

**THE ANNUAL REPORT OF
THE RADIATION ADVISORY COMMITTEE
FOR THE YEAR ENDING SEPTEMBER 1999**

RADIATION ADVISORY COMMITTEE
Melbourne, Australia

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RADIATION ADVISORY COMMITTEE

Hon John Thwaites MP
Minister for Health

Dear Minister

Pursuant to Section 108AK(10) of the *Health Act* 1958, the Radiation Advisory Committee submits the 1999 Annual Report of the Committee for presentation to Parliament.

Yours faithfully

A handwritten signature in black ink, appearing to read 'B M Tress', written in a cursive style.

B M Tress
(Professor)
Chairman
RADIATION ADVISORY COMMITTEE

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THE RADIATION ADVISORY COMMITTEE

Composition

The Radiation Advisory Committee met on 7 occasions from September 1998 to May 1999. This ended the triennium of the Committee's appointment.

Members of the Radiation Advisory Committee until May 1999 were:

		Meetings Attended	
<p>Professor B. M. Tress Department of Radiology University of Melbourne</p>	<p>Chairman</p>	<p>4</p>	
<p>Mr. K. Bennets Chief Radiographer Northern Hospital</p>	<p>Member</p>	<p>3</p>	
<p>Mr. P. Burns Director Environmental and Radiation Health Branch ARPANSA</p>	<p>Member</p>	<p>3</p>	
<p>Dr. J. Heggie Director Department of Medical Engineering & Physics St. Vincent's Hospital</p>	<p>Member</p>	<p>7</p>	

Meetings Attended

Dr. M. Kelly
Director of Nuclear Medicine
Alfred Hospital

Member

5



Mr. F. Robotham
Radiation Safety Consultant

Member

7



Dr. G. Rouch
Chief Health Officer
Department of Human Services

Member

4



Dr. M. Sim
Senior Lecturer & Head
Unit of Occupational &
Environmental Health
Monash University

Member

2



Dr. A. Wirth
Staff Specialist in Radiation
Oncology
Peter MacCallum Cancer
Institute

Member

3



Dr. A. Wood
Senior Lecturer in Biophysics
School of Biophysical Sciences
and Electrical Engineering
Swinburne University of
Technology

Member

5



Ms C. Isakow
Radiation Safety Unit
Department of Human Services

Secretary



THE RADIATION ADVISORY COMMITTEE FROM JUNE 1999

Following the end of the previous term of appointment Mr Bennets; Mr Robotham; Dr Sim; and Dr Wirth advised that they were not available for re-appointment. They were replaced by Mr Brough; Ms Fejer; Mr Benke and Dr Bernshaw.

The Radiation Advisory Committee met on 4 occasions from June 1999 to September 1999.

Members of the Radiation Advisory Committee from June 1999 were:

Meetings Attended

Professor B. M. Tress
Department of Radiology
University of Melbourne

Chairman

3



Mr. G. Benke
Research Fellow
Department of Epidemiology &
Preventive Medicine
Monash Medical School

Member

4



Dr. D. Bernshaw
Consultant Radiation
Oncologist
Peter MacCallum Cancer
Institute

Member

4



Meetings Attended

Mr. P. Brough
Chief Medical Imaging
Technologist
Barwon Health
The Geelong Hospital

Member

4



Mr. P. Burns
Director
Environmental and Radiation
Health Branch
ARPANSA

Member

2



Ms. C. Fejer
Manager, Occupational
Hygiene Unit
Victorian Workcover Authority

Member

3



Dr. J. Heggie
Director
Department of Medical
Engineering & Physics
St. Vincent's Hospital

Member

4



Dr. M. Kelly
Director of Nuclear Medicine
Alfred Hospital

Member

3



Dr. G. Rouch
Chief Health Officer
Department of Human Services

Member

2



Meetings Attended

Dr. A. Wood
Senior Lecturer in Biophysics
School of Biophysical Sciences
and Electrical Engineering
Swinburne University of
Technology

Member

2



Ms C Isakow
Radiation Safety Unit
Department of Human Services

Secretary



Responsibilities

The Radiation Advisory Committee was established by the Minister for Health under *the Health Act 1958* (as amended) to advise the Minister or the Chief General Manager on any matters relating to the administration of the radiation legislation referred to it by the Minister or the Chief General Manager 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 ionizing and non-ionizing radiation; and
- (f) any matter which the Minister agrees the Committee should consider and report on.

1. INTRODUCTION

The year under review has been one of major change at both the national and state level.

Nationally the *Australian Radiation Protection and Nuclear Safety Act* was proclaimed and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) established. One of the important tasks of the Agency will be the development of nationally uniform codes of practice, standards and regulations.

Lack of uniformity in States' regulations causes various problems not least in the licensing conditions imposed on medical and other specialists who use ionizing radiation. A consistent national approach will be welcomed widely by radiation safety practitioners.

National radiation safety legislation and associated regulations are also being reviewed by the National Competition Review Committee to see if they represent restraint of trade. Radiation Safety Unit (RSU) staff are involved in these reviews and advise the Radiation Advisory Committee of significant developments.

The Committee has been pleased to make submissions to two important Victorian Government initiatives—the Review of the Health Act and the development of a Strategic Plan for the Public Health and Development Division.

During the year the Committee became aware of increasing international and national interest in naturally occurring radioactive materials (NORM). The International Atomic Energy Agency, amongst others, is developing policy proposals for radiological control, even though public radiation exposures are generally very low.

The Committee received information on several radiation exposures that have occurred, in both Australia and overseas, during cardiology fluoroscopy. The Committee was

prompted to review current licensing arrangements for cardiologists. Some anomalies were removed and radiation licence conditions were made uniform.

Four members of the Committee; Mr Ken Bennetts, Mr Rob Robotham, Dr Malcolm Sim and Dr Andrew Wirth retired at the end of their appointments and were replaced by Mr Phillip Brough, Ms Christy Fejer, Mr Geza Benke and Dr David Bernshaw.

Some major changes have occurred in the RSU. Amongst others Mr Alan Melbourne, who had been Manager of the RSU since 1986, resigned to take up a post with ARPANSA, and Dr Trevor Boal, Acting Manager, took up an 11 month secondment to the International Atomic Energy Agency in Vienna.

Of the radiation incidents reported to the RSU two involved an untoward radiation dose to the patient concerned. The recovery of a radiation source inadvertently disposed of at a public tip was one of the Unit's less enjoyable tasks and exactly how a small radiation source from a University in the eastern suburbs of Melbourne found its way to a Geelong beach remains a mystery.

Non-ionizing radiation issues still concern members of the public and will continue to do so whilst conflicting and often inaccurate stories appear in the media. Increasingly the scientific evidence reviewed by the Committee supports the view that it is still not possible to conclude that there are any adverse health effects from exposure to electromagnetic fields from power lines, mobile phones, and such sources. If such effects existed, however, they would be minimal, and the benefits would overwhelmingly outweigh any health costs.

2. IONIZING RADIATIONS

2.1 Model Statement on Radiation Risk

The Committee has been concerned for some time, that Patient Information Sheets provided to volunteers or patients involved in research projects requiring exposure to ionizing radiation frequently contain inadequate advice about radiation risks. After discussions with Ms Bebe Loff, Monash Medical School, Epidemiology Unit, the Committee approved the following statement as a model.

During the programme you will be exposed to some radiation. The amount will be about half (or appropriate proportion) of the amount you receive from natural background radiation each year. This background radiation comes from the sun, the earth, the air and is all around us. All people on earth are exposed to radiation.

The radiation you will receive will give you a very small chance of getting cancer. The maximum risk is about 1 in 20,000 (or appropriate figure). Recent research indicates that the risk may be actually much smaller, perhaps as low as 1 in a million, about the same as smoking two cigarettes or being struck by lightning.

These risks can be compared with the chance anybody has of dying of cancer which is about 1 in 4.

Increasingly statements based on this model are being included in Patient Information Sheets.

2.2 Rapiscan Secure 1000 Personnel Scanning Unit

The Committee considered a request to install an X-ray scanning unit for screening visitors to a Victorian prison. The Committee was concerned that visitors were not to be advised that they would be exposed to radiation even though the doses would be very low. The proposal was approved subject to a radiation warning symbol being placed on the machine and visitors signing

a suitably worded consent form.

