THE ANNUAL REPORT OF

THE RADIATION ADVISORY COMMITTEE

FOR THE YEAR ENDING SEPTEMBER 2006

RADIATION ADVISORY COMMITTEE
Melbourne, Australia

ISBN 1035-7912

This document is available on-line at:

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Hon Bronwyn Pike MP
Minister for Health

Dear Minister

Pursuant to Section 108AK(10) of the Health Act 1958, the Radiation Advisory Committee submits the 2006 annual report of the Committee for presentation to Parliament.

Yours faithfully

Professor B M Tress
Chairman
RADIATION ADVISORY COMMITTEE

CONTENTS

RADIATION ADVISORY COMMITTEE

The Radiation Advisory Committee is established under Section 108AK(1) of the Health Act 1958. The present term of appointment for the Committee is the period 17 August 2005 to 16 August 2008. However, in accordance with Schedule 1 of the Radiation Act 2005, the Committee will be abolished on 1 September 2007. A new Radiation Advisory Committee will be established on that day.

(i) Composition

The Radiation Advisory Committee met on eleven occasions from October 2005 to September 2006. The members of the Radiation Advisory Committee during this period were:

CHAIRMAN
Professor Brian M. Tress
Department of Radiology
University of Melbourne

Meetings Attended: 8

Dr. Geza Benke
Research Fellow
Dept of Epidemiology & Preventive Medicine
Monash Medical School

Meetings Attended: 8

Dr. David Bernshaw
Consultant Radiation Oncologist
Peter MacCallum Cancer Centre

Meetings Attended: 8

Mr. Philip Brough
Chief Medical Imaging Technologist
Department of Medical Imaging
Geelong Hospital

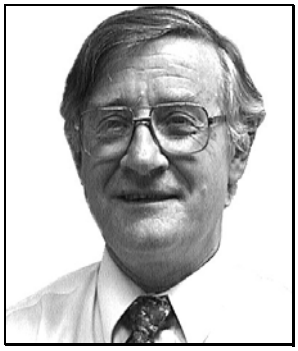
Meetings Attended: 9

Mr. Peter Burns
Director
Environmental and Radiation Health Branch
Australian Radiation Protection & Nuclear Safety Agency

Meetings Attended: 7

Ms. Christy Fejer
Occupational Health and Safety Consultant

Meetings Attended: 5



Dr. John Heggie
Director
Department of Medical Engineering and Physics
St. Vincent's Hospital

Meetings Attended: 10

Dr. Ken Joyner
Director
Global EME Strategy & Regulatory Affairs
Motorola Australia Pty Limited

Meetings Attended: 9

Professor Robert Gibson
Deputy Head, Department of Radiology
University of Melbourne

Meetings Attended: 2

Dr. Roslyn Drummond
Radiation Oncologist
Peter MacCallum Cancer Centre

Meetings Attended: 10

SECRETARY
Ms Caroline Isakow
Radiation Safety Section
Department of Human Services

(ii) Responsibilities

The Radiation Advisory Committee is to advise the Minister for Health or the Secretary of the Department of Human Services, on any matters relating to the administration of Section 108AA to Section 108AK of the *Health Act 1958* referred to it by the Minister or the Secretary including the following:

(a) the promotion of radiation safety procedures and practices

(b) recommending the criteria for the licensing of persons and the qualifications, training or experience required for licensing

(c) recommending the criteria for the registration of radiation apparatus and sealed radioactive sources

(d) recommending the nature, extent and frequency of periodic safety assessments of radiation apparatus and sealed radioactive sources

(e) codes of practice with respect to particular radioactive substances and uses of ionising and non-ionising radiation

(f) any matter which the Minister agrees the Committee should consider and report on.

1. INTRODUCTION

Throughout the year a number of issues were considered by the Committee including:

- the licensing requirements of various occupational groups
- new ionising radiation apparatus
- the implementation of the Code of Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes (2005)
- reviews of conditions of registration and licence for computed tomography scanners
- radiation incidents
- non-ionising radiation matters
- a variety of research projects involving the irradiation of human volunteers.

