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AND HEALTH

DOSES RECEIVED BY RADIATION WORKERS IN AUSTRALIA 1991

by

Neil D Morris

Australian Radiation Laboratory

Lower Plenty Road, Yallambie, Victoria 3085
Telephone: (03) 433 2211 Facsimile: (03) 432 1835

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AUSTRALIAN RADIATION LABORATORY

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LOWER PLENTY ROAD
YALLAMBIE VIC 3085
TELEPHONE: (03) 433 2211
FACSIMILE: (03) 432 1835

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INTRODUCTION

Exposure to radiation can cause genetic defects or cancer. People who use sources of radiation as part of their employment are potentially at a greater risk than others owing to the possibility of their being continually exposed to small radiation doses over a long period.

In Australia, the National Health and Medical Research Council (NHMRC 1981 and 1991) has established radiation protection standards and set annual effective dose limits for radiation workers in order to minimise the chance of adverse effects occurring. These standards are based on the recommendations of the International Commission on Radiological Protection (ICRP 1990).

In order to ensure that the prescribed limits are not exceeded and to ensure that doses are kept to a minimum, some sort of monitoring is necessary. For exposure to external radiation, personal monitoring is recommended.

The primary purpose of this Report is to provide data on the distribution of Effective Doses for different occupational categories of radiation worker in Australia. This data is periodically sent to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) for incorporation in their reports.

THE ARL PERSONAL RADIATION MONITORING SERVICE

The Australian Radiation Laboratory has operated a Personal Radiation Monitoring Service since 1932 for the determination of the doses received by persons who are exposed to radiation as a result of their occupation.

Before 1989, the main monitor issued by the Personal Radiation Monitoring Service was personal monitoring film. A technical description of this Service is described in Swindon 1981. Since 1989, the Service has issued thermoluminescent dosemeters (TLD), as described in Morris 1992.

Doses are reported as an absorbed dose to the skin. An effective dose is calculated from knowledge of the radiation energy and the skin dose to effective dose conversion factors as listed in Table 1. These conversion factors were derived in Morris 1983 and assume that the radiation worker has been exposed from the front, in an aligned and expanded radiation field, and are based on the dimensions of "reference man" as described in ICRP 1972.

Prior to 1986, monitors were not allocated to specific wearers and accumulated doses for individual wearers were not kept. This meant that it was virtually impossible to determine individual annual doses, as each monitor was only issued for a period of up to four weeks. Although the doses recorded on each monitor could be categorised by sex and occupation, any statistical analysis of the doses assumed that each person received 13 monitors per year. This assumption underestimates the number of persons monitored, as it does not take into account those people who only wear monitors for part of the year or only when they are using radiation sources. Consequently, the average absorbed dose to the skin for a particular sex and occupational category would be higher than the value obtained by averaging the total annual absorbed dose to the skin for these individuals.

Since late 1986, all persons monitored by the Service have been registered on a data base which maintains records of the doses received by each individual wearer. Each person is uniquely registered and identified by their name and initials, sex and date of birth. Specific monitors are issued to individuals so that their cumulative doses can be determined. Ultimately, this data base will become a National Register of the doses received by radiation workers within Australia. In 1991, the Service regularly monitored approximately 20,000 persons, which is roughly 60 percent of those monitored in Australia, and maintained the dose histories of over 35,000 people.

Each registered person is classified into one of the various occupational categories listed in Table 2. The establishments in which they work are also classified into the establishment types listed in Table 3. These classifications have been derived from the type of work performed and the workload involved rather than from strict occupation categories. By categorising workers in this manner, it is possible to make a comparison of doses that workers receive when they perform similar work and therefore allows the work practices and the adequacy of radiation protection measures for an individual to be evaluated.

The cumulative doses on the data base allows an extensive analysis of dose distributions which can be categorised by occupation and establishment type. Periodic examination of the data can also be used to examine trends in the doses received by the workers in the various occupation and establishment type categories.

DISTRIBUTION OF EFFECTIVE DOSES

Tables 4 to 13 give the distribution of annual effective doses for occupationally exposed workers monitored by the ARL Personal Radiation Monitoring Service within Australia in 1990/91. These Tables do not include workers who are exposed to neutron sources. The data are arranged into occupational category and categorised by the establishment type code listed in Table 3. The number of wearers (No Wrr) is also given for each dose interval.

Table 14 gives the distribution of annual effective doses for occupationally exposed workers who use neutron sources. They have been sub-divided by establishment type, but have not been sub-divided by occupational classification.

Any reported doses greater than a pro-rata weekly dose of 0.4 mSv are investigated by the establishment where the dose was received and the Licensing Authorities to determine the cause of the high dose. In some cases, it has been found that the dose was not received by the wearer and the dose is, therefore, removed from the wearer's record. However, if the dose is believed to be real or if there is no evidence that the wearer did not receive the dose, then it remains on the wearer's record. These doses are included in the dose distributions reported.

The distribution of effective doses for all occupational categories is given in Table 15.

In order to characterise the dose distributions, UNSCEAR request data on the fraction of the work force that receive doses that exceed either 10 mSv or 15 mSv per year. In countries that have a nuclear industry, this number may be significant. However, in Australia, for those workers covered by our Service, there were only 9 people who received effective doses from external sources of radiation exceeding 10 mSv. Only 4 of these workers had an effective dose greater than 15 mSv. Consequently, the fraction of the work force that receive doses that exceed either 10 or 15 mSv per year would not be very effective in categorising the dose distributions for Australian workers.

Very few occupational categories in Australia receive effective doses from external radiations greater than one-tenth of the recommended annual limit of 20 mSv. Less than 1.23 % of people monitored received effective doses more than 2 mSv per year with only one person receiving more than the limit of 20 mSv.

The main occupational categories that received annual doses greater than 2 mSv are Nuclear Medicine Technologists (3%), Industrial Radiographers (18.5%) and those people working in the Mineral Sands Mining and Uranium Mining industries (5.8% and 14.8% respectively). Plots of this information are shown in Graphs 1 to 4.

For the 18416 workers covered by the Personal Radiation Monitoring Service in 1990/91, the average annual effective dose was 0.1205 mSv. The average effective dose for the 9971 workers who received measurable doses was 0.2226 mSv with a total collective effective dose of 2.22 Sv. The collective effective dose for the 1.23 % of workers with doses greater than 2 mSv per year is 0.86 Sv.

AGE DISTRIBUTION OF OCCUPATIONALLY EXPOSED WORKERS

The age distribution of occupationally exposed workers is of interest. Table 16 lists the age distribution and the average annual effective doses for each age grouping for 1990/91. A plot of the age distribution is shown in Graph 5 and the dose distribution in Graph 6.

Graph 5 also shows the age distribution of radiation workers for 1975, which was derived from Swindon 1981. The age distribution for 1975 and 1990/91 are similar, except for the age group of workers below 20 years old who now seem to be in the age range 30 to 40 years old, which is understandable.

The average effective dose distribution in Graph 6 shows that the doses that workers receive is reasonably independent of their age. The apparent smaller doses for those workers below 20 and the apparent higher doses for those workers over 65 years old may be explained by either their work practices or poor statistics for the relatively fewer workers in these age groupings.

POPULATION DOSES FOR AUSTRALIA

In 1991, there were five personal monitoring services operated within Australia. The Australian Radiation Laboratory's Personal Radiation Monitoring Service monitored radiation workers in Victoria, South Australia, Tasmania, the Northern Territory, the ACT and all workers in Commonwealth Departments and the Armed Forces. The Service also monitored all workers in the Uranium Mining and Mineral Sands industries.

The New South Wales Department of Health operated a Service for radiation workers in New South Wales except for some specialist workers at the Australian Nuclear Science and Technology Organisation (ANSTO). Since 1991, the Australian Radiation Laboratory's Personal Radiation Monitoring Service has taken over the Personal Monitoring Service operated by the New South Wales Department of Health.