2.3 Licence Exemption for Calibration Source Kits

Following a request from Australian Radiation Services (ARS) the Committee granted an exemption from licensing for calibration source kits, subject to the RSU being advised, before the sale of a kit, of the names of the purchasers.

2.4 IEC Draft Standard—X-ray Equipment for Interventional Procedures

The Committee received extracts from IEC Draft Standard 60601-2-43 which addresses X-ray equipment for interventional procedures. The issues of concern noted by the Committee were:

- The grid should be removable without tools;
- The draft does not demand automatic collimation, which is especially important where the possibility of causing burns exists; and
- The equipment must include capacity for dose measurements to be calculated on the dosimeter.

The Committee agreed that the draft document should be referred to the appropriate professional bodies.

2.5 Meeting with RACR

The Manager of the RSU, Mr Melbourne and the Senior Radiation Physicist, Dr Boal met with Victorian Branch members of the RACR as part of the continuing programme of consultation with users of ionizing radiation. The issues discussed were:

- strontium-89 therapy;
- assessment of 10 year old CT scanners;
- city based general practitioners taking radiographs; and
- interstate reporting of CT scans.

Both parties agreed that such meetings are of considerable value and should continue on an annual basis.

2.6 Student Licences

The Committee was consulted on the interpretation of exemptions from licensing for students (Regulation 21; as amended 1997). The Head of the Unit of Radiography and Medical Imaging at Monash University advised that a 12 week professional clinical placement programme was being proposed for the end of Years 2 and 3 of the Bachelor of Radiography and Medical Imaging course. The students would be under the same degree of supervision as in the Radiography Intern Programme.

The Committee approved the exemption.

2.7 Yttrium-90 Guidelines

The first draft of proposed radiation guidelines for yttrium-90 Synovectomy was sent to the Committee for comment. The draft was prepared by a small Working Party set up by the RAC.

Members of the working party were:

Dr Michael Kelly
Mr Bruce van Every
Mr Alan Melbourne
Ms Ingrid Cardillo
Dr George Klempner
Dr John Findeisen

2.8 Radon in Underground Caves



Figure 1. Buchan caves.

A final Plan for Radiation Management in Caves was presented to the Committee.

Following discussions with Ms Fejer of Workcover it was agreed that area monitoring would be an acceptable way of estimating exposures provided the monitors are changed three monthly to avoid saturation effects.

2.9 Detection of *Helicobacter Pylori* Using Carbon-14 Urea

The Committee was advised that a breath test using carbon-14 urea had revolutionized the diagnosis of *Helicobacter Pylori*, the causative agent for certain forms of gastritis, peptic ulcer, and gastric cancer. The test kit contains 37 kilobecquerel (37 kBq) of carbon-14.

Known as the Pytest, it was developed in Perth. The kit received the approval of the Australian Therapeutic Goods Administration. The Committee noted that the levels of carbon-14 in the kits are well below the exemption limit for carbon-14 allowed in the *Health (Radiation Safety) Regulations 1994* and approved the distribution of the test kits.

2.10 Licence to Use Samarium-153

An application to use samarium-153 was reviewed. The Committee noted that the applicant already held a management licence to use strontium-89 as a therapy agent and had satisfied the requirements of the Joint Scientific Accreditation Committee (JSAC) of the Australian and New Zealand Society of Nuclear Medicine.

Although no guidelines on the use of samarium-153 have been developed, the RAC gave interim approval to the request.

2.11 Licences for Medical Specialists to Use Mobile Image Intensifiers in Operating Theatres

Dr G Schnier, Director of Radiology, Alfred Hospital and Mr B van Every, Hospital Physicist, met with the Committee to explain their request for licences to be issued to 42 medical specialists. Dr Schnier described the crisis situation that existed at the Alfred Hospital. There is a chronic shortage of radiographers for theatre attendance,

especially for trauma operations. Like all public hospitals the Alfred is suffering severe budgetary constraints.

The Chairman Professor Tress advised that the RAC could not recommend granting 'limited operator licences' to 42 specialists as this could lead to every specialist in Victoria making the same request. Radiation safety for both patients and specialists would be severely compromised.

Limited operator licences were not issued.

2.12 Training Video for Users of Iodine-125

The RSU was asked to review the content of a training video proposed for laboratory staff using iodine-125. The RSU's concerns were that some of the text included out of date terms and information. A superseded version of the recommendations of the International Commission on Radiological Protection was referred to even though it is no longer used for guidance. The Committee shared the RSU's concerns especially given that the video may well be used as a training tool for several years. The Committee recommended that professional health physics advice be obtained in compiling the text for the video.

2.13 Operator Licence for a Registered Nurse

A request to issue a licence to allow a registered nurse to administer radiopharmaceuticals to children was received from The Royal Children's Hospital. The Hospital argued that a high degree of skill is required to obtain venous access in very young children, and that registered nurses have this specialised skill. Given, that a nuclear medical technologist always prepares and checks the radiopharmaceuticals and that a physician may not always be available, the RAC approved the request.

2.14 Paramedic Licences

The Secretary of the Medical Radiation Technologists Board (MRTB) sought clarification of the circumstances whereby a

paramedic could be granted an operator licence. Mr Melbourne advised the Committee that the particular case that had caused this inquiry was of a person issued with a licence limited to plain radiography and dental procedures only at a specified location.

Following a review of limited operator licences the RAC concluded that only two or three such licences would be of concern to the MRTB.

Mr Melbourne subsequently attended a meeting of the Board to clarify the situation.

2.15 Review of the Victorian Public Health Act 1958

The RAC was invited to make a submission to the review of the Victorian *Health Act* (1958), in particular Chapter 6 of the Discussion Document which addressed the issue of radiation safety. Several important matters raised in the document included:

- the need for registration and licensing;
- national uniformity;
- compatibility with other relevant Victorian legislation eg EPA, Workcover; and
- the implications of National Competition Policy principles.

The Committee's reply is given at Appendix 5

2.16 Radiation Dosimetry Services

During the year the Committee received several requests from private consultants for licences to provide personal radiation monitoring services. One the Committee's major concerns was the ability of the service providers to trace their calibrations to a National Radiation Standard. A set of provisional requirements was drafted for the Committee by Mr Peter Burns pending production of a set of National guidelines.

The interim guidelines are given as Appendix 6

2.17 Remote Control Receiving Units Containing Radioactive Materials

The Committee received advice that the Queensland Radiation Health Unit had been alerted to an electrical device containing radioactive materials. A remote control receiving unit (surge arrestor) manufactured by Zellweger (Type ZE22) between 1955 and 1968 contained either radium-226 (37 kBq to 120 kBq) or tritium (activity unknown).

It was estimated that approximately 11,000 receivers had been installed in Brisbane.

The RSU contacted all electricity supply utilities in Victoria. Advice was received that no Zellweger Type ZE22 devices had ever been installed in Victoria.

2.18 Chiropractic Fluoroscopy

The Western Australian Radiological Council advised the Committee that they had declined an application for chiropractic use of fluoroscopy equipment. The principal reason given was the inadequate knowledge of the chiropractor in the safe use of fluoroscopy. The RAC agreed with the approach taken by the Radiological Council and agreed that the introduction of chiropractic fluoroscopy in Victoria could not be supported.

2.19 Formation of ARPANSA

The Committee was advised formally of the passage through Federal Parliament of the *Australian Radiation and Nuclear Safety Act 1998*. This Act establishes the Australian Radiation and Nuclear Safety Agency (ARPANSA).



Figure 2. ARPANSA logo.

The Agency is charged with responsibility for:

- promoting uniformity of radiation protection and nuclear safety policy and practices across jurisdictions of the Commonwealth, the States, and the Territories;

- providing advice to Government and the community on radiation protection and nuclear safety;
- undertaking research and providing services in relation to radiation protection, nuclear safety and medical exposures to radiation; and
- regulating all Commonwealth entities involved in radiation or nuclear activities or dealings.

The Committee welcomed the establishment of ARPANSA and was pleased to note that Mr Peter Burns, Head, Scientific Services Section, ARPANSA, is a member of the RAC.

2.20 Exemption from Personal Monitoring

The Committee declined two requests for exemption for the requirement to wear a personal dosimeter when working with a mobile X-ray image intensifier. The RAC considered that evidence of past satisfactory radiation monitoring results must be provided before an exemption could be considered.