With the implementation of the Code of Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes as a condition of relevant company/institution licences, the role of the Committee has changed. Historically, the Committee has reviewed proposed research projects involving exposure of human participants to ionising radiation. However with the Code in force, institution human research ethics committees are now responsible for approving most of the radiation procedures used in research projects. In the few trials where specified dose constraints are exceeded, the research projects must still be submitted to the Committee for approval.

The Committee was advised of the progress of the implementation of the *Radiation Act 2005*. The purpose of this Act is to protect the health and safety of persons and the environment from the harmful effects of radiation.

The Committee would like to thank the Radiation Safety Section, Public Health, and in particular Ms Isakow, for their continuing assistance and support. Ms Isakow has departed from the Department of Human Services and the Committee thanked her for her years of service to the Department of Human Services and the Committee, and wished her luck in the future.

2. IONISING RADIATION

2.1 Radiation Act 2005

The Committee monitored the progress of the implementation of the Radiation Act 2005, and the development of the proposed Radiation Regulations. Among the major tasks associated with the implementation of the Act is the introduction of a third-part equipment inspection program, communication of the impact of the new Act to stakeholders, and management of the transitional period.

Under the Act, prescribed radiation sources may only be used if they have a valid certificate of compliance. Certificates of compliance may only be issued by testers approved under the Act for that purpose. The implementation of the inspection program is seen by the Committee as an important step towards improving radiation safety in Victoria, and reducing exposures received by users of radiation and medical patients undergoing radiological procedures. Initially medical diagnostic x-ray equipment is to require a certificate of compliance before it may be used. The Committee noted the importance of implementing the inspection program in a manner that ensures sufficient testers are available, so that equipment owners are given a reasonable opportunity to

comply with requirements of the Act. Consultation with stakeholders is a vital way of ensuring the radiation safety standards set are achievable by most equipment currently in use, and the costs of achieving compliance will not be prohibitive.

2.2 Research involving irradiation of human volunteers

The Committee monitored the trial stage of the implementation of the Code Practice for the Exposure of Humans to Ionizing Radiation for Research Purposes as a condition of company/institution licences to conduct research involving radiation exposure on human volunteers. During the trial stage in Victoria, with the exception of proposed research projects where specified dose constraints are exceeded, responsibility for approving radiation exposures conducted on human volunteers during research projects was given to institutional human research ethics committees.

Under the Code, an approved medical physicist must provide an assessment of the radiation dose expected to be received by participants. The Radiation Safety Section proposed that physicists wishing to gain approval to perform dose assessments under the Code would need to be accredited by the Australasian College of Physical Scientists and Engineers in Medicine. It was also proposed that persons not possessing accreditation could receive approval if they were eligible for membership of the Australasian College of Physical Scientists and Engineers in Medicine and had a minimum of five years experience in regularly carrying out dose assessments for research projects. In the case of physicists who are eligible for membership to the Australasian College of Physical Scientists and Engineers in Medicine, but who have not carried out dose assessments of research projects regularly for at least five years, approval could be granted if they perform 10 dosimetry calculations and have them assessed by a medical physicist who has already been approved in the relevant area of expertise. The Committee supported these criteria, and recommended that a number of currently practising medical physicists be given immediate approval on the basis that they possessed appropriate qualifications and experience.

2.3 Exemption from disposal limits for iodine-131 used in radionuclide therapy

The Committee considered requests from a number of Victorian hospitals for an exemption from Regulation 73 of the Health (Radiation Safety) Regulations 1994. Regulation 73 sets out the maximum activity concentration of radioactive substances permitted to be disposed of via the sewerage system over 24-hour and 7-day periods. These hospitals were concerned with the possible need for installation of holding tanks in which to store patient excreta (urine) until it had decayed to an acceptable activity concentration for discharge. It was noted almost all hospitals performing iodine-131 radionuclide therapy did not currently have holding tanks installed, and that standard practice was for the patients excreta to be collected by nuclear medicine staff and stored until it had decayed to an acceptable level for discharge.

