian	32	51	154	65	629	1301	214	178	682	674	0	7	3987
	0.06	0.09	0.04	0.12	0.03	0.07	0.02	0.04	0.03	0.04	0.00	0.00	0.05
Veterinary technician	0	0	2	0	0	2	0	0	2	2	0	0	8
	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Ward aide/orderly	33	14	26	52	1079	385	82	40	38	98	5	0	1852
	0.06	0.05	0.02	0.09	0.09	0.11	0.02	0.08	0.03	0.04	0.00	0.00	0.08
OVERALL	**981**	**236**	**1641**	**1083**	**15124**	**22781**	**3186**	**1937**	**3833**	**4743**	**202**	**112**	**55859**
	0.09	**0.04**	**0.09**	**0.10**	**0.10**	**0.10**	**0.04**	**0.10**	**0.09**	**0.09**	**0.02**	**0.02**	**0.09**
Nuclear Power													
Reactor - administration	0	0	0	125	327	3624	0	0	0	0	0	0	4076
	0.00	0.00	0.00	0.07	0.17	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Reactor - chemical and radiation control	0	0	0	27	45	315	0	0	0	0	0	0	387
	0.00	0.00	0.00	0.68	1.66	2.06	0.00	0.00	0.00	0.00	0.00	0.00	1.91
Reactor - construction	0	0	0	13	59	1271	0	0	0	0	0	0	1343
	0.00	0.00	0.00	0.00	0.03	1.06	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Reactor - control technician	0	0	0	0	103	9	0	0	0	0	0	0	112
	0.00	0.00	0.00	0.00	1.41	1.08	0.00	0.00	0.00	0.00	0.00	0.00	1.38
Reactor - electrical maintenance	0	0	0	68	42	904	0	0	0	0	0	0	1014
	0.00	0.00	0.00	0.88	1.49	1.20	0.00	0.00	0.00	0.00	0.00	0.00	1.19
Reactor - fuel handling	0	0	0	30	11	3	0	0	0	0	0	0	44
	0.00	0.00	0.00	4.03	4.25	0.39	0.00	0.00	0.00	0.00	0.00	0.00	3.84
Reactor - general maintenance	0	0	0	152	80	1066	0	0	0	0	0	0	1298
	0.00	0.00	0.00	0.83	2.81	0.74	0.00	0.00	0.00	0.00	0.00	0.00	0.88
Reactor - health physics	0	0	0	29	10	43	0	1	0	0	0	0	83
	0.00	0.00	0.00	1.26	0.11	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.54
Reactor - industrial radiographer	0	0	0	0	0	25	0	0	0	0	0	0	25
	0.00	0.00	0.00	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00	0.00	2.20
Reactor - mechanical maintenance	0	0	0	71	169	1188	0	0	0	0	0	0	1428
	0.00	0.00	0.00	2.55	3.11	2.19	0.00	0.00	0.00	0.00	0.00	0.00	2.32
Reactor - operations	0	0	0	91	110	1667	0	0	0	0	0	0	1868
	0.00	0.00	0.00	0.72	0.90	1.68	0.00	0.00	0.00	0.00	0.00	0.00	1.59
Reactor - scientific/ professional	0	0	0	365	141	881	0	0	0	0	0	0	1387
	0.00	0.00	0.00	0.68	0.53	1.62	0.00	0.00	0.00	0.00	0.00	0.00	1.26
Reactor - training	0	0	0	24	20	11	0	0	0	0	0	0	55
	0.00	0.00	0.00	0.16	0.85	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38
Reactor - visitor	0	0	0	0	0	35	0	0	0	0	0	0	35
	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.64
OVERALL	**0**	**0**	**0**	**995**	**1117**	**11042**	**0**	**1**	**0**	**0**	**0**	**0**	**13155**
	0.00	**0.00**	**0.00**	**0.87**	**1.19**	**1.05**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.05**

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
Uranium Mining													