2.21 Radiography Course for New Zealand Trained Dental Therapy Students

The Committee received advice that New Zealand undergraduate dental therapy courses do not contain any experience or training in the taking of X-rays. Victorian training does include such components and Victorian graduates can be issued with operator licences on completion of their course.

The RAC approved the oral radiography content of a course to be run by the School of Dental Science, University of Melbourne, for New Zealand graduates.

2.22 Administration of Neurolite

Patients suffering from intractable partial epilepsy can occasionally have seizures when undergoing video-EEG monitoring. The Committee gave conditional approval for appropriately trained nurses to administer Neurolite (technetium 99m-bicisate) under

such circumstances.

The condition being that the system is coordinated, supervised and managed by the relevant Nuclear Medicine Department.

2.23 Iodine-125 Permanent Seed Implants

The Committee approved an application to use iodine-125 seed implants in the treatment of prostate cancer. Patients stay overnight in a private hospital ward. Training of nursing staff, monitoring of sources and catheter bags are all under the control of the Hospital Physics Department.

2.24 Public Health and Development Division Strategic Plan

Professor John Catford, Director Public Health and Development, invited the RAC to contribute to the development of the strategic plan for the Public Health and Development Division. The Committee was pleased to respond to certain specific issues in the Discussion Document.

Matters the Committee considered significant included:

- The preparation of ‘Certificate of Need’ for specific high cost, potential high dose equipment. Although at odds with free market philosophies such certificates are one possible way of restricting excessive provision of expensive services.
- Deregulation of radiation control could lead to increased public radiation exposures with increased public radiation detriment. In an earlier paper prepared for the Committee it was estimated that current radiation protection programmes save Victoria about \$50 million per annum.
- Much modern radiation equipment delivers a lower radiation dose per patient. Further reductions in radiation doses will occur as a result of the up-grading of equipment whilst at the same time placing extra cost burdens on

hospital budgets. Constructive, consistent high level planning will be needed to balance public benefit against public cost.

- Irradiation of certain foodstuffs could be of significant public health benefit in helping to minimise outbreaks of food poisoning.

2.25 Radioactive Gas Mantles

A Mr Dix wrote to the RAC advising that he had found that some gas mantles were radioactive. He had recently purchased a radiation monitor and whilst testing it at home was surprised to find some slightly elevated levels of radioactivity associated with gas mantles. He subsequently carried out a survey of mantles on public sale, finding some were radioactive, some were not.

The RSU contacted both the Victorian Office of Fair Trading and the Federal Consumer Affairs Division to request that the radioactive mantles be withdrawn from sale, and further importation stopped.

Mr Dix was thanked for his interest and concern. He was advised that it had been known for some time that some gas mantles contain radioactive thorium. Mr Dix was informed that in October 1995 the then Australian Radiation Laboratory (ARL) had produced an information sheet. In it ARL had recommended that ‘Users should purchase lantern mantles that contain the non-radioactive element yttrium’. Mr Dix was also advised of the action taken by the RSU.

2.26 Year 2000 Computer Concerns

The Committee was advised that the International Atomic Energy Agency had prepared a document entitled ‘Safety measures to address the year 2000 issue at medical facilities which use radiation generators and radioactive materials’. The document is available on the internet.

At the Committee’s suggestion the RSU circulated the table of contents to people with

registered equipment to help them assess their year 2000 compatibility.

2.27 Ballarat Veterinary Practice Equine Clinic Gamma Camera

The Committee received a request from the Ballarat Veterinary Practice Equine clinic to install a gamma camera and perform scintigraphy examinations on lame horses. Licensed nuclear medicine specialists from St John of God Hospital, Ballarat would supply and administer the technetium-99m radionuclide.

The request was approved subject to certain conditions including:

- the veterinary surgeons receive appropriate training and wear monitoring badges;
- appropriate signage be placed on transport vehicles and rooms where horses are being treated; and
- radionuclide transport complies with *Health (Radiation Safety) Regulations* 1994.

2.28 DEXA BMD Research Projects Involving Doses of Less Than 1 mSv

A paper from the RSU proposed that the Unit be given the authority to approve Dual Energy X-ray Absorptiometry (DEXA) research projects involving human volunteers where the radiation dose is less than 1 millisievert (1 mSv). Approval would only be given if the wording in the patient information sheet is in a suitable form and the calculation of dose is correct.

The Committee agreed to the proposal.

2.29 Testing of Radiation Apparatus

Dr Boal of the RSU wrote to the Committee seeking the views of members on the establishment of a subcommittee to assist the Unit in the development of a system for the testing of radiation apparatus by private testers. The Committee was reminded that the 1994 review of the RSU recommended that a quality

assurance inspection programme be developed and implemented. The issues to be considered in any such programme are:

- the inspection protocols to be used by the inspectors;
- the accreditation programme for private inspectors; and
- the role of the RSU in the system.

The RAC concluded that a subcommittee was not necessary, and suggested that the RSU seek advice on the protocols developed by the West Australian Radiation Safety Branch. When some draft protocols have been developed they should be circulated to the Australasian College of Physical Scientists and Engineers in Medicine (ACPSEM) and the Australasian Radiation Protection Society (ARPS) for comment.

2.30 Residual Radioactivity at Bairnsdale College of TAFE

During the early part of this century some impressive science was carried out at the then Bairnsdale School of Mines. An effective process was developed to extract almost pure radium from carnotite ore mined at Radium Hill in South Australia. Unfortunately, in line with the practice of the time, the tailings from the process were just piled up and later used for building foundations. Although the residual activity did not present a significant radiation hazard to either staff or students at the College the stockpiling of tailings in this manner does not constitute current best practice.

The principle radioactive contaminant is radium-226.

The RAC approved the designation of the material as 'prescribed waste' suitable for disposal at a waste facility approved by the EPA.

After the removal of the contaminated overburden, further contaminated soil was found in a few locations. This material will be buried on site in a specially constructed concrete bunker covered with 15 cm of

concrete and a metre of soil.

2.31 Radiation Licences for Cardiologists

The Committee received advice that several anomalies had crept into operating licences issued to cardiologists using fluoroscopy equipment. These included:

- failure, in two cases, to specify the need for radiation safety training;
- some inconsistencies in the requirement to have a radiographer present during fluoroscopic cardiology; and
- the requirement to have had training in radiation safety when no such training courses had been approved.

The RAC confirmed the need for effective and consistent radiation exposure control in cardiology fluoroscopy procedures given incidents that have occurred, both overseas and in Australia, in which patients had received significant radiation over-exposures.

After considering a detailed review paper prepared by the RSU the Committee made the following recommendations:

- Uniform conditions must apply to all licensed cardiologists;
- The requirement whereby a radiographer has to be present when a cardiologist is using fluoroscopy equipment is to be continued. The only exception being emergency angioplasty, if the patient's condition is considered life threatening and a radiographer has been called; and
- No further site or equipment specific licences are to be issued.

The Committee approved two radiation safety training courses for cardiologists developed by two Victorian Hospital Physicists. Those cardiologists using fluoroscopy equipment have been advised that they must attend one or other of the courses if they wish to continue holding a licence.

2.32 Austin and Repatriation Hospital Cardiology

The Committee approved the request from the Austin and Repatriation Hospital to have one radiographer to provide a service to two separate catheter laboratories. The laboratories are connected by a 4 m long corridor. The Committee considered such an arrangement complied with the spirit of the Committee's recommendations on cardiology fluoroscopy.

2.33 National Waste Repository

The Committee received a copy of a booklet published as part of the National Waste Repository site selection process. The booklet contained comments and responses to those comments, made during the public discussion period, allowed after the announcement of the proposed site. The site selected is in the north central region of South Australia.

Public concerns included, amongst other things, the site selection process, the potential for contamination of groundwaters including the Great Artesian Basin, and the potential for accidents during transportation.

The Committee reconfirmed its support for a National Waste Repository.

2.34 Research Projects Involving Human Volunteers

During the year the Committee reviewed 24 new or continuing research projects. Research involving radiation exposure of human volunteers requires approval from both the institution's Ethics Committee and the Department of Human Services. Institutions proposing such research must provide copies of the research protocol, patient information sheet, radiation dose estimate, and evidence of approval by the institution's Ethics Committee. This information is reviewed by the Radiation Safety Committee before approval of the research project is given.