The Committee noted that under Regulation 73 of the Regulations the maximum activity of iodine-131 permitted to be disposed of via the sewerage system in a seven-day period was 20 times the annual limit of intake (ingestion). Furthermore, the maximum concentration of iodine-131 in sewerage permitted to be discharged in a 24-hour period was 2.2 MBq per 1000 litres. The Committee agreed that many hospitals performing iodine-131 radiotherapy would exceed the limits if they were to allow patients to discharge excreta into the sewerage system immediately. Bases on the International Committee for Radiological Protection Publication No. 94 *Release of Patients After Therapy with Unsealed Radionuclides* the Committee recommended the disposal pathway for this type of patient excreta should be via designated toilets using a double flush technique, and this

practice would not pose a risk to the health and safety of persons. No justification could be seen by the Committee for requiring the installation of holding tanks due to the high costs involved.

The Committee recommended the Secretary of the Department of Human Services, under Sub-regulation 73 (3) of the Health (Radiation Safety) Regulations 1994, issue an exemption from Sub-regulation 73 (2) of the Regulations to persons wishing to discharge iodine-131 in concentrations in excess of the prescribed limits. Furthermore, the Committee recommended that the Secretary place conditions on any such exemption where deemed appropriate.

2.4 Supervision and reporting of computed tomography procedures from remote locations

The Committee considered in detail the requirements for supervision by radiologists for computed tomography procedures. The Radiation Safety Section received a number of applications from practices operating computed tomography scanners for exemption from the requirement to have a radiologist on site for all procedures, requesting that teleradiology, a system in which computed tomography images are transmitted electronically to an off-site location, be utilised to provide radiologist supervision remotely.

A standing condition of registration for computed tomography scanners had required that any teleradiology system be approved prior to its use, and only for reporting where the site was classified as remote. The Committee has previously determined that, at a minimum, teleradiology systems should comply with the Royal Australian and New Zealand College of Radiologists position statement *Position on Teleradiology.*

One of the key requirements of the College's position statement is that transmission of images for reporting must be not result in a loss of image quality. The Committee was of the opinion that the digital imaging and communications in medicine format, being the accepted standard for diagnostic image transmission, was the only appropriate to mechanism to achieve lossless transmission of images. The Radiation Safety Section had determined that of the computed tomography scanners registered in Victoria, approximately 15 per cent were not digital imaging and communications in medicine format compatible. The majority of computed tomography scanners that were not digital imaging and communications in medicine format compatible were older machines that were located in regional areas, and were due for replacement in the near future. The Committee was concerned that for some of the proposed teleradiology systems, the computed tomography scanners were not digital imaging and communications in medicine format compatible, and therefore would not allow for lossless transmission of diagnostic images.

It was concluded that a radiologist must be available to supervise all procedures, where required. This supervision could be achieved by the radiologist being present within a practice or via a teleradiology system that met the Royal Australian and New Zealand College of Radiologists standards. A teleradiology system could be utilised regardless of the remoteness of the practice. The requirement for supervision by a radiologist is waived in emergency circumstances, though the radiologist should be contacted as soon as possible. The decision to allow for remote supervision reflects the changes in technology which allow for the same level of diagnostic services to be provided remotely as can be provided locally.

The Committee recommended that teleradiology systems only be approved if the computed tomography scanners used were digital imaging and communications in medicine format compatible, and the images were transmitted in digital imaging and communications in medicine

format. This would ensure that images transmitted would be of an acceptable quality for diagnostic purposes.