The Queensland and Western Australian Health Departments also operate their own Services for workers within their States and ANSTO operates a Service for their own specialist workers.

There were approximately 2.5 radiation workers per 1000 population for those States covered by our Service. This number is consistent with the number of workers that we now monitor in New South Wales and the number of radiation workers in Western Australia (WA 1994).

If it is assumed that the number of workers monitored in Queensland is of the same proportion as for the rest of Australia, then the number of radiation workers in Australia in 1991 was roughly 34000, excluding those specialist workers at ANSTO.

Provided that the type of radiation work undertaken throughout Australia was similar in each State, then it can be assumed that the average annual effective dose of 0.120 mSv derived from our Service is a reasonable estimate for the whole of Australia.

The ANSTO Service monitored an additional 760 workers who do specialist work. These workers received an average annual effective dose of 1.100 mSv in 1991/92 (ANSTO 1994).

Consequently, the Total Collective Effective Dose for radiation workers in Australia, including those monitored by ANSTO in 1990/91 would be of the order of 4.9 Sv for a total of 34750 workers.

Using the risk factors of 5.6×10^{-2} per Sv for the total risk of a radiation induced detrimental effect and 4.0×10^{-2} per Sv for risk of fatal cancers (ICRP 1990), then the Total Collective Effective Dose predicts that there would have been 1 detrimental effect produced in 3.5 years and 1 fatality in 5 years.

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TABLE 1
MULTIPLYING FACTORS TO CONVERT THE ABSORBED DOSE TO THE SKIN TO EFFECTIVE DOSE

Radiation Type	Effective Energy (keV)	Multiplying Factor Male	Female
30 kV Xrays	17	.20	.10
50 kV Xrays	20	.30	.10
75 kV Xrays	23	.40	.20
75 - 130 kV Xrays	33	.60	.40
140 - 180 kV Xrays	60	.80	.60
180 - 220 kV Xrays (medium filtration)	70	80	.65
230 - 250 kV Xrays (medium filtration)	95	.85	.70
250 kV Xrays (heavy filtration)	122	.90	.75
^{99m}Tc	140	.90	.75
300 kV Xrays (heavy filtration)	170	.90	.75
^{51}Cr	320	.90	.80
^{131}I	360	.90	.80
^{137}Cs, ^{192}Ir	660	.90	.80
^{226}Ra, ^{60}Co	1200	.90	.80

TABLE 2
CLASSIFICATION OF WEARER OCCUPATIONS

Code	
	Diagnostic Radiology
01	Radiation Safety Officers, Hospital Physicists
02	Radiologists
03	Medical Practitioners (other than 07 below)
04	Radiographers and others X-raying patients (including trainees)
05	Assistants to the above
06	Receptionists, office workers, etc
07	Medical Specialists (eg cardiologists, urologists, surgeons)
	Radiotherapy
11	Radiotherapists, dermatologists, gynaecologists
12	Radiation Safety Officers, Hospital Physicists, Therapy Radiographers (including trainees)
13	Those nursing patients with radioactive sources in situ
14	Assistants to the above
15	Receptionists, office workers
	Nuclear Medicine or Pathology
21	Radiation Safety Officers, Hospital or Medical Physicists
22	Nuclear Medicine Specialists or Pathologists
23	Nuclear Medicine Technologists or Medical Lab. Technologists (including trainees)
24	Assistants to above
25	Receptionists, office workers
	Dentistry
31	Dentists
32	Assistants to above
33	Receptionists, office workers
	Chiropractic
41	Chiropractors, osteopaths, etc
42	Assistants to above
43	Receptionists, office workers, etc

TABLE 2 (CONTINUED)
CLASSIFICATION OF WEARER OCCUPATIONS

Code	
	Veterinary
51	Veterinary surgeons
52	Assistants to above
53	Receptionists, office workers, etc
	Industry, Research and Education
61	Those using X-ray diffraction units and/or electron microscopes, etc
62	Those working outside totally enclosed installations
63	Those using non or partially enclosed radiation sources (other than 64)
64	Those using radioactive isotopes in tracer techniques
66	Teachers/Demonstrators
67	Students (other than post-graduate research included in above classifications)
68	Radiation Safety Officers
	Uranium Mining
71	Mill workers
72	Mine workers
73	Miscellaneous
74	Radiation Safety Officers
	Mineral Sand Mining
81	Miner
82	Wet Plant Operator
83	Dry Plant Operator
84	Miscellaneous
85	Radiation Safety Officers
90	**Installation and Maintenance Personnel**
91	**Inspectors**

TABLE 3
CLASSIFICATION OF ESTABLISHMENT TYPES

Code	
	Diagnostic Radiology
01	Small hospital department with one or two radiographers
02	Large hospital department with more than two radiographers
03	Private radiological practice
04	Other medical practices
05	Other hospital and nursing establishments
	Radiotherapy
11	Dermatology
12	Radiotherapy department
13	Private radiotherapy practice
	Nuclear medicine/pathology
20	Nuclear medicine department
21	Private nuclear medicine practice
25	Pathology departments or practices
	Dental
30	Hospital
31	Private practice
32	Government service
33	School dental service
	Chiropracty
40	Chiropractic practice
	Veterinary
50	Veterinary practice
	Industry
60	Manufacturer utilising quality control or quality assurance devices
61	Industrial radiography
	Mining
70	Uranium mining
80	Mineral sand mining

TABLE 3 (CONTINUED)
CLASSIFICATION OF ESTABLISHMENT TYPES

Code	
	Research
90	Government
91	Medical and veterinary
92	Industry
	Education
93	Tertiary
94	Secondary

Table 4

Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Diagnostic Radiology : Radiation Safety Officer, Hospital Physicist																					
2	Av Dose		.099																		
	No Wrr	3	6																		
5	Av Dose																				
	No Wrr	2																			
Tot	Av Dose		.099																		
	No Wrr	5	6																		
Diagnostic Radiology : Radiologists																					
1	Av Dose		.132	.534	1.125																
	No Wrr	3	14	1	1																
2	Av Dose		.105	.761	1.253	1.568		2.676					5.909								
	No Wrr	44	184	10	4	3		2					1								
3	Av Dose		.088	.686		1.957															
	No Wrr	13	57	6		2															
4	Av Dose		.078																		
	No Wrr	6	17																		
5	Av Dose		.025																		
	No Wrr	2	8																		
Tot	Av Dose		.099	.721	1.227	1.724		2.676					5.909								
	No Wrr	68	280	17	5	5		2					1								

Table 4 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Diagnostic Radiology : General Medical Practitioners																				
1	Av Dose		.029																	
	No Wrr	56	34																	
2	Av Dose		.097	.665	1.324															
	No Wrr	14	21	1	1															
3	Av Dose		.012																	
	No Wrr	8	8																	
4	Av Dose		.022	.809																
	No Wrr	141	55	1																
5	Av Dose		.026		1.493															
	No Wrr	42	37		1															
Tot	Av Dose		.034	.737	1.409															
	No Wrr	261	155	2	2															

Table 4 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Diagnostic Radiology : Radiographers and others X-raying patients (including trainees)																					
1	Av Dose		.047	.584	1.177									6.377							
	No Wrr	108	191	2	1									1							
2	Av Dose		.053	.723	1.129		2.040	2.986				4.949	5.847								
	No Wrr	146	1023	3	5		1	1				1	1								
3	Av Dose		.069	.697																	
	No Wrr	52	350	1																	
4	Av Dose		.046																		
	No Wrr	38	112																		
5	Av Dose		.029																		
	No Wrr	46	81																		
91	Av Dose		.003																		
	No Wrr	9	1																		
93	Av Dose		.019																		
	No Wrr	44	126																		
Tot	Av Dose		.052	.672	1.137		2.040	2.986				4.949	5.847	6.377							
	No Wrr	443	1884	6	6		1	1				1	1	1							