In a number of cases the Committee requested revised or more detailed dose estimates or revision to the patient information sheet

statement on risk before approving the research

The 19 projects approved by the Committee are listed in Appendix 1

2.35 Training Courses in Radiation Safety

The Committee was advised that in the last 12 months, the RSU had been involved in several radiation safety training courses for various occupational categories. These included institutions involved with the use of radiation gauges, laboratory irradiators, industrial radiography and nuclear moisture/density gauges (NMDG). The industrial radiography course was run by RMIT. ANSTO Training ran the remaining courses with some lectures being provided by RSU staff. A summary of the number of courses and attendees appears as Appendix 4.

Following the industrial radiography training course held in May/June 1999 a *Radiation Protection in Industrial Radiography* examination was held. The Committee has in the past recommended that this examination be passed by all industrial radiographers and applicants for licences in the industrial radiography field. People who had not attended the course were allowed the opportunity to sit the examination at other times during the year. A total of nine examinations were held between October 1998 and the end of September 1999. Further examinations were also held during the year for people requiring restricted licences to carry out industrial radiography and for people operating fixed enclosure X-ray apparatus.

The first examination for operator licensing in the occupational category of nuclear density/moisture gauge operator was held in May 1996. Since that time (up to October 1999), there have been 322 passes from 385 candidatures. At the time of writing, there were 281 people licensed or applying for licence on the radiation register. Approximately 95% of licence holders/applicants have passed the Victorian examination. Other licensees may have passed

an equivalent examination from interstate and are therefore exempt from the requirement to pass the Victorian examination. Details of the examinations held in 1998/99 and since inception in 1996 are included in Appendix 4.

2.36 RSU Project Reports

The Committee received several reports from the RSU on radiation safety projects being carried out by the unit. These included:

1 *Revised Guidance Doses for Chiropractic Procedures.*

Guidance doses have been established for a variety of radiographic procedures, as an indicator of best practice. They provide a radiation exposure target level for a particular procedure that radiography practices should aim to achieve.

In 1993 the RSU and RAC established guidance levels for chiropractic radiology based on dose to tissue. Guidance levels for all other procedures are based on dose to air, with no backscatter. Dr Boal has recalculated his group's 1993 measurements in terms of dose to air and the revised figures were presented to the RAC.

The recalculation lead to significant changes in the guidance levels for; cervical spine AP (reduced from 2 to 1.3 mSv), thoracic spine lateral (10 to 6 mSv), and lumbar spine lateral (10 to 6 mSv).

The RAC approved the changes.

2 *Draft Departmental Document on Guidance Levels.*

The RAC received an early draft of a document being prepared by the RSU to enable radiology centres to compare their delivered doses with the RSU's recommended guidance levels. The draft includes guidance levels for a wide range of procedures including paediatric, neonate, general adult, fluoroscopy, CT, etc. The derivation of guidance levels and methods of measuring radiation exposure will be included. The document makes clear that guidance levels are not dose limits. The

importance of ALARA, image quality and processing conditions will all be emphasised.

The Chairman congratulated Dr Boal on the draft and asked that a copy of the final report be made available to the Committee.

3 Guidance Levels for Diagnostic Radiology in Victoria.

A paper on guidance levels was presented to the 23rd Annual Conference of the Australasian Radiation Protection Society held in Ballarat, October 1998. The paper by Boal, Einsiedel, and Cardillo of the RSU summarised the work done in surveying patient doses in Victoria and the conclusions drawn when those doses were compared with overseas data and was provided to the RAC for information.

The guidance levels recommended for Victoria were similar to those recommended by the USA and the IAEA, but considerably lower than the levels recommended by the European Union, the UK and New Zealand.

4 CT Image Quality Assessment.

Dr Boal reported on work being carried out by the RSU on CT image quality assessment. It has been found that Q-values for some CT scanners determined from parameters measured at the centre of a phantom should not be used for comparing the performance of the scanners. It was found that the parameters measured at the surface of the phantom allow a more meaningful comparison, although it was also found there may be a bias in favour of scanners with a very low half value layer.

2.37 Brachytherapy

Brachytherapy is a radiation therapy procedure in which small radiation sources are inserted into a patients body to deliver a carefully calculated and controlled radiation dose. The Committee was advised of newly developing programmes using coronary artery brachytherapy and had received a request to perform such procedures at a major public hospital starting in early 2000.

The procedure raises significant radiation

issues. The Committee decided they would be dealt with most appropriately by a sub-committee of relevant specialists and recommended a list of possible members for this sub-committee.

2.38 Former Westminster Carpet Factory Site

During the 1960s and 70s the Westminster Carpet Company operated a gamma sterilisation plant on their Dandenong site. Cobalt-60 was used to sterilise goat fibre for carpet production. The plant was closed down in 1979, the sources returned to the manufacturer, the source well emptied and the building left vacant. As part of a reclamation programme the storage well was monitored late 1998 and some radioactive contamination was found on an iron bogie that had been dumped at the bottom of the source well. Further contamination was found in the concrete around the edge of the well. The contaminated section of the bogie was cut out and along with some contaminated concrete was removed for storage in the RSU store. The maximum level of contamination found was 30 microsievert per hour on the bogie at the bottom of the well. No loose contamination was detected and the site had not been a public radiation hazard.

After the site was cleared of contamination, approval was given to continue the demolition of the site as normal.

2.39 NORM and TENORM

Both in Australia and overseas increasing attention is being paid to any potential radiological problems caused by naturally occurring radioactive material (NORM) and technologically enhanced naturally occurring radioactive material (TENORM).

Examples of NORM are mineral sands, uranium ore, superphosphate, oil and natural gas residues, and the radon found in some caves (section 2.8 of this report). The residual radioactivity found at Bairnsdale TAFE (2.30) and radioactivity in gas mantles (2.25) are examples of TENORM. Both NORM and TENORM present relatively minor

radiological hazards. Some controls are necessary however, to minimise any potential public exposure. The International Atomic Energy Agency is developing radiation protection guidance for NORM in the oil, gas and mineral extraction and processing industries. Following a regional IAEA meeting held in Sydney in March 1998 a questionnaire was circulated in August 1999 seeking information that may help determine whether NORM is a hazard in the South-East Asia Region.

The RSU is working with the EPA to develop policies for activities that involve or generate NORM or TENORM.

2.40 General Practitioners Working Party

It has proved difficult to convene a meeting of the General Practitioners Working Party. The Committee received a summary, prepared in NSW, of the variations between the States in licensing arrangements for GP's working in remote areas. It was noted that 'the amount of variation is nothing short of bizarre'. The Committee recommended that a meeting of the GP working party be held as soon as possible to review the NSW paper given the moves to nationally uniform standards.

The Committee denied a request to video the Radiography Course for General Practitioners given at the Royal Melbourne Hospital. The Committee were fearful that if such a video were produced, GPs who acquire access to the video may later claim that they have enough knowledge to take X-rays even though they will not have had 'hands on' practical experience.

2.41 Other Matters Considered

- The Committee reviewed the content of a course for staff and post-graduate students at the Department of Human Movement, Recreation & Performance, Victoria University, who wish to access the DEXA Bone Mineral Densitometer. The Committee approved the courses subject to a written assessment being included as part of the course.

- The Committee reviewed an article entitled *First Analysis of Mortality & Occupational Radiation Exposure Based on the National Dose Registry of Canada*, Am J. of Epidemiol. 1998; 148(6), 564-574.

The Committee concluded that the paper did not provide compelling evidence for an increased risk of cancer at low dose and dose rate due to insufficient numbers and the resultant wide confidence intervals.

- The Committee received a copy of a circular produced by the RSU concerning iodine-131 therapy and pregnancy. The circular had been produced at the Committee's suggestion after an iodine-131 dose of 150 MBq was given to a woman of child-bearing age, who found she was pregnant a week after she had received the therapy dose. The Committee recommended that all nuclear medicine centres review their protocols for iodine-131 therapy to ensure that the issue is managed appropriately.
- The Committee received advice that, as a result of a reassessment in the United States, the Type B(U) Certification for the shipping of '660' series projectors for non-destructive testing sources had been withdrawn with effect from 30 June 1999. The Committee agreed that the NDT Companies who use the containers had been given very little notice (2 weeks) in which to obtain the approved containers and so were granted one month's grace in which to comply.
- A draft was received, for comment, of a proposed common research project application form, prepared by the Victorian Department of Human Services Ethics Committee. The Radiation Advisory Committee suggested some changes to the document and noted their support of a more uniform approach to research applications.
- The Committee received several papers on radiation hormesis, the concept that low

doses of radiation may be beneficial. This idea runs contrary to the prevailing philosophy applied to radiation protection, that all exposure to ionizing radiation carries with it some risk. It is assumed that low doses of radiation represent low risk, higher doses higher risk, ie. a linear relationship. Standards setting bodies such as International Commission on Radiation Protection and The International Atomic Energy Agency have yet to be persuaded by the arguments advanced by the proponents of what is known as the hormetic effect.