2.5 Radiation incidents

The Committee continued to review reports of radiation exposures notified under the Health (Radiation Safety) Regulation 1994. Under the Regulations, a registered person or company/institution licensee must make a report to the Department of Human Services if:

- a person has or may have received a radiation dose exceeding one millisievert effective dose as a result of an abnormal or unplanned radiation exposure
- a source of radiation is or has been out of control
- a source of radiation is damaged or malfunctioning in a manner which could result in a person receiving a higher equivalent dose than under normal circumstances
- there has been an unintentional or accidental release of a radioactive substance in excess of the concentration levels specified in the Regulations.

An increased awareness of the reporting requirements for unplanned radiation exposures has been noted. Often the cause of unplanned medical exposures can be attributed to a staff member failing to follow correct patient identification procedures.

Of the reports of unplanned exposures, 15 involved a computed tomography scan of an incorrect patient, eight involved the maladministration of a radiopharmaceutical to a patient, one involved the spillage of a radiopharmaceutical, and one involved an unexpectedly lengthy fluoroscopic procedure. Common causes were found to be incorrect patient identification, incorrect identification sticker on procedure request forms, and incorrect protocols being used for scans.

The Committee continued to debate the issue of reporting the identity of persons who may have been responsible for abnormal or unplanned radiation exposures. In the interests of open reporting, the Committee agreed the reporting of names of staff members involved in incorrect exposures should not be mandatory.

2.6 Training of radiation apparatus operators

The Committee reviewed submissions requesting approval of four training courses. The courses covered areas including bone mineral densitometry, radiography assistants, and dental assistants. In considering new courses for operators the Committee wishes to ensure course content is relevant, up to date, and provides a level of understanding that is appropriate for the activities to be carried out by operators. It is a requirement that internationally accepted terminology is adopted in all course material.

The Committee also received a submission requesting that approval be granted for individuals with a non-medical background, who were conducting research on human volunteers, to use fluoroscopic equipment. It was Committee's view that the only appropriate operators of fluoroscopic equipment under such circumstances should be radiographers possessing a valid registration with the Medical Radiation Technologists Board of Victoria due to the potential for high doses to volunteers.

2.7 Changes to requirements regarding dental radiography

The requirements for operators and owners of dental radiography equipment changed significantly with the introduction of the Code of Practice for Radiation Protection in Dentistry published by the Australian Radiation Protection and Nuclear Safety Agency, as well as a clarification of shielding and personal monitoring requirements. Given the low radiation doses involved in plain dental radiography, it was agreed structural lead shielding should not be a mandatory requirement for registration of this type of equipment. Additionally, it was seen as extremely unlikely than any operator conducting only plain dental radiography would receive a total effective dose of greater then one millisievert in a 12-month period. Therefore a clarification was issued to practices, stating that persons conducting only plain dental radiography would not be required to wear personal monitoring devices. This did not apply to anyone operating panoramic, cephalometric, or dental computed tomography apparatus.

Compliance with the Code of Practice for Radiation Protection in Dentistry was made mandatory for operators and owners of dental radiography equipment. This was achieved through amendments to the conditions of operator licences and registration. The Code applies to plain, panoramic, and cephalometric radiography, and it is the nationally accepted standard for radiation protection in dentistry.

3. NON-IONISING RADIATION

3.1 Magnetic resonance imaging operator exposure to non-ionising radiation

The Committee discussed a number of articles from scientific journals and media concerning the introduction in Europe of new exposure limits to the operators or magnetic resonance imaging (MRI) devices.