Table 4 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Diagnostic Radiology : Assistants																					
1	Av Dose		.032																		
	No Wrr	63	57																		
2	Av Dose		.048	.628																	
	No Wrr	175	394	6																	
3	Av Dose		.064	.539																	
	No Wrr	11	52	1																	
4	Av Dose		.033				2.152														
	No Wrr	75	43				1														
5	Av Dose		.020																		
	No Wrr	101	75																		
91	Av Dose																				
	No Wrr	2																			
	Av Dose		.044	.615			2.152														
Tot	No Wrr	427	621	7			1														

Table 4 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Diagnostic Radiology : Receptionists, office workers, etc																				
1	Av Dose		.008																	
	No Wrr	14	11																	
2	Av Dose		.012																	
	No Wrr	16	17																	
3	Av Dose		.007																	
	No Wrr	18	11																	
4	Av Dose		.005																	
	No Wrr	18	8																	
5	Av Dose		.006																	
	No Wrr	4	5																	
Tot	Av Dose		.008																	
	No Wrr	70	52																	

Table 4 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Diagnostic Radiology : Medical Specialists (eg cardiologists, urologists, surgeons)																				
1	Av Dose		.036																	
	No Wrr	1	6																	
2	Av Dose		.087	.711		1.803	2.485													
	No Wrr	39	58	2		1	1													
3	Av Dose																			
	No Wrr	1																		
4	Av Dose		.070				2.315													
	No Wrr	12	14				1													
5	Av Dose		.094	.561																
	No Wrr	6	12	1																
Tot	Av Dose		.082	.661		1.803	2.400													
	No Wrr	59	90	3		1	2													

Table 5
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Radiotherapy : Radiotherapists, dermatologists, gynaecologists																					
11	Av Dose			.640																	
	No Wrr	1		4																	
12	Av Dose		.137	.712	1.120	1.909															
	No Wrr	6	13	6	3	1															
13	Av Dose		.199																		
	No Wrr		3																		
Tot	Av Dose		.148	.683	1.120	1.909															
	No Wrr	7	16	10	3	1															
Radiotherapy : Radiation Safety Officer, Hospital Physicist, Therapy Radiographers (including trainees)																					
11	Av Dose		.497	.556																	
	No Wrr		1	1																	
12	Av Dose		.191	.656	1.418	1.848												11.43			31.96
	No Wrr	39	200	25	1	3												1			1
13	Av Dose		.075		1.231																
	No Wrr	1	5		3																
93	Av Dose		.063		1.158																
	No Wrr	22	32		1																
Tot	Av Dose		.173	.652	1.254	1.848												11.43			31.96
	No Wrr	62	238	26	5	3												1			1

Table 5 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Radiotherapy : Those nursing patients with radioactive sources in situ																				
12	Av Dose		.161	.689	1.182	1.748	2.272			3.733	4.178							11.25			
	No Wrr	28	101	14	5	4	2			1	1							1			
13	Av Dose		.065																		
	No Wrr		1																		
Tot	Av Dose		.160	.689	1.182	1.748	2.272			3.733	4.178							11.25			
	No Wrr	28	102	14	5	4	2			1	1							1			
Radiotherapy : Assistants																				
12	Av Dose		.047																		
	No Wrr	6	6																		
13	Av Dose																				
	No Wrr	2																			
Tot	Av Dose		.047																		
	No Wrr	8	6																		
Radiotherapy : Receptionists, Office workers																				
11	Av Dose		.024																		
	No Wrr	4	1																		
13	Av Dose			.969	1.011																
	No Wrr			1	1																
Tot	Av Dose		.024	.969	1.011																
	No Wrr	4	1	1	1																

Table 6
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Nuclear Medicine or Pathology : Radiation Safety Officer, Hospital Physicist or Medical Physicist																				
20	Av Dose		.151											6.113						
	No Wrr	2	12											1						
21	Av Dose		.035																	
	No Wrr	1	1																	
91	Av Dose		.014																	
	No Wrr		1																	
Tot	Av Dose		.133											6.113						
	No Wrr	3	14											1						
Nuclear Medicine or Pathology : Nuclear Medicine Specialist or Pathologist																				
20	Av Dose		.210	.764	1.252	1.599														
	No Wrr	5	23	6	2	2														
21	Av Dose		.269		1.293				3.040											
	No Wrr		2		3				1											
25	Av Dose		.026																	
	No Wrr	6	1																	
91	Av Dose																			
	No Wrr	1																		
Tot	Av Dose		.207	.764	1.276	1.599			3.040											
	No Wrr	12	26	6	5	2			1											

Table 6 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Nuclear Medicine or Pathology : Nuclear Medicine Technologists or Medical Lab Technologists (including trainees)																					
20	Av Dose		.137	.737	1.225	1.717	2.216	2.795	3.157		4.377	4.990	5.000	6.087							
	No Wrr	74	84	40	32	17	6	3	2		1	1	1	1							
21	Av Dose		.203	.784	1.226	1.719		2.845	3.495	3.764	4.035	4.898									
	No Wrr	7	5	5	5	5		2	1	2	1	1									
25	Av Dose		.057																		
	No Wrr	216	113																		
91	Av Dose		.044	.598																	
	No Wrr	16	7	1																	
93	Av Dose		.187	.574																	
	No Wrr	10	35	6																	
Tot	Av Dose		.106	.720	1.225	1.718	2.216	2.815	3.269	3.764	4.206	4.944	5.000	6.087							
	No Wrr	323	244	52	37	22	6	5	3	2	2	2	1	1							

Table 6 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals .mSv)																		
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Nuclear Medicine or Pathology : Assistants																				
20	Av Dose		.143	.591	1.222	1.776	2.461													
	No Wrr	17	23	10	5	2	1													
21	Av Dose		.179							3.872										
	No Wrr	2	1							1										
25	Av Dose		.087																	
	No Wrr	8	7																	
91	Av Dose		.299																	
	No Wrr	3	1																	
Tot	Av Dose		.137	.591	1.222	1.776	2.461			3.872										
	No Wrr	30	32	10	5	2	1			1										
Nuclear Medicine or Pathology : Receptionists, office workers, etc																				
20	Av Dose		.088		1.048	1.976														
	No Wrr	11	9		1	1														
21	Av Dose		.292																	
	No Wrr	1	4																	
25	Av Dose		.310						3.250											
	No Wrr	4	1						1											
Tot	Av Dose		.162		1.048	1.976			3.250											
	No Wrr	16	14		1	1			1											

Table 7

Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Dentistry : Dentists																				
30	Av Dose		.014																	
	No Wrr	58	27																	
31	Av Dose		.014							3.898										
	No Wrr	396	364							1										
32	Av Dose		.013																	
	No Wrr	69	41																	
33	Av Dose		.006																	
	No Wrr	26	34																	
Tot	Av Dose		.013							3.898										
	No Wrr	549	466							1										
Dentistry : assistants																				
30	Av Dose		.012																	
	No Wrr	112	46																	
31	Av Dose		.008																	
	No Wrr	700	444																	
32	Av Dose		.008																	
	No Wrr	116	91																	
33	Av Dose		.007																	
	No Wrr	48	73																	
93	Av Dose																			
	No Wrr	2																		
Tot	Av Dose		.008																	
	No Wrr	978	654																	

Table 7 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Dentistry : Receptionists, office workers, etc																					
30	Av Dose		.006																		
	No Wrr	14	6																		
31	Av Dose		.006																		
	No Wrr	72	38																		
32	Av Dose		.006																		
	No Wrr	7	11																		
Tot	Av Dose		.006																		
	No Wrr	93	55																		

Table 8
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Chiropracty : Chiropractors																					
40	Av Dose		.030																		
	No Wrr	53	60																		
93	Av Dose		.016																		
	No Wrr	3	9																		
Tot	Av Dose		.028																		
	No Wrr	56	69																		
Chiropracty : assistants																					
40	Av Dose		.003																		
	No Wrr	22	2																		
Chiropracty : Receptionists, office workers, etc																					
40	Av Dose		.006																		
	No Wrr	31	9																		
93	Av Dose		.004																		
	No Wrr	2	2																		
Tot	Av Dose		.005																		
	No Wrr	33	11																		