- The Committee considered a request from Dr Trevor Boal, Acting Manager, RSU to establish a sub-committee to formulate a system for the regular testing of radiation apparatus by private testers. The Committee resolved that a sub-committee was not required but requested that the RSU prepare details of a quality assurance programme for RAC approval.
- Committee member Dr Michael Kelly submitted a draft of a chapter he had prepared for an NHMRC manual. The manual is intended to provide guidance to Research Ethics Committees. The Committee suggested some minor corrections and rewording.

3 NON-IONIZING RADIATIONS

3.1 Papers Considered in the Past 12 Months Related to Biological Effects from Exposure to Power Frequency Electromagnetic Fields

The attention of the Committee was directed to the question of possible health effects associated with exposure to power frequency electromagnetic fields.

The Meta-Analysis Project Advisory Group in its report submitted to the Minister for Health in December 1988 recommended that the Minister for Health commission and publish each year for at least the next five years a report summarising studies in the literature within the previous year on the effects on human health of exposure to non-ionizing radiation at or near the powerline frequency.

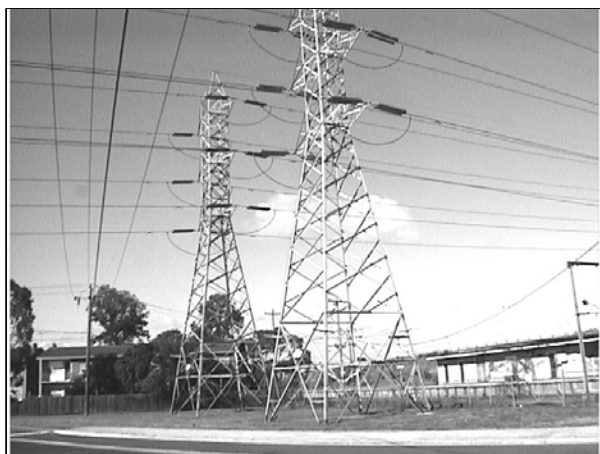


Figure 3. High tension powerlines.

In addition, the report of the Panel on Electromagnetic Fields and Health, commissioned by the Minister for Health, was released by the Minister in September 1992. One recommendation in the Minister's response to the report was that the newly appointed Radiation Advisory Committee continue to monitor, and produce regular updates, on the medical and scientific literature on possible health effects from power frequency electromagnetic fields.

A list of papers considered by the Committee in the past 12 months is presented in Appendix 7.

Cell Studies

In the past year there has been renewed interest in the question of whether electric and magnetic fields (EMF) can alter the rate of growth of cells, either normal or cancerous cells. In general, those reporting positive results are employing fields at least 1000 times greater than generally encountered in the environment (about 0.2 μ T). For example, DeMattei *et al.* compared cell proliferation rates of a transformed and a normal cell line in respect to their responses to 2.3 mT pulsed magnetic fields at 75 Hz repetition. The incorporation into cell cultures of labelled thymidine, with zero magnetic field as a reference was used to estimate proliferation rate. The transformed cells showed differential proliferation rates after 30 minutes, but normal cells required at least 6 hours of magnetic field exposure. A field enhancement in rate of up to 350% is reported.

Loschinger, *et al.* (a) have reported that magnetic fields of 8 mT at 20 Hz affect differentiation and proliferation of skin cells (fibroblasts) as revealed by expression levels of the proto-oncogene *c-myc*. In a related paper (Loschinger, *et al.* b) mitotic progenitor fibroblasts show field-enhanced intracellular calcium 'spiking' patterns, whereas postmitotic fibrocytes show a reduction, but only 30% of cells show this response and they have to be co-stimulated with a platelet-derived growth factor.

Using power frequency fields, Scarfi *et al.* showed that micronucleus induction was unaffected by 50 Hz fields up to 1 mT for 72 hours, but proliferation rate (measured by cytokinesis-block proliferation index) was slightly affected. Singh & Lai studied rat brain cells exposed for 2 h to 0.5 mT 60 Hz magnetic fields with evidence of both DNA-DNA crosslinks and DNA-protein crosslinks, as revealed by microgel electrophoresis assay. Walleczek *et al.* reported that 0.7 mT 60 Hz magnetic fields may enhance gamma-ray induced mutagenesis

in Chinese hamster ovary cells.

There is thus no evidence that mutagenic processes are affected by power-frequency fields commonly encountered. The efficacy of stronger fields used in a therapeutic context is also hard to judge, but the evidence of clear biological effects at fields in excess of 1 mT is growing.

Animal Studies

One of the most telling arguments against the existence of a health hazard from environmental power frequency EMF is the lack of evidence of detriment in populations of rodents with a lifetime exposure to high levels of EMF in laboratory conditions. The results of the Australian study on genetically modified mice exposed to 50 Hz magnetic fields was commented on in last year's report. During the year the results of two large-scale USA studies have been published.

McCormick *et al.* studied lymphoma induced in rats by single injection of N-ethyl-N-nitrosurea (ENU) followed by exposure to 0, 0.002, 0.2 and 1 mT EMF (the last level both continuous and intermittent). Experiments with mice were similar, except no ENU was used. Overall there was no evidence of magnetic fields being a risk factor in lymphoma, the only significant result being a reduction of incidence of lymphoma in male mice exposed to continuous 1 mT magnetic field.

The other group (Sasser *et al.*) studied skin cancer in mice initiated by a sub-carcinogenic dose of dimethylbenzanthracene (DMBA) followed by the tumour promoter tetradecanoylphorbol acetate (TPA) in various doses. Outcomes in terms of tumour incidence & multiplicity were monitored in mice with and without a concomitant exposure to 2 mT 60 Hz fields (6 h/day; 5 d/wk). There were no significant differences between the magnetic field exposed and unexposed groups. In a related report from the same group (DiGiovanni *et al.*), tumour markers such as epidermal thickness, ornithine decarboxylase activity and protein kinase C activity were

monitored, again with no effects attributable to magnetic field exposure. Kumlin *et al.* also studied ornithine decarboxylase and found significant changes only in the case of acute exposures to magnetic field together with ultraviolet light.

Previously the hormone melatonin was identified as a marker for magnetic effects in animals and humans. Contrary to some positive findings by other groups, Burchard *et al.* (a) found that melatonin measured in 16 dairy cows alternately exposed or sham exposed for 28 day periods showed no variations attributable to EMF. Neither Bakos *et al.* nor Heikkinen *et al.* was able to demonstrate any field-related effects on melatonin in rats and mice respectively. Loscher *et al.* studied exposure periods ranging from 1 day to 13 weeks in rats. They obtained a significant reduction at 6 hrs after onset of darkness for a 2 week exposure period only. Finally, Wilson *et al.* reported significant reductions in pineal melatonin in hamsters exposed either to acute or intermittent 0.1 mT magnetic fields if the animals were on a short day long night cycle. Other hormones such as noradrenaline and prolactin were also affected.

In other experiments on dairy cows, measurements of quinolic acid on the last 3 days of a 30 day exposure period and for 3 days starting 5 days after cessation of exposure showed a significant increase associated with exposure, which was interpreted as a possible weakening of blood-brain barrier (Burchard *et al.* b). In another report (Burchard, Nguyen & Block), a 15% longer oestrous cycle length with exposure was reported.

Lai & Carino studied cholinergic activity in rat brain regions and showed a 'strength-duration' effect, whereby 2 mT 60 Hz fields showed significant decreases after 60 min, but 0.05 mT fields require a duration of 180 min before significant changes are observed. Cholinergic activity was gauged by measuring choline uptake into synaptosomes isolated from brain tissue. In a related experiment,

Sienkiewicz *et al.* showed transient and reversible deficits in the ability of rats to negotiate a maze. These effects were noted at field strengths of 0.075 mT and above.