- *'European Union limits may lead to big cuts in Magnetic Resonance Imaging scans' by James Meikle, Health Correspondent, The Guardian (21/09/05)*
- *'Magnetic Resonance Imaging European Community Physical Agents Directive' 2004/40/European Comminity (20/10/05)*
- *Commentary: 'Electromagnetic field exposure limitation and the future of Magnetic Resonance Imaging, The British Journal of radiology, 78 (2005), 973-975.*
- *Institute of Electrical and Electronics Engineers Committee on Man and Radiation Technical Information Statement 'Exposure of Medical personnel to Electromagnetic Fields from Open Magnetic Resonance Imaging Systems', H. Bassen et al, Health Physics Society 2005, United States of America.*

The Committee suggested a small group of local magnetic resonance imaging users be convened to evaluate acceptable levels of exposure for operators. This is an important occupational health and safety issue for personnel operating magnetic resonance imaging devices but is not an issue for patients undergoing magnetic resonance imaging procedures. The Committee also requested the Radiation Safety Section refer the issue of exposure of magnetic resonance imaging operators to the Australian Radiation Protection and Nuclear Safety Agency.

3.2 Possible health effects of power frequency electromagnetic fields.

Associate Professor Andrew Wood, Research Director, Australian Centre for Radiofrequency Bioeffects Research, Swinburne University and Chairman of the Australian Radiation Protection and Nuclear Safety Agency Extra Low Frequency Standard Working Group gave an overview of the development of an Australian standard for human exposure to power frequency electric and magnetic fields. A draft of the new standard is expected to be circulated by the Australian Radiation Protection and Nuclear Safety Agency for public comment later this year.

3.3 Childhood leukemia and magnetic fields

Kabuto et al, Childhood leukemia and magnetic fields in Japan: A case-control study of childhood leukemia and residential power-frequency magnetic fields in Japan, Int J Cancer. 2006 Aug 1. The researchers were from the Japanese National Institute for Environmental Studies conducted a population-based case-control study, which covered areas inhabited by 54 per cent of Japanese children. They analysed 312 cases of children (0-15 years old) newly diagnosed with acute lymphoblastic leukaemia or acute myelocytic leukaemia in 1999-2001 (2.3 years) and 603 controls matched for gender, age and residential area. The odds ratios for children whose bedrooms had power frequency magnetic field levels of 0.4 μT or higher compared with the reference category (magnetic field levels below 0.1 μT) was 2.6 (95 percent confidence interval = 0.76-8.6) for acute myelocytic leukaemia + acute lymphoblastic leukaemia and 4.7 (1.15-19.0) for acute lymphoblastic leukaemia only. The authors concluded their results provided additional evidence that high magnetic field exposure was associated with a higher risk of childhood leukaemia, particularly of acute lymphoblastic leukaemia.

Whilst this study was positive the Committee referred to epidemiological studies reviewed in last year's report to the Minister and, in particular the article 'Advances in childhood leukaemia: successful clinical-trials research leads to individualised therapy.' D. S. Ziegler et al Medical Journal of Australia 2005; 182: 78–81 where the authors commented:

Exposure to electromagnetic fields has been ruled out as playing any significant role.

3.4 Mobile phone use and risk of glioma in adults

Hepworth et al Mobile phone use and risk of glioma in adults: case-control study, BMJ 2006 published on line. The authors studied 966 people aged 18 to 69 years diagnosed with a glioma between 1 December 2000 and 29 February 2004, and 1716 controls randomly selected from general practitioner lists in the UK. The overall odds ratio for regular phone use was 0.94 (95 per cent confidence interval 0.78 to 1.13). There was no relation between risk of glioma and time since first use, lifetime years of use, and cumulative number of calls and hours of use. A significant excess risk for reported phone use ipsilateral to the tumour (1.24, 1.02 to 1.52) was paralleled by a significant reduction in risk (0.75, 0.61 to 0.93) for contralateral use. The authors concluded that use of a mobile phone, either in the short or medium term, is not associated with an increased risk of glioma. This is consistent with most but not all published studies. The complementary positive and negative risks associated with ipsilateral and contralateral use of the phone in relation to the side of the tumour might be due to recall bias.

The Committee noted this is one national study out of a 13-nation study coordinated by the International Agency for Research on Cancer and the combined results are anticipated to be

published within the next 12 months. It is expected that this Interphone study and the individual national studies will have examined 6000 cases of gliomas and meningiomas.