Table 9
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Veterinary : Veterinary surgeons																					
50	Av Dose		.024	.632																	
	No Wrr	450	295	3																	
91	Av Dose																				
	No Wrr	1																			
93	Av Dose		.054																		
	No Wrr	11	10																		
Tot	Av Dose		.025	.632																	
	No Wrr	462	305	3																	
Veterinary : assistants																					
50	Av Dose		.013																		
	No Wrr	453	212																		
91	Av Dose		.024																		
	No Wrr		1																		
93	Av Dose		.013																		
	No Wrr	6	4																		
Tot	Av Dose		.013																		
	No Wrr	459	217																		
Veterinary : Receptionists, office workers, etc																					
50	Av Dose		.008																		
	No Wrr	63	32																		
93	Av Dose																				
	No Wrr	1																			
Tot	Av Dose		.008																		
	No Wrr	64	32																		

Table 10
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Industry, Research and Education : Those using X-ray diffraction units and/or electron microscopes, etc																				
60	Av Dose		.048	.652	1.191															
	No Wrr	122	82	1	1															
90	Av Dose		.040																	
	No Wrr	132	95																	
91	Av Dose																			
	No Wrr	2																		
93	Av Dose		.034	.713																
	No Wrr	55	35	1																
Tot	Av Dose		.042	.683	1.191															
	No Wrr	311	212	2	1															
Industry, Research and Education : Those working outside totally enclosed installations																				
60	Av Dose		.047		1.207													11.19		
	No Wrr	321	206		1													1		
61	Av Dose		.093	.720	1.262	1.536	2.209	2.652	3.203	3.817	4.069	4.858	5.329	6.210		8.844				
	No Wrr	65	46	7	3	2	5	2	3	2	1	2	1	1		1				
90	Av Dose		.081	.616																
	No Wrr	65	27	5																
91	Av Dose		.030																	
	No Wrr	14	5																	
92	Av Dose		.024																	
	No Wrr	3	2																	
93	Av Dose		.014																	
	No Wrr	9	5																	
Tot	Av Dose		.056	.677	1.249	1.536	2.209	2.652	3.203	3.817	4.069	4.858	5.329	6.210		8.844		11.19		
	No Wrr	477	291	12	4	2	5	2	3	2	1	2	1	1		1		1		

Table 10 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Industry, Research and Education : Those using non or partially enclosed radiation sources																					
60	Av Dose		.092	.676	1.260	1.809	2.260	2.740			4.439	4.513			7.214						
	No Wrr	275	361	14	5	3	2	2			1	1			1						
61	Av Dose		.171	.718	1.147	1.795	2.109	2.848	3.366	3.679	4.204		5.937	6.454	7.474			10.24	15.87		
	No Wrr	28	50	12	6	6	6	4	7	3	3		1	4	2			1	2		
90	Av Dose		.072	.861	1.004																
	No Wrr	141	140	1	1																
91	Av Dose		.091	.758																	
	No Wrr	26	17	1																	
92	Av Dose		.226																		
	No Wrr	3	3																		
93	Av Dose		.065	.613	1.038																
	No Wrr	73	67	2	1																
96	Av Dose																				
	No Wrr	2																			
Tot	Av Dose		.091	.697	1.171	1.800	2.147	2.812	3.366	3.679	4.263	4.513	5.937	6.454	7.387			10.24	15.87		
	No Wrr	548	638	30	13	9	8	6	7	3	4	1	1	4	3			1	2		

Table 10 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers witnin Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Industry, Research and Industry ; Those using radioactive isotopes in tracer techniques																					
60	Av Dose		.116	.573																	
	No Wrr	31	22	1																	
90	Av Dose		.092	.575	1.334	1.666															
	No Wrr	524	458	3	2	1															
91	Av Dose		.071	.610	1.141																
	No Wrr	635	451	3	1																
92	Av Dose		.086																		
	No Wrr	38	15																		
93	Av Dose		.057				2.437														
	No Wrr	468	227				1														
94	Av Dose																				
	No Wrr	2																			
Tot	Av Dose		.077	.590	1.270	1.666	2.437														
	No Wrr	1698	1173	7	3	1	1														

Table 10 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Industry, Research and Education ; Teachers/Demonstrators																					
60	Av Dose		.005																		
	No Wrr	16	7																		
90	Av Dose		.004																		
	No Wrr	6	5																		
91	Av Dose																				
	No Wrr	1																			
92	Av Dose																				
	No Wrr	1																			
93	Av Dose		.044		1.286		2.017														
	No Wrr	33	30		1		1														
94	Av Dose																				
	No Wrr	6																			
Tot	Av Dose		.033		1.286		2.017														
	No Wrr	63	42		1		1														

Table 10 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Industry, Research and Education ; Students (other than post-graduate research)																					
60	Av Dose																				
	No Wrr	1																			
61	Av Dose							2.757													
	No Wrr							1													
90	Av Dose		.092																		
	No Wrr	22	8																		
91	Av Dose		.057																		
	No Wrr	9	12																		
93	Av Dose		.056	.546																	
	No Wrr	136	54	1																	
Tot	Av Dose		.060	.546				2.757													
	No Wrr	168	74	1				1													

Table 10 (continued)
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																		
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Industry, Research and Education ; Radiation Safety Officer																					
60	Av Dose		.062	.599																	
	No Wrr	27	11	1																	
61	Av Dose		.041																		
	No Wrr	5	4																		
90	Av Dose		.076																		
	No Wrr	15	20																		
91	Av Dose		.127																		
	No Wrr	1	2																		
93	Av Dose		.020																		
	No Wrr	12	2																		
94	Av Dose		.026																		
	No Wrr	2	1																		
Tot	Av Dose		.067	.599																	
	No Wrr	62	40	1																	

Table 11
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Uranium Mining : Mine workers																					
70	Av Dose		.259	.741	1.224	1.733	2.229	2.741	3.234	3.656	4.240	4.684	5.646								
	No Wrr		45	40	24	26	18	26	10	7	5	3	2								
Uranium Mining : Mill workers																					
70	Av Dose		.196	.734	1.218	1.689	2.161	2.644	3.259		4.254	4.660	5.470				9.848				
	No Wrr		226	49	36	23	9	5	2		1	1	1				1				
Uranium Mining : Miscellaneous workers																					
70	Av Dose		.164	.746	1.189	1.806	2.237														
	No Wrr	2	39	14	4	2	2														
Uranium Mining : Radiation Safety Officer																					
70	Av Dose		.293	.608							4.351										
	No Wrr		10	2							1										

Table 12
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Mineral Sand Mining : Miner																					
80	Av Dose		.141																		
	No Wrr		1																		
Mineral Sand Mining : Wet Plant Operator																					
80	Av Dose		.110				2.317	2.788				4.651									
	No Wrr		38				1	2				1									
Mineral Sand Mining : Dry Plant Operator																					
80	Av Dose		.242	.768	1.241	1.713	2.338	2.762	3.162		4.132					8.720					
	No Wrr	2	71	27	22	15	5	4	1		2					1					
Mineral Sand Mining : Miscellaneous workers																					
80	Av Dose		.155	.808	1.281	1.606	2.070														
	No Wrr	2	86	14	8	3	1														
Mineral Sand Mining : Radiation Safety Officer																					
80	Av Dose		.128																		
	No Wrr		6																		