In experiments involving human volunteers, Preece *et al.* showed that the ability to correctly recognise words shown 20 min previously or to retain a string of digits in memory was impaired by exposure to a 0.6 mT magnetic field. Akerstedt *et al.* reported that 1 μ T field reduces sleep time, Slow Wave Sleep and Slow Wave Activity. Melatonin & other hormones (testosterone, cortisol, prolactin & growth hormone) were unaffected. Graham & Cook, using a higher field strength (28.3 μ T) report that if this field is intermittent (15 sec on then 15 sec off and for 1 hr on then 1 hr off throughout the night) a number of endpoints change significantly. These include decreases in sleep time, efficiency and REM sleep with increases in Stage II sleep and REM latency.

Epidemiology

The Non-Ionizing Radiation Sub-Committee of the RAC (since disbanded) reviewed eight major epidemiological studies in May 1993. A copy of this review is included as Appendix IV in the annual report of the RAC for the year ending September 1993. These studies were better designed and coordinated than previous studies and sought to redress the weaknesses inherent in them.

The RAC has subsequently reviewed the important epidemiological studies over the past year and a copy of the results are included as Appendix 8 of this report. Once again these studies have been well designed and coordinated. However, they still suffer from the ongoing problems of possible confounding and bias, control selection, and the fact that the exposure assessment, whilst improved, is still imperfect. It is important that these problems are thoroughly addressed, particularly exposure assessment, before epidemiological research in this area will be able to produce more meaningful results.

In summary, one of the continuing problems with regard to epidemiological research in this

area is that, because of the generally low odds ratios obtained (of the order of 2), it is quite possible that the effects being seen are due to the problems mentioned above. Thus it is still not possible to reach the conclusion that exposure to power frequency electric and magnetic fields plays a role in contributing to chronic health effects such as cancer.

Dosimetry

International research is continuing to attempt to quantify trends in domestic and occupational exposure to power frequency magnetic (and electric) fields. This information can be used in epidemiological studies of possible health effects associated with these fields. Debate has continued over what would be the most appropriate type of magnetic field measurement to make as an indicator of putative risk in relation to cancer incidence.

Clivard *et al.*, for example, have shown that, whilst spot measurements of magnetic fields outside dwellings agree well with 24 hour measurements inside dwellings in rural areas, this agreement is not as good in the case of urban and suburban dwellings.

Kavet *et al.* have explored the variability in measured magnetic fields (spot measurements) inside homes that have the same "wire code" classification in epidemiologic(al) studies. They identified the ground current in dwellings, the number of service drops in secondaries serving the dwellings, the age of the dwellings, and the area in which they are located (ie. rural vs. suburban/urban) as explaining some of this difference.

Epidemiology, therefore, continues to prove of little or no value in establishing limits on exposure to power frequency magnetic and electric fields. Guidelines are generally based on the limitation of induced currents in the human body, so that these are no greater than the natural or endogenous current existing in the body.

In relation to this, Furse and Gandhi have calculated the induced currents in a model of

the human body exposed to magnetic and electric fields typically found under high tension power lines. They found that induced currents in many organs are significantly greater than the natural currents in those organs.

This area will have to be investigated further as it may lead to a re-evaluation of limits on exposure. It should be stressed, however, that this has no bearing on the putative risk of cancer, for which there is still no conclusive evidence.

Reviews and Editorials

In general the reviews have reinforced the view that there is still no conclusive evidence of a link between power frequency electric and magnetic fields and cancer. Miller, in particular raises the point that, in the case of epidemiological studies, scientists have to put special effort into more accurate ways of assessing exposure.

The US National Institute for Environmental Health Sciences was given the responsibility in 1993 to manage the EMF-Rapid Program (Research and Public Information Dissemination). Their original budget was \$65M, but the final figure was \$45M. The Director of NIEHS presented a final report to US Congress at start of June this year. This referred to evidence for an 'increased risk' for childhood leukaemia and chronic lymphocytic leukaemia associated with EMFs, but emphasised that there was no evidence from animal or biophysical studies. The report advocates passive regulatory action and in particular public education to allow individuals to make 'prudent' decisions regarding personal exposure. It stated that more study into neurodegenerative and heart diseases was warranted.

Part of the EMF Rapid program was that the National Academy of Sciences should carry out an audit of the NIEHS activities in the program. The results of this process were published in a report in May. The panel consisted of eight EMF experts and seven National Research Council staff. They noted delays in program schedule, and that of the

\$45M, \$25.6M was spent on 61 biological research projects, with no support for any epidemiological studies. They also noted that very few of the biology projects had appeared in peer reviewed literature as yet (thus it was hard to assess outcome in terms of scientific advance). However, of the 61, most outcomes were negative, only seven reporting robust effects. The Panel felt that contract research would perhaps have been more appropriate and that the extensive consultative process had done little to resolve differences of opinion. The panel also pointed out that the earlier NAS report (1997) concluded that there was 'no effect' whereas NIEHS indicated 'possible concern' with regard to EMF.

The World Health Organisation, via the International Commission on Non-ionizing Radiation Protection, continue to sponsor conferences to consider research needs still existing in this area. In particular Repacholi & Greenbaum suggested that experiments should incorporate *exposures that include intermittency, transients and duration as important variables and the interaction of ELF fields with other agents such as ionizing radiation, chemicals or other sources of compromised health status.*

Other

The World Health Organization, in its fact sheet No 1, July 1998 states that many scientific studies have been conducted to determine if electromagnetic fields could have any health consequence. The fact sheet concludes that factors including indoor air quality, job-related stress and ergonomic issues, such as posture and seating while using a VDU. These studies have suggested that the work environment, and not EMF emissions from VDUs, may be a contributing factor of possible health effects associated with VDU use.

Vistnes *et al.* tested the hypothesis of Hopwood, that electric and magnetic fields close to high voltage power lines might focus electrically charged particles in cosmic radiation so that people living close by would be exposed to higher doses of radiation than if

the lines were not present. Hopwood presented this hypothesis based on measurements made near a power line using a more or less home-made GM tube.

The authors tested Hopwood's hypothesis using TLDs, which are free from electric noise artefacts and their results did not support Hopwood's hypothesis. Hopwood's results are assumed to be due to pick up of RF noise due to corona activity.

3.2 Submission to Moreland City Council

Moreland City Council sought comment on a report it had commissioned which advocated the reduction of magnetic fields to which residents are exposed to below 2 milligauss (mG) and the placing of power lines underground. The strategy documents made the statement that there are significant risks to public health arising from exposure to extremely low frequency (ELF) fields from the electrical power distribution system and that an undergrounding program could have a central role in reducing public risk. The Committee's view stated in a letter to the Council was that *the cost for undergrounding would represent a considerable burden, particularly in a climate of competing calls on public health funding. There would thus need to be a clear indication that such measures would lead to significant improvements in health outcomes before committing such funds, even if phased in over several years. As such, the limit of 2 mG proposed by Moreland City Council and the concomitant public and private expense involved in putting power lines underground cannot be justified on health grounds. It should also be noted that no health authority anywhere in the world has imposed such a limit.*

3.3 Papers Considered in the Past 12 Months Related to Biological Effects from Exposure to Radiofrequency Radiation

Possible health effects of emissions from mobile phones has continued to dominate research into biological effects of radiofrequency radiation (RFR).

Scienkiewicz states that after many years of research and much effort, very few biological effects can be unequivocally attributed to low intensity electromagnetic fields (including RFR). There is no categorical evidence to suggest that exposure at the levels commonly found in the environment causes any significant long term or pathological effect.

The heating effects of radiofrequency radiation are well established and the vast majority of the reported biological effects of exposure to RF radiation are consistent with the absorption of heat. The magnitude of these effects is dependent on field strength and will be insignificant at exposure levels experienced by the majority of the population. Effects in the absence of heating are controversial and have not been established firmly, although pulsed RF radiation may cause specific behavioural effects, possibly as a consequence of auditory perception of the field.



Figure 4. Cellular mobile phone base station.