3.5 Neuropsychological sequelae of digital mobile phone exposure in humans

Keetley et al Neuropsychological sequelae of digital mobile phone exposure in humans, Neuropsychologia 2006. The authors studied the performance of 120 volunteers on eight neuropsychological tests during real or sham exposure to a digital mobile phone set to maximum permissible radiofrequency power output. When results were adjusted for known covariates (gender, age, or education), several alterations at significance levels of $p < 0.05$ were obtained. Of these eight tests, simple and choice reaction times showed strong evidence of impairment. Further, performance on the trail making task improved, supporting the hypothesis that digital mobile phone radiofrequency emissions improve the speed of processing of information held in working memory.

The Committee noted other published papers on cognitive effects, such as reaction time, have reported differences in exposed and sham values of just a few percent and could be considered statistically insignificant. Similarly the Keetley et al study reported statistically significant but small changes which would not appear to be biologically relevant.

3.6 Reported cancer cluster at the RMIT university

The Committee discussed the controversy about the reported cancer cluster at the RMIT University. The Victorian Cancer Registry (VCR) published an explanation of the alleged cancer cluster (Cancer News Issue 193 July 2006). Using Victorian statistics spanning the time period in which the tumours were diagnosed, the VCR were able to estimate the number of cases that could be expected within that workforce. They reported that the confirmed cancer cases known on the two floors were below expected, based on the incidence in the Victorian population. Further, the article stated that the initial media reports suggesting seven staff members had brain tumours were incorrect. While four staff members did have brain tumours, each had a different type of tumour. The other cancers were located in different parts of the body. The article concluded: 'The details of the cancers showed it wasn't really a brain cancer cluster after all'.

The Committee noted a report by Vodafone "The Role of Mobile Phones in Increasing Accessibility and Efficiency in Healthcare" Vodafone Policy Paper Series Number 4, March 2006. The report highlighted three areas where mobile applications offer potential value to healthcare providers, patients and funding agencies:

- Tackling inefficiencies in service provision by improving communications between health professionals and patients. Missed appointments cost the United Kingdom National Health Service approximately £780 million per annum. Using existing text messaging reminder schemes could save between £240-£370 million per year in the UK.

- Improving the effectiveness of healthcare through improved self-management and monitoring of patients with chronic conditions.

- Increasing the ability of some hard-to-reach groups such as teenagers, the working population or the homeless to access healthcare services by reducing the barriers of inconvenience, confidentiality or privacy.

3.7 The Committee's view on possible health effects of power frequency electromagnetic fields.

The additional evidence reviewed by the Committee concerning possible health effects of power frequency electromagnetic fields has not altered the Committee's position that based on the total database of scientific research, there is insufficient evidence to conclude that exposure to the normally encountered environmental levels cause adverse health effects in humans. The Committee noted that the Australian Radiation Protection & Nuclear Safety Agency is developing a set of comprehensive guidelines for human exposure to power frequency fields.

3.8 The Committee's view on possible health effects of radiofrequency radiation

The Committee considers there is no substantive evidence to suggest that exposure to radiofrequency radiation can increase the risk of chronic health effects such as cancer. However, the Committee acknowledges the current controversy over mobile phones and their bases stations and will continue to review the relevant research literature. The Committee notes the results of a 13-nation study (the Interphone Study) coordinated by the International Agency for Research on Cancer are to be published within the next 12 months. It is expected that the Interphone study and the individual national studies will have examined 6000 cases of gliomas and meningiomas.