Table 13
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

Est. Type Code		Effective Dose Intervals (mSv)																			
		0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Installation and Maintenance Personnel																					
60	Av Dose		.099	.634		1.533													18.25		
	No Wrr	151	156	9		1													1		
90	Av Dose		.038																		
	No Wrr	12	11																		
92	Av Dose		.046	.571																	
	No Wrr		1	1																	
93	Av Dose		.003																		
	No Wrr	1	1																		
Tot	Av Dose		.097	.652		1.533							5.240						18.25		
	No Wrr	172	187	11		1							1						1		
Inspectors																					
60	Av Dose		.015																		
	No Wrr	3	2																		
70	Av Dose		.172	.608																	
	No Wrr		2	1																	
90	Av Dose		.056																		
	No Wrr	2	10																		
Tot	Av Dose		.067	.608																	
	No Wrr	5	14	1																	

Table 14
Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91
Exposure to sources of neutrons

	Effective Dose Intervals (mSv)																			
	0	.001 - .499	.500 - .999	1.000 - 1.499	1.500 - 1.999	2.000 - 2.499	2.500 - 2.999	3.000 - 3.499	3.500 - 3.999	4.000 - 4.499	4.500 - 4.999	5.000 - 5.999	6.000 - 6.999	7.000 - 7.999	8.000 - 8.999	9.000 - 9.999	10.00 - 14.99	15.00 - 19.99	20.00 - 24.99	> 25.00
Medical uses : radiotherapy																				
Av phot dose		.102	.432																	
Av neut dose		.084	.365																	
Av tot dose		.186	.797																	
Av no wrr	12	22	2																	
Industrial, Research and Educational uses : those working outside totally enclosed installations																				
Av phot dose		.140	.119														11.19			
Av neut dose		.020	.615	1.260																
Av tot dose		.160	.734	1.260													11.19			
Av no wrr	56	34	2	1													1			
Industrial, Research and Educational uses : those using non or partially enclosed radiation sources																				
Av phot dose		.096	.533	1.001	1.955	2.308					4.439									
Av neut dose		.036	.113	.203		.090					.100									
Av tot dose		.132	.646	1.204	1.955	2.398					4.539									
Av no wrr	325	197	16	4	1	1					1									

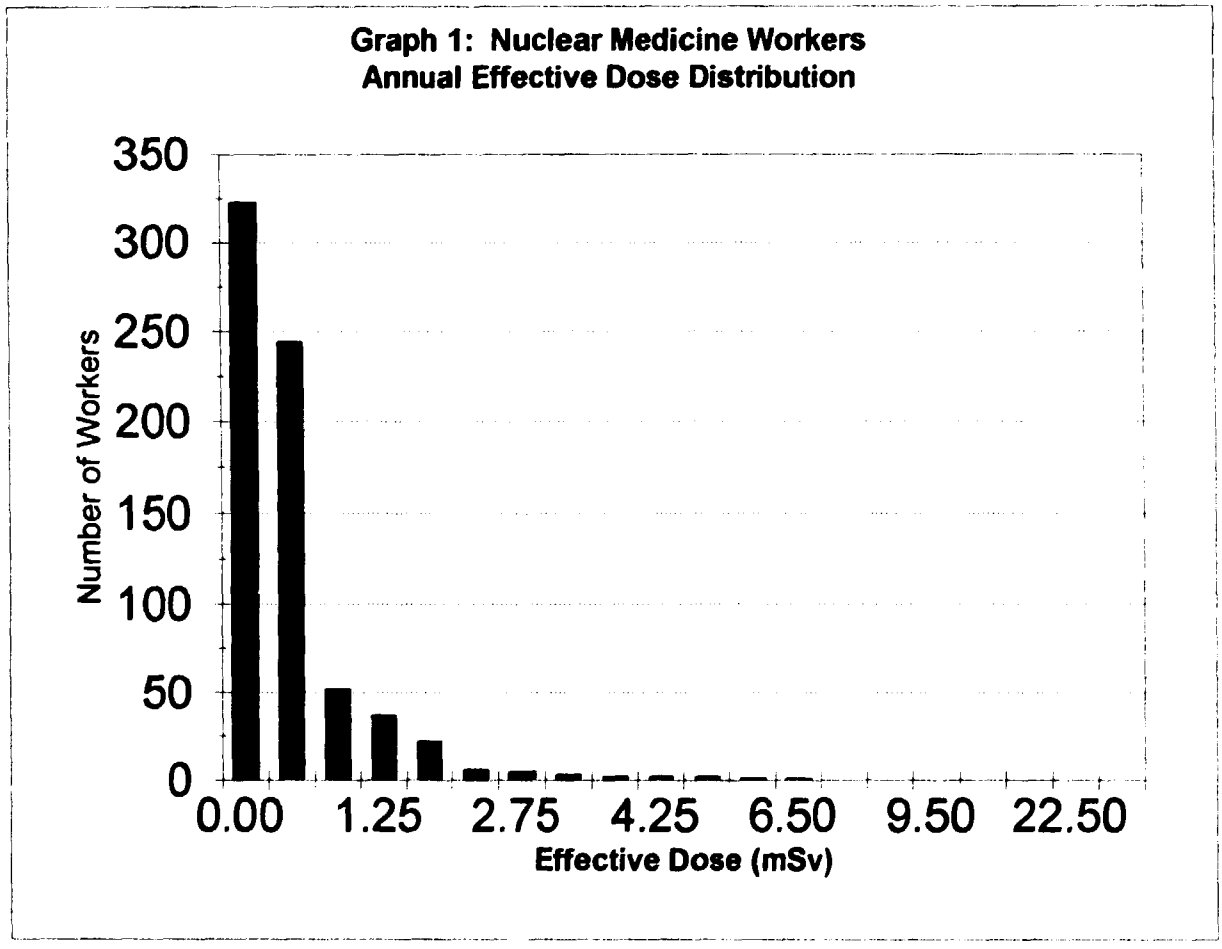
Table 15

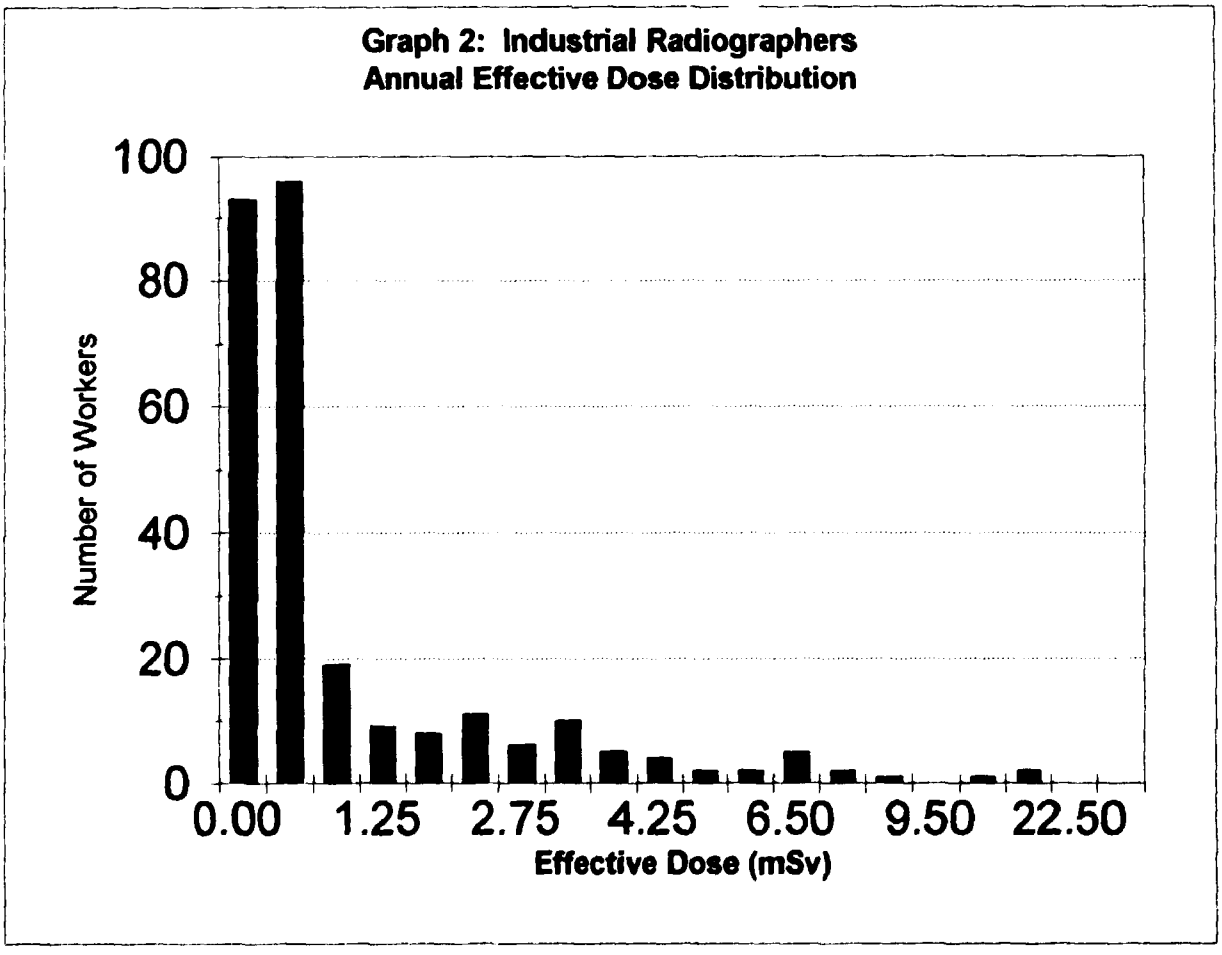
Total Distribution of Annual Effective Doses for Occupationally Exposed Workers within Australia in 1990/91