Uranium mine mill maintenance	0	0	0	0	0	8	0	156	0	0	0	0	164
	0.00	0.00	0.00	0.00	0.00	0.21	0.00	2.91	0.00	0.00	0.00	0.00	2.78
Uranium mine mill worker	0	0	0	0	0	28	0	217	0	0	0	0	245
	0.00	0.00	0.00	0.00	0.00	0.62	0.00	3.29	0.00	0.00	0.00	0.00	2.99
Uranium mine nurse	0	0	0	0	0	0	0	6	0	0	0	0	6
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.15
Uranium mine office staff	0	0	0	0	0	14	0	82	0	0	0	0	96
	0.00	0.00	0.00	0.00	0.00	0.48	0.00	0.72	0.00	0.00	0.00	0.00	0.69
Uranium mine support worker	0	0	0	0	0	65	0	70	0	0	0	0	135
	0.00	0.00	0.00	0.00	0.00	4.56	0.00	4.54	0.00	0.00	0.00	0.00	4.55
Uranium mine surface maintenance	0	0	0	0	0	90	0	157	0	0	0	0	247
	0.00	0.00	0.00	0.00	0.00	2.13	0.00	0.87	0.00	0.00	0.00	0.00	1.33
Uranium mine surface miner	0	0	0	0	0	0	0	214	0	0	0	0	214
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	0.00	0.00	0.00	0.00	1.30
Uranium mine surface personnel	0	0	0	0	0	0	0	61	0	0	0	0	61
	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 surface support worker	0	0	0	0	0	63	0	233	0	0	0	0	296
	0.00	0.00	0.00	0.00	0.00	0.27	0.00	1.17	0.00	0.00	0.00	0.00	0.98
Uranium mine underground maintenance	0	0	0	0	0	37	0	64	0	0	0	0	101
	0.00	0.00	0.00	0.00	0.00	3.22	0.00	4.22	0.00	0.00	0.00	0.00	3.85
Uranium mine underground miner	0	0	0	0	0	123	0	349	0	0	0	0	472
	0.00	0.00	0.00	0.00	0.00	7.30	0.00	10.36	0.00	0.00	0.00	0.00	9.56
Uranium mine underground personnel	0	0	0	0	0	128	0	262	0	0	0	0	390
	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.95	0.00	0.00	0.00	0.00	0.82
Uranium mine visitor	0	0	0	0	0	0	0	232	0	0	0	0	232
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	0.00	0.21
OVERALL	**0**	**0**	**0**	**0**	**0**	**556**	**0**	**2103**	**0**	**0**	**0**	**0**	**2659**
	0.00	**0.00**	**0.00**	**0.00**	**0.00**	**2.91**	**0.00**	**3.07**	**0.00**	**0.00**	**0.00**	**0.00**	**3.04**

1996 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	12	247	1	260
		Average dose (mSv)	0.51	0.01	0.00	0.04
	25-34	Number of Workers	83	1023	5	1111
		Average dose (mSv)	0.29	0.04	0.00	0.06
	35-44	Number of Workers	167	1274	6	1447
		Average dose (mSv)	0.90	0.05	0.00	0.14
	45-54	Number of Workers	220	820	2	1042
		Average dose (mSv)	0.31	0.06	0.15	0.11
	55-up	Number of Workers	63	250	6	319
		Average dose (mSv)	0.22	0.04	0.00	0.07
	Unknown	Number of Workers	13	50	1	64
		Average dose (mSv)	0.21	0.05	0.00	0.08
	Overall	**Number of Workers**	**558**	**3664**	**21**	**4243**
		Average dose (mSv)	**0.48**	**0.04**	**0.01**	**0.10**
Industry and Research	Below 25	Number of Workers	718	383	1	1102
		Average dose (mSv)	1.93	0.06	0.00	1.28
	25-34	Number of Workers	3481	1521	13	5015
		Average dose (mSv)	1.11	0.10	0.98	0.81
	35-44	Number of Workers	4319	1114	19	5452
		Average dose (mSv)	0.74	0.10	0.30	0.61