APPENDICES

4. SUMMARY OF AUTHORISATIONS

4.1 Operator licences

(i) Summary of operator licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Radiologist Total: 321	Irradiating apparatus: 283 Irradiating apparatus & unsealed radioactive sources: 38
Radiation oncologist Total: 48	Irradiating apparatus: 6 Sealed radioactive sources: 1 Irradiating apparatus & sealed radioactive sources: 20 Irradiating apparatus, sealed & unsealed radioactive sources: 21
Nuclear medicine specialist Total: 42	Unsealed radioactive sources: 38 Sealed & unsealed radioactive sources: 1 Irradiating apparatus & unsealed radioactive sources: 3
General medical practitioner Total: 155	Irradiating apparatus: 155
Dentist Total: 2226	Irradiating apparatus: 226
Chiropractor Total: 228	Irradiating apparatus: 228
Dermatologist Total: 4	Irradiating apparatus: 4

(i) Summary of operator licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Ophthalmologist Total: 18	Sealed radioactive sources: 16 Sealed & unsealed radioactive sources: 2
Other medical specialist Total:17	Irradiating apparatus: 15 Unsealed radioactive sources: 2
Dental therapist / dental hygienist Total: 344	Irradiating apparatus: 344
Tester Total: 73	Irradiating apparatus: 26 Sealed radioactive sources: 1 Irradiating apparatus & sealed radioactive sources: 39 Irradiating apparatus, sealed & unsealed radioactive sources: 7
Radiation apparatus service technician Total: 294	Irradiating apparatus: 192 Sealed radioactive sources: 48 Irradiating apparatus & sealed radioactive sources: 50 Irradiating apparatus, sealed & unsealed radioactive sources: 4
Researcher (with human volunteers) Total: 52	Irradiating apparatus: 43 Sealed radioactive sources: 1 Unsealed radioactive sources:7 Sealed & unsealed radioactive sources: 1
Veterinarian Total: 716	Irradiating apparatus: 695 Irradiating apparatus & sealed radioactive sources: 10 Irradiating apparatus & unsealed radioactive sources: 10 Irradiating apparatus, sealed & unsealed radioactive sources: 1

(i) Summary of operator licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Industrial radiographer Total: 313	Irradiating apparatus: 81 Sealed radioactive sources: 8 Irradiating apparatus & sealed radioactive sources: 224
Radiation consultant Total: 10	Sealed radioactive sources: 1 Irradiating apparatus & sealed radioactive sources: 1 Sealed & unsealed radioactive sources: 3 Irradiating apparatus, sealed & unsealed radioactive sources: 5
Cardiologist Total: 70	Irradiating apparatus: 69 Irradiating apparatus & unsealed radioactive sources: 1
Borehole logger Total: 42	Sealed radioactive sources: 39 Irradiating apparatus & sealed radioactive sources: 3
Portable moisture/density meter operator Total: 327	Sealed radioactive sources: 327
Paramedical worker Total: 19	Irradiating apparatus: 13 Unsealed radioactive sources: 6
Radiologist & nuclear medicine specialist Total: 28	Irradiating apparatus & unsealed radioactive sources: 28

(i) Summary of operator licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Forensic radiographer Total: 20	Irradiating apparatus: 20
Service technician & tester Total: 17	Irradiating apparatus: 11 Sealed radioactive sources: 4 Irradiating apparatus & sealed radioactive sources: 1 Sealed & unsealed radioactive sources: 1
Veterinarian & dentist Total: 1	Irradiating apparatus & sealed radioactive sources: 1
Vascular surgeon Total: 26	Irradiating apparatus: 26
Dental assistant Total: 4	Irradiating apparatus: 4
Veterinary nurse Total: 8	Irradiating apparatus: 8
Synchrotron accelerator physicist Total: 6	Irradiating apparatus: 6

(i) Summary of operator licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Urologist Total: 8	Irradiating apparatus: 1 Unsealed radioactive sources:7
Radioisotope application engineer Total:	Sealed radioactive sources: 9
Orthopaedic surgeon Total: 39	Irradiating apparatus: 39