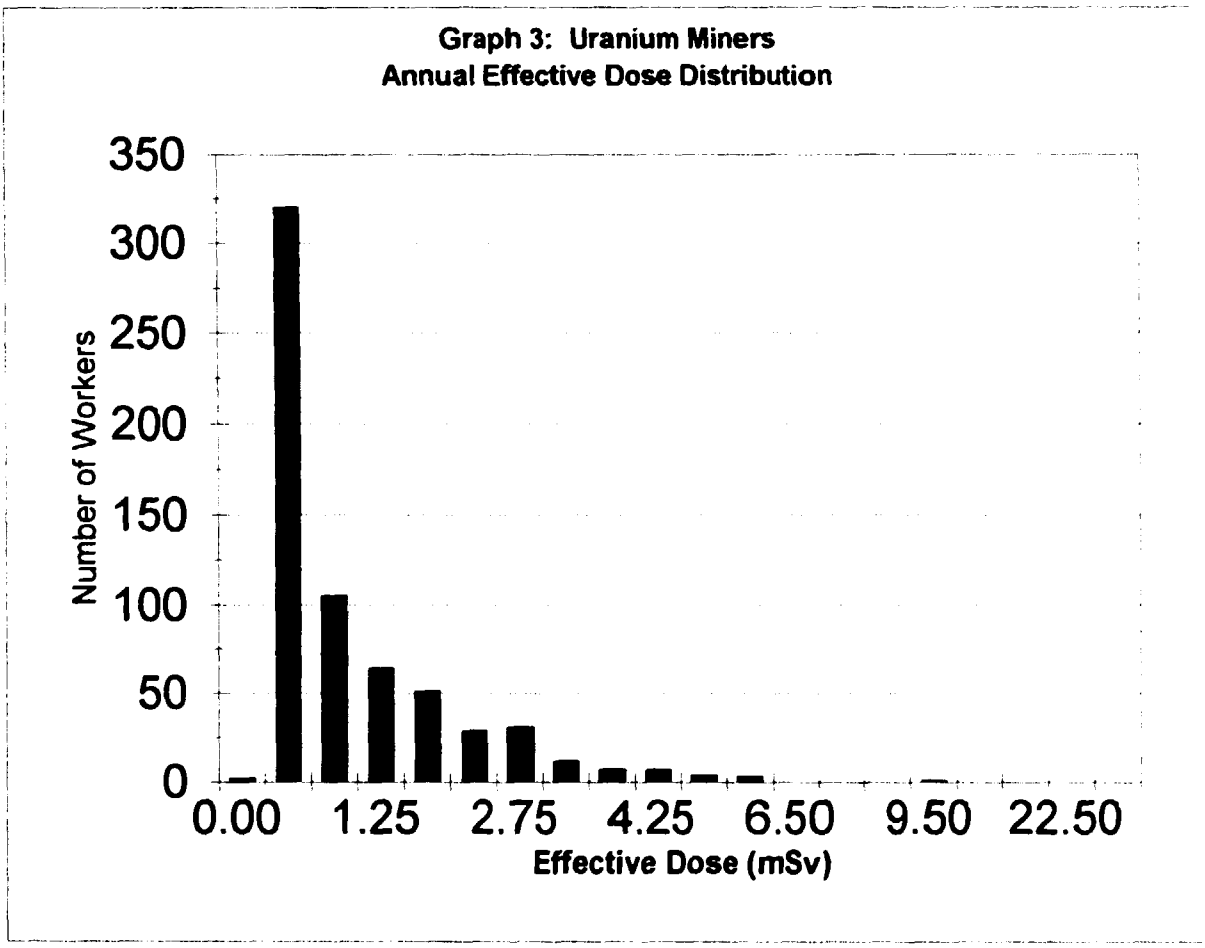
Occupation Grouping		Effective Dose Intervals (mSv)																			
		0	.001 – .499	.500 – .999	1.000 – 1.499	1.500 – 1.999	2.000 – 2.499	2.500 – 2.999	3.000 – 3.499	3.500 – 3.999	4.000 – 4.499	4.500 – 4.999	5.000 – 5.999	6.000 – 6.999	7.000 – 7.999	8.000 – 8.999	9.000 – 9.999	10.00 – 14.99	15.00 – 19.99	20.00 – 24.99	> 25.00
Diagnostic Radiology	Av Dose		.054	.637	1.213	1.738	2.248	2.779				4.949	5.878	6.337				11.34			31.96
	No Wrr	1333	3088	35	13	6	4	3				1	2	1				2			1
Radiotherapy	Av Dose		.167	.679	1.182	1.806	2.272			3.733	4.178										
	No Wrr	121	385	53	14	8	2			1	1										
Nuclear Med/ Pathology	Av Dose		.120	.705	1.226	1.723	2.251	2.815	3.219	3.800	4.206	4.944	5.000	6.100							
	No Wrr	384	330	68	48	27	7	5	5	3	2	2	1	2							
Dentistry	Av Dose		.010							3.898											
	No Wrr	1620	1175							1											
Chiropracty	Av Dose		.024																		
	No Wrr	111	82																		
Veterinary	Av Dose		.019	.632																	
	No Wrr	985	554	3																	
Industrial	Av Dose		.079	.669	1.207	1.761	2.192	2.770	3.317	3.734	4.224	4.692	5.633	6.405	7.387	8.844		10.87	15.87		
	No Wrr	3708	2701	7'	27	13	16	9	10	5	5	4	2	5	3	1		3	2		
Uranium Mining	Av Dose		.204	.736	1.218	1.716	2.208	2.725	3.238	3.656	4.258	4.678	5.587				9.848				
	No Wrr	2	320	105	64	51	29	31	12	7	7	4	3				1				
Mineral Sand Mining	Av Dose		.176	.782	1.252	1.695	2.297	2.771	3.162		4.132	4.651				8.720					
	No Wrr	4	202	41	30	18	7	6	1		2	1				1					
Maintenance & Inspectors	Av Dose		.095	.648		1.533							5.240						18.25		
	No Wrr	177	201	12		1							1						1		
ALL OCCUPATIONS	Av Dose		.070	.707	1.221	1.725	2.223	2.749	3.260	3.723	4.222	4.747	5.558	6.320	7.387	8.782	9.848	11.06	16.66		31.96
	No Wrr	8445	9038	388	196	124	65	54	28	17	17	12	9	8	3	2	1	5	3	0	1
% Total of wearers		45.9	49.1	2.1	1.1	.7	.35	.29	.15	.09	.09	.07	.05	.04	.02	.01	.01	.03	.02	.00	.01