Repacholi has expressed the hope that sufficient research will be completed to allow an assessment of RFR carcinogenicity by the International Agency for Research on Cancer (IARC) in 2003 and a non-cancer risk assessment by the WHO International EMF project by 2004. In particular that, over the next few years, research will be of sufficiently high quality and focused in the areas that both the IARC and WHO need so that the next generation of reviews will have better information on which to base more precise conclusions about any EMF health risks.

Hocking has found, in a preliminary report, based on interviews with mobile phone users, that some users reported pain associated with the use of phones, the type of pain being either heat/warmth, dull pain, or other types of pain, eg. a burning feeling. Overall, however, there is a fundamental weakness in a study that asks for volunteers to come forward and it would be expected that this study is unacceptably biased. It is possible, for example, that subjects with psychosomatic effects may have been included in the study.

Hocking goes on to state that *laboratory studies should include double blind testing of patients to confirm if RFR is causative of their symptoms.*

Preece *et al.* used simulated analog and digital mobile phone signals to examine effects on reaction times on attentional tasks, accuracy on attentional tasks, speed on working and secondary tasks (eg. identifying words shown originally in sequence with distracters), and accuracy on working and secondary tasks.

The only test affected was the choice reaction time (the time to click in response to the word “yes” or “no” on the computer screen) and this showed as an increase in speed (decrease in reaction time). The effect was strong for analogue simulation and less strong for digital simulation.

The authors state that the effect on choice reaction time could be associated with an effect on the angular gyrus, which acts as an interface between the visual and speech centres and which lies directly under and on the same side as the antenna. They state that such an effect could be consistent with mild localized heating, or possibly a non-thermal response.

In a related study, Fruede *et al.* measured EEG slow potentials from the scalps of subjects during a visual monitoring task. They showed a significant shift in potential towards the negative direction. Another study from the same group (Eulitz *et al.*) showed an alteration in event-related EEG high frequency (beta) power in the brain hemisphere adjacent to the phone.

Hardell *et al.* studied a group of 209 cases of brain tumour and 425 matched controls in relation to amount of mobile phone use. Approximately one-third of both groups were mobile phone users and overall no increased risk of brain tumour was found either for digital or analog phone use.

In animal studies, Frei *et al.* measured the incidence of mammary tumours and other survival endpoints in mammary tumour-prone mice. Previously this group had studied long-term exposure to 2450 MHz radiation with a Specific Absorption Rate (SAR) of 0.3 W/kg. This study used a higher SAR of 1.0 W/kg, again with no difference between exposed and sham-exposed groups in any of the endpoints studied. Jauchem *et al.* reported no changes in heart rate or blood pressure in anaesthetised rats exposed to Ultra-Wideband Pulses (electric field 20 kV/m, repetition frequency of 1 kHz for 0.5 s).

References for the papers considered are listed in Appendix 9.

3.4 The Committee's View on the Health Effects of Electromagnetic Fields

The additional evidence concerning health effects of electromagnetic fields reviewed by the Committee during the past year has not been sufficiently compelling to alter the Committee's position concerning the issue. This is that, overall, there is insufficient evidence to come to a firm conclusion regarding possible health effects from exposure to power frequency electric and magnetic fields.

3.5 The Committee's View on the Health Effects of Radiofrequency Radiation

The Committee considers that there is no substantive evidence to suggest that exposure to radiofrequency radiation can increase the risk of chronic health effects such as cancer. It has, however, noted the extent of public concern over the issue, particularly in view of the current controversy over mobile phones and base transmitters, and will continue to review the relevant research literature.

4 RADIATION INCIDENTS

4.1 Theft of a Nuclear Density Gauge

In December a soil moisture radiation gauge was stolen from the car of an engineer. The Police were notified of the theft and they issued a warning and a request for information from any member of the public who knew of the gauge's whereabouts. It was found 5 days later near Tullamarine Airport. The gauge did not appear to have been tampered with nor damaged in any way.

4.2 Misadministration of a Radiopharmaceutical

The Committee was advised of the inadvertent misadministration of a radiopharmaceutical at a small nuclear medicine practice. A woman patient of age over 50 was injected with 180 megabecquerel of gallium-67 citrate instead of thallium-201 chloride. The incident was caused by a nuclear technologist selecting the wrong radionuclide storage pot from the central storage lead castle.

As a result of the incident all radionuclide storage pots were to be colour coded and all nuclear technologists were briefed on the importance of correct radionuclide identification and the need to store current and outdated pots in the correct storage area

4.3 Non-Ionizing Radiation Incident

In April six police officers rescued a man who had been climbing a radio transmission tower. The mast was 'live' and the climber had received a radio-frequency shock. The Officers were required to go to the base of the mast, initially believed to be a mobile phone tower. On taking the climber to hospital at least one of the police officers became alarmed on being told 'he would not be having any more children as a result of the exposure'. The police officers returned normal blood and ECG results. They were discharged from hospital that morning.

4.4 Accidental Dumping of a Redundant Radiotherapy Source

In May 1999 a redundant brachytherapy source (16.3 gigabecquerel iridium-192) was mistakenly collected from a major hospital and taken to an approved land fill. The mistake was made because two radioactive material pick-ups were to be made from the same hospital on the same day. One of low-level waste for disposal at an approved landfill, the other the radiotherapy source for return to the Netherlands. An inexperienced driver did not recognise the difference between low-level bagged waste and a medium level transport container.

As per standard practice the waste container was dumped in a specially prepared trench and covered with 2 metres of soil. On being notified of the problem, staff from the RSU monitored the tip site. No radiation levels above background were detected. However the RSU was advised that in 2 to 3 years time, bore holes would be sunk to extract methane. The decision was made to recover the source and it was eventually found and forwarded to its original destination.



Figure 5. Recovered source container.

Following the incident, the transport company agreed to give more detailed training to its drivers, and, after discussions with RSU staff, has prepared more comprehensive pick-up protocols.

4.5 Temporary Loss of a Borehole Logging Source

A 55 gigabecquerel source fell from its container whilst being moved on a rig. The source fell to a platform below the level on which it was being carried. An employee picked up the source and replaced it in the container, a process which took about 45 seconds.

Dose calculations indicated the employee's whole body radiation dose was about 0.8 millisievert. The Radiation Advisory Committee recommended that a blood chromosome aberration test be carried on the person who picked up the source. Blood tests for lymphocytes returned normal levels.

Several basic rules were broken during this incident:

- the incident was not reported on occurrence;
- no recovery tool was available (none was present at site of the incident);
- a retrieval protocol was not in place; and
- in this incident one employee was wearing an American personal monitoring device, which has not been approved for use in Victoria. People employed in this type of work are required to wear approved monitoring badges.

4.6 Discovery of a Radioactive Source on a Geelong Beach

One of the more intriguing matters brought to the Committee's attention was the discovery of a radioactive source on Eastern Beach, Geelong.

Three young girls aged 8, 10 and 13 found a grey container at the waters edge and took it home. The grandfather of two of the girls opened the container and find it contained a vial marked 'radioactive P-32'. He advised the RSU who collected and monitored the source. From the labelling it was determined that the source had been delivered to a University in the eastern suburbs of

Melbourne.

The University advised that the source, as described, had been received by the Biochemistry Department and that the contents had been used.

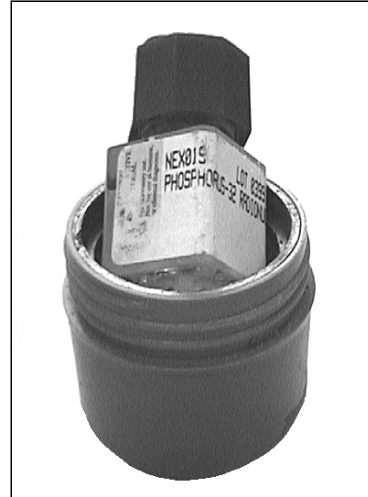


Figure 6. The vial shown with lead container.

Analysis of the vial's contents showed it contained sulphur-35 with traces of phosphorus-32. Sulphur-35 does not present an external radiation hazard confirming that the girls who found the source had not been at any risk.

How this lead pot came to be located at the beach in Geelong remains a mystery

4.7 Radiation Oncology Incident

A potentially serious incident occurred at a radiation oncology centre when a beam was generated, very briefly, whilst a radiation technologist was in the treatment room.

During a double exposure port film verification procedure and while the radiation technologist was positioning the port film the interlock gate swung sufficiently closed to clear the interlock microswitch. The second technologist checked the beam room through the control room port hole, but could not see her co-worker as he was obscured by the patient and the machine.