Total number of people licensed to deal with

- irradiating apparatus: 4536
- sealed radioactive sources: 455
- unsealed radioactive sources: 60
- irradiating apparatus and sealed radioactive sources: 349
- sealed and unsealed radioactive sources: 8
- irradiating apparatus and unsealed radioactive sources: 80
- irradiating apparatus, sealed and unsealed radioactive sources: 38

TOTAL NUMBER OF OPERATOR LICENCES: 5526

4.2 Company / Institution Licences

(ii) Summary of Company/Institution Licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Sales Total: 142	Irradiating apparatus: 55 Sealed radioactive sources: 52 Unsealed radioactive sources: 18 Irradiating apparatus & sealed radioactive sources: 14 Sealed & unsealed radioactive sources: 3
Industrial Total: 7	Unsealed radioactive sources: 7
Hospital Total: 16	Unsealed radioactive sources: 16
Pathology laboratory Total: 8	Unsealed radioactive sources: 8
Education / research Total: 39	Irradiating apparatus: 1 Unsealed radioactive sources: 39
Research with human subjects Total: 28	Irradiating apparatus, sealed & unsealed radioactive sources: 28
Radiotherapy Total: 2	Unsealed radioactive sources: 2
Nuclear medicine Total: 57	Unsealed radioactive sources: 57
Government departments Total: 3	Unsealed radioactive sources: 3

(ii) Summary of Company/Institution Licences as of 31 August 2006

Category	Type of radiation source permitted to be dealt with
Veterinary Total: 8	Unsealed radioactive sources: 8
Mining Total:	Sealed radioactive sources: 1
Category	**Number of Company/Institution licences to transport radioactive substances**
Transport of radioactive substances	17
Transport of Low Level Waste	5

Total number of organisations licensed to deal with

- irradiating apparatus: 56
- sealed radioactive sources: 52
- unsealed radioactive sources: 159
- irradiating apparatus and sealed radioactive sources: 14
- sealed and unsealed radioactive sources: 3
- irradiating apparatus and unsealed radioactive sources: 0
- irradiating apparatus, sealed and unsealed radioactive sources: 29

Total number of organisations licensed to transport radioactive substances: 22

TOTAL NUMBER OF COMPANY/INSTITUTION LICENSEES: 335

4.3 Registrations

(iii) Summary of Registrations as of 31 August 2006

Category	Irradiating apparatus	Sealed radioactive sources	Total
Fixed plain radiography	413		437
Fixed fluoroscopy/ image intensifier	184		184
Computed tomography scanner	155		155
Linear accelerator	39		39
Radiotherapy		15	15
Ophthalmology		15	15
Dental	2187		2187
Chiropractic	72		72
Plain radiography (general practitioner)	24		24
X-ray analysis	70	21	91
Borehole logging		42	42
Radiation gauge	18	427	445
Portable soil moisture/density meter		160	160
Industrial radiography	54	37	91
Veterinary	387		387
Calibration	2	152	154
Teaching	17	59	76
Other industrial	5	29	34

(iii) Summary of Registrations as of 31 August 2006

Category	Irradiating apparatus	Sealed radioactive sources	Total
Research	1	20	21
Other medical	2	8	10
Mammography	162		162
Orthopantomographic / cephalometric unit	236		236
Cyclotron	3		3
Bone mineral densitometer	74		74
Mobile image intensifier	148		148
Condensor discharge mobile x-ray unit	83		83
Irradiator		12	12
Lithotripter	5		5
Industrial radiography crawler guide source		17	17
Veterinary dental unit	12		12
Therapy simulator	5		5
Cabinet x-ray equipment	120		120
Gas chromatography electron capture detectors		31	31
Mobile plain radiography x-ray unit	92		92
Hybrid single positron emission tomography/ computed tomography scanner system	7		7
Superficial / orthovoltage	12		12

(iii) Summary of Registrations as of 31 August 2006			
Category	**Irradiating apparatus**	**Sealed radioactive sources**	**Total**
Veterinary radiotherapy	1	3	4
TOTAL	**4600**	**1048**	**5672**