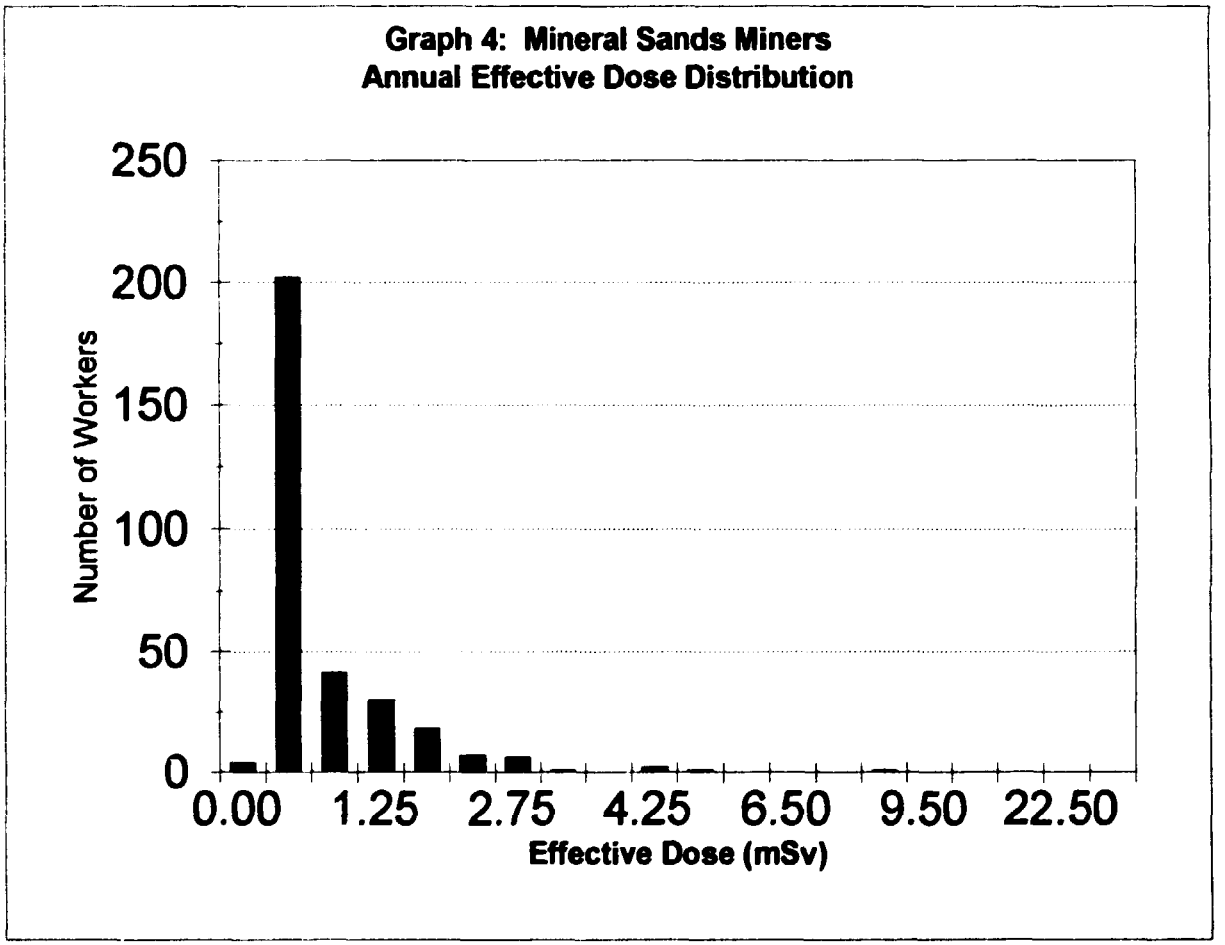
Table 16
Age Distribution of Average Annual Effective Doses for Occupationally Exposed Workers in Australia in 1990/91
(Average Doses in mSv)

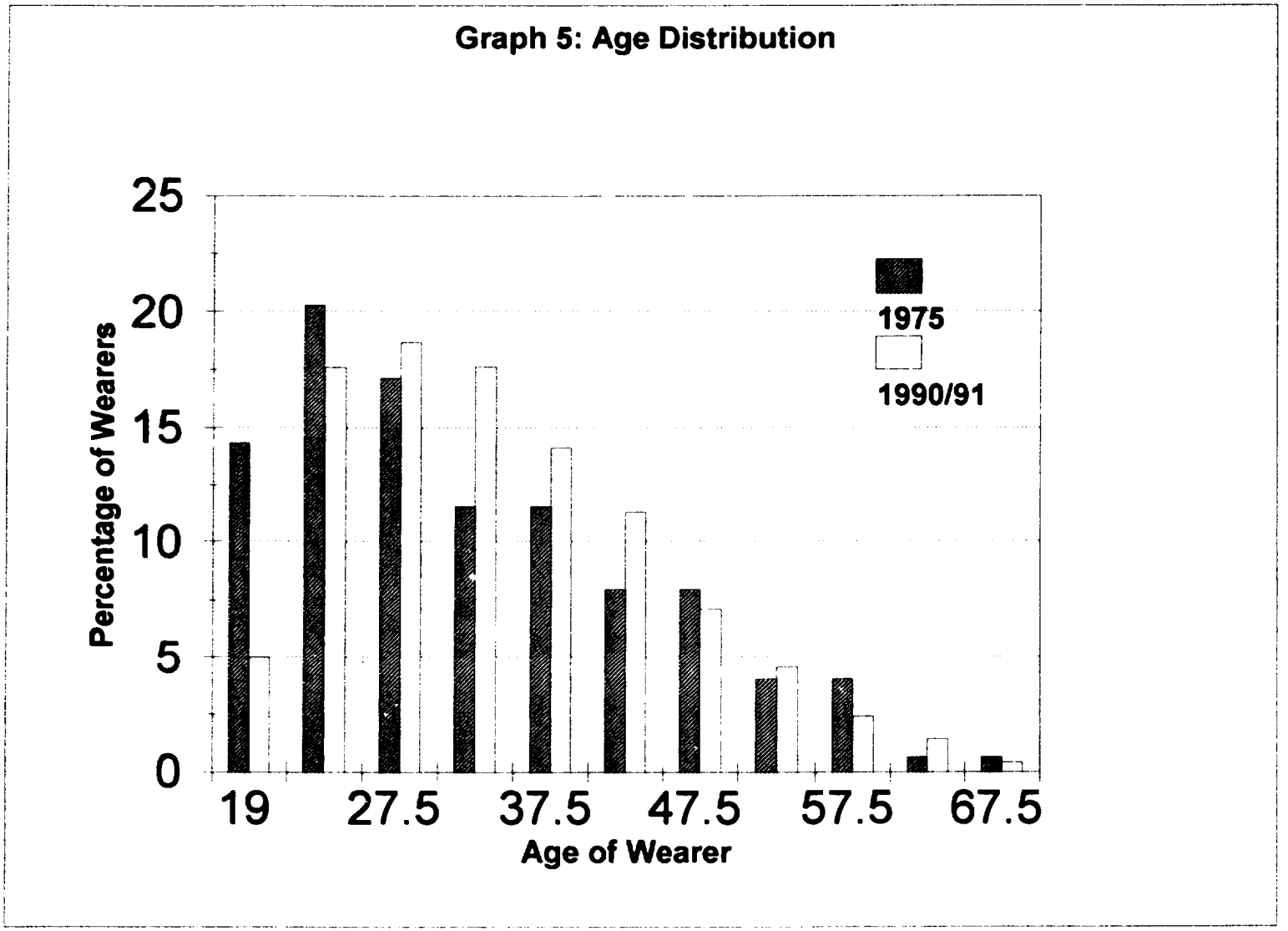
Occupational Grouping		Age Groupings										
		< 20	20 - 25	25 - 30	30 - 35	35 - 40	40 - 45	45 - 50	50 - 55	55 - 60	60 - 65	> 65
Diagnostic Radiology	Av Dose	.013	.078	.050	.072	.052	.063	.069	.077	.068	.069	.021
	No Wrr	51	429	701	813	786	610	431	246	134	92	27
Radiotherapy	Av Dose	.085	.688	.277	.419	.260	.338	.286	.294	.295	.107	.243
	No Wrr	3	61	95	125	74	65	38	42	17	8	3
Nuclear Medicine/ Pathology	Av Dose	.147	.405	.282	.457	.267	.257	.317	.373	.529	.439	.678
	No Wrr	6	130	153	169	129	118	55	23	14	6	1
Dentistry	Av Dose	.003	.004	.003	.004	.004	.023	.005	.005	.005	.012	.006
	No Wrr	316	738	452	393	309	221	129	107	64	42	19
Chiropracty	Av Dose	.000	.001	.016	.002	.005	.018	.009	.013	.013	.001	.080
	No Wrr	1	13	38	29	22	22	17	19	8	6	2
Veterinary	Av Dose	.002	.004	.007	.007	.014	.013	.009	.024	.014	.009	.036
	No Wrr	115	373	317	221	164	170	85	42	11	10	4
Industrial (general)	Av Dose	.182	.163	.081	.070	.046	.081	.140	.048	.058	.279	.719
	No Wrr	55	292	453	435	335	226	185	120	57	31	4
Industrial Radiography	Av Dose	1.916	1.635	1.025	.978	.705	.558	1.637	.419	.500	.000	.022
	No Wrr	8	35	63	57	52	41	13	17	3	1	1
Uranium Mining	Av Dose	.483	.929	.927	1.089	.943	1.007	.895	.655	.670	.158	
	No Wrr	23	100	158	136	80	65	35	23	16	5	
Mineral Sand Mining	Av Dose	.065	.473	.508	.588	.760	.518	.758	.819	.447	.646	4.651
	No Wrr	8	32	52	69	44	40	31	23	10	8	1
Research	Av Dose	.012	.026	.038	.037	.032	.044	.057	.053	.044	.054	.158
	No Wrr	43	607	693	595	457	382	200	118	81	38	6
Education	Av Dose	.033	.029	.029	.023	.020	.025	.042	.106	.005	.022	.132
	No Wrr	286	419	254	191	128	115	83	52	25	10	3