	45-54	Number of Workers	2558	470	9	3037
		Average dose (mSv)	0.52	0.16	0.09	0.47
	55-up	Number of Workers	883	108	16	1007
		Average dose (mSv)	0.30	0.10	0.38	0.28
	Unknown	Number of Workers	163	24	0	187
		Average dose (mSv)	0.38	0.05	0.00	0.33
	Overall	**Number of Workers**	**12122**	**3620**	**58**	**15800**
		Average dose (mSv)	**0.84**	**0.10**	**0.44**	**0.67**
Medicine	Below 25	Number of Workers	331	3481	4	3816
		Average dose (mSv)	0.15	0.06	0.00	0.07
	25-34	Number of Workers	3549	14768	33	18350
		Average dose (mSv)	0.15	0.08	0.05	0.10
	35-44	Number of Workers	5347	12608	36	17991
		Average dose (mSv)	0.13	0.09	0.03	0.10
	45-54	Number of Workers	4356	6523	31	10910
		Average dose (mSv)	0.09	0.09	0.05	0.09
	55-up	Number of Workers	2378	1386	64	3828
		Average dose (mSv)	0.10	0.08	0.03	0.09
	Unknown	Number of Workers	277	319	3	599
		Average dose (mSv)	0.11	0.06	0.13	0.09
	Overall	**Number of Workers**	**16238**	**39085**	**171**	**55494**
		Average dose (mSv)	**0.12**	**0.08**	**0.04**	**0.09**

Table 3 (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	169	63	0	232
		Average dose (mSv)	0.40	0.11	0.00	0.32
		% tritium	20.8	32.7	0.0	22.0
	25-34	Number of Workers	2163	491	0	2654
		Average dose (mSv)	1.45	0.34	0.00	1.24
		% tritium	25.9	25.6	0.0	25.8
	35-44	Number of Workers	4664	656	1	5321
		Average dose (mSv)	1.21	0.27	0.00	1.09
		% tritium	21.3	21.7	0.0	21.3
	45-54	Number of Workers	3560	297	1	3858
		Average dose (mSv)	1.10	0.22	0.00	1.03
		% tritium	39.5	26.2	0.0	39.3
	55-up	Number of Workers	761	18	0	779
		Average dose (mSv)	0.70	0.03	0.00	0.69
		% tritium	15.8	33.3	0.0	15.8
	Unknown	Number of Workers	165	8	0	173
		Average dose (mSv)	0.47	0.53	0.00	0.48
		% tritium	18.6	0.0	0.0	17.7
	Overall	**Number of Workers**	**11482**	**1533**	**2**	**13017**
		Average dose (mSv)	**1.16**	**0.27**	**0.00**	**1.06**
		% tritium	**27.4**	**23.9**	**0.0**	**27.3**
Mining	Below 25	Number of Workers	173	35	0	208
		Average dose (mSv)	2.41	0.71	0.00	2.12
		% radon progeny	60.8	77.5	0.0	61.7
	25-34	Number of Workers	513	94	1	608
		Average dose (mSv)	4.09	0.96	0.00	3.60
		% radon progeny	57.2	58.0	0.0	57.2
	35-44	Number of Workers	818	50	0	868
		Average dose (mSv)	3.50	0.99	0.00	3.36
		% radon progeny	59.9	59.2	0.0	59.8
	45-54	Number of Workers	577	36	0	613
		Average dose (mSv)	3.28	0.41	0.00	3.11
		% radon progeny	59.6	57.1	0.0	59.6
	55-up	Number of Workers	234	8	5	247
		Average dose (mSv)	2.18	0.28	0.00	2.07
		% radon progeny	61.4	45.5	0.0	61.3
	Unknown	Number of Workers	35	1	0	36
		Average dose (mSv)	3.42	1.20	0.00	3.36
		% radon progeny	66.6	58.3	0.0	66.5
	Overall	**Number of Workers**	**2350**	**224**	**6**	**2580**
		Average dose (mSv)	**3.36**	**0.81**	**0.00**	**3.13**
		% radon progeny	**59.3**	**60.8**	**0.0**	**59.4**