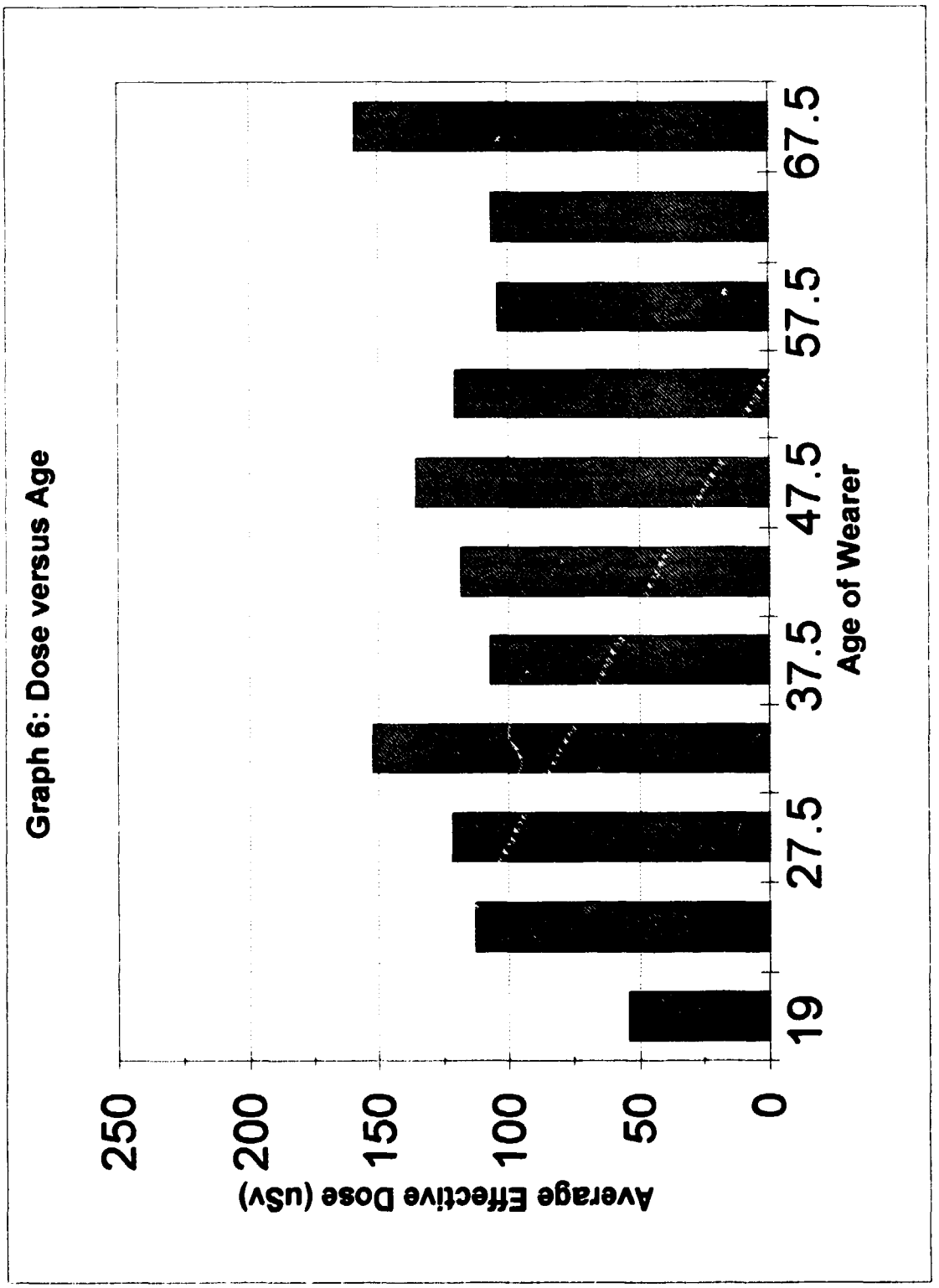

Graph 1: Nuclear Medicine Workers
Annual Effective Dose Distribution
Number of Workers
350
300
250
200
150
100
50
0
0.00
1.25
2.75
4.25
6.50
9.50
22.50
Effective Dose (mSv)


Graph 2: Industrial Radiographers
Annual Effective Dose Distribution
Number of Workers
100
80
60
40
20
0
0.00
1.25
2.75
4.25
6.50
9.50
22.50
Effective Dose (mSv)


Graph 3: Uranium Miners
Annual Effective Dose Distribution
Number of Workers
350
300
250
200
150
100
50
0
0.00
1.25
2.75
4.25
6.50
9.50
22.50
Effective Dose (mSv)


Graph 4: Mineral Sands Miners
Annual Effective Dose Distribution
Number of Workers
250
200
150
100
50
0
0.00
1.25
2.75
4.25
6.50
9.50
22.50
Effective Dose (mSv)


Graph 5: Age Distribution
25
20
15
10
5
0
Percentage of Wearers
1975
1990/91
19
27.5
37.5
47.5
57.5
67.5
Age of Wearer


Graph 6: Dose versus Age
Average Effective Dose (uSv)
250
200
150
100
50
0
19
27.5
37.5
47.5
57.5
67.5
Age of Wearer