The beam fired for three monitor units, the time preset for the film.

Using a phantom the incident was reconstructed and the technologists exposure estimated to have been 23 microsievert. This figure is consistent with the technologists total dose of 200 microsievert for the preceding 10 week period.

The Radiation Advisory Committee recommended that Victorian Oncology Centres be advised of the incident and that they must install interlock gates that default to an open position and establish more thorough beam room inspection procedures.

4.8 Unintended Irradiation of a Nuclear Medicine Patient

The Committee was advised that the wrong radiopharmaceutical had been injected into a 59 year old man. One nuclear medicine technologist was dealing with two patients simultaneously. One patient was scheduled to have a bone scan injection using 740 megabecquerel of technetium-99m and the other one was due to be injected with tellurium-201 for a stress test. The two doses were drawn up correctly and placed side by side on the dispensing tray. Unfortunately, working under pressure, the technologist picked up and administered the wrong dose. The administered dose was calculated to be about 29 millisievert. The patient was advised of the dose.

This incident was the second (see 4.2) at this particular centre. The Committee recommended that a review of dispensing and associated control procedures be carried out at the centre.

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APPENDICES

**APPENDIX 1
RESEARCH WITH HUMAN VOLUNTEERS — PROJECTS APPROVED**

Licensee	Research Work Location	Researcher Name	Research Project
Austfin and Repatriation Medical Centre		Jerums	Role of dietary sodium intake & ACE genotype in effectiveness of losartan therapy in type 2 diabetic patients with raised blood pressure & albuminuria.
St. Vincent's Hospital	Department of Gastroenterology	Little; Taylor	Evaluation of the accuracy and acceptability of computed tomography colography compared to colonoscopy in the diagnosis of colonic diseases.
Alfred Hospital	Alfred Baker Medical Unit	Kaye	Determination of regional arginine kinetics.
Austfin and Repatriation Medical Centre		Karlsson	Evaluation of ultrasound when measuring bone density.
Monash Medical Centre	Centre for Molecular Biology & Medicine. Epworth Hospital	Richardson; Linnane; McMeeken	Assessment of coenzyme Q10 treatment of hip replacement patients.
Deakin University	School of Health Sciences, Burwood	Hargraves	Effects of prior exercise on glucose metabolism in humans.
University of Melbourne	School of Physiotherapy	Bennell	The effect of low-intensity, pulsed ultrasound on disuse osteoporosis following spinal cord injury.
University of Melbourne	School of Physiotherapy	Bennell	The efficacy of physiotherapy management of patellofemoral pain syndrome: A randomized, double-blind, controlled trial.
Monash Medical Centre		Littlejohn	Evaluation of the leflunomide/sulphasalazine combination versus sulphasalazine alone in patients with active arthritis non-responders to leflunomide.
University of Melbourne	Department of Medicine, St. Vincent's Hospital	Ng Kong Wah	Comparison of raloxifene HCL and alendronate Na to placebo in the treatment of postmenopausal women with osteoporosis.
University of Melbourne	Department of Medicine, St. Vincent's Hospital	Ng Kong Wah	Comparison of raloxifene in prevention of osteoporosis.

Licensee	Research Work Location	Researcher Name	Research Project
St. Vincent's Hospital		Clemens; Laurence	A pivotal multicentre, double-blind, placebo-controlled, group-comparison study to investigate the efficacy and safety of Bay 12-9566 in the treatment of patients with mild to moderate osteoarthritis of the hip, over two years.
Monash Medical Centre		Littlejohn	A pivotal multicentre, double-blind, placebo-controlled, group-comparison study to investigate the efficacy and safety of Bay 12-9566 in the treatment of patients with mild to moderate osteoarthritis of the hip, over two years.
St. Vincent's Hospital		Choong	A multicentre, multinational, randomized, double-blind, comparison of subcutaneous SR90107A/ORG31540 with enoxaparin in the prevention of deep vein thrombosis and symptomatic pulmonary embolism after elective hip replacement or a revision.
Monash Medical Centre		Naidoo	A multicentre, multinational, randomized, double-blind, comparison of subcutaneous SR90107A/ORG31540 with enoxaparin in the prevention of deep vein thrombosis and symptomatic pulmonary embolism after elective hip replacement or a revision.
St. Vincent's Hospital		O'Brien	An eight-week, double-blind, placebo controlled, parallel group study of pregablin (150 and 300 mg/day) in patients with postherpetic neuralgia.
Austin & Repatriation Medical Centre		Bradney	The Effects of exercise during growth.
St. Vincent's Hospital	Institute of Medical Research	Campbell; Macisaac	The study of the relationship between plasma BNP precursor (pro BNP) levels and cardiac function in patients scheduled for orthopaedic surgery
University of Melbourne	School of Physiotherapy	Bennell	Assessment of stress fracture repair and the effect of low-intensity pulsed ultrasound on the rate of repair.

APPENDIX 2a

NUMBERS OF OPERATOR LICENCES AS OF 30 SEPTEMBER 1999.

CATEGORY	IRRADIATING			SEALED			UNSEALED			ENDORSED		
	Status			Status			Status			Status		
	A	P	T	A	P	T	A	P	T	A	P	T
Radiologists	202	—	—	—	—	—	—	—	—	46	—	—
Radiation Oncologists	1	—	—	1	—	—	—	—	—	37	—	1
Nuclear Medicine Specialists	—	—	—	—	—	—	24	—	—	1	—	—
General Practitioners	367	—	10	—	—	—	—	—	—	—	—	—
Dentists	1974	1	1	—	—	—	—	—	—	—	—	—
Chiropractors	251	1	—	—	—	—	—	—	—	—	—	—
Dermatologists	6	—	—	—	—	—	—	—	—	—	—	—
Ophthalmologists	—	—	—	19	—	1	—	—	—	2	—	—
Other Medical Specialists	28	—	10	—	—	—	5	—	1	—	—	—
Dental Therapists	174	—	—	—	—	—	—	—	—	—	—	—
Testers	27	—	1	2	—	—	—	—	—	28	—	2
Service Technicians	163	2	11	40	1	1	—	—	—	28	—	—
Research (Human Volunteers)	47	1	—	1	—	—	14	—	1	3	—	—
Veterinary Surgeons	565	3	1	—	—	—	—	—	1	17	—	—
Industrial Radiographers	109	—	3	—	—	—	—	—	—	181	1	2
Consultants	1	—	—	1	—	—	—	—	—	8	—	—
Dental Hygienists	53	1	—	—	—	—	—	—	—	—	—	—
Cardiologists	24	—	15	—	—	—	—	—	—	—	—	1
Borehole Loggers	—	—	—	45	—	—	—	—	—	3	—	—
Moisture/Density Gauge Operators	—	—	—	259	2	20	—	—	—	—	—	—
Other Paramedical	12	—	—	1	—	—	5	—	—	—	—	—
Radiologist/Nuclear Medicine Specialist	—	—	—	—	—	—	—	—	—	6	—	—
Multiple Category	1	—	—	—	—	—	—	—	—	1	—	—
Subtotal	4005	9	52	369	3	22	48	—	—	361	1	6
TOTALS	A status: 4783			P status: 13			T status: 83					
	A status: approved licence			P status: licence to be issued pending payment			T status: application not yet approved - temporary status					

Notes: Endorsed licences are licences which permit use of more than one category of irradiating apparatus, sealed source and unsealed source on the one licence.

Medical Imaging Technologists, Radiation Therapists and Nuclear Medicine Technologists are now registered with the Medical Radiation Technologists Board.

APPENDIX 2b

NUMBERS OF REGISTRATIONS AS OF 30 SEPTEMBER 1999.

CATEGORY	IRRADIATING			SEALED		
	Status			Status		
	A	P	T	A	P	T
Radiology (Hospital)	437	6	3	—	—	—
Radiology (Private)	476	9	4	—	—	—
CT Scanner	114	1	5	—	—	—
Linear Accelerator	29	—	1	—	—	—
Radiotherapy	11	—	—	25	—	—
Dermatology	3	—	—	1	—	—
Ophthalmology	—	—	—	20	—	—
Dental	1971	8	6	—	—	—
Chiropractor	80	—	—	—	—	—
Medical (GP)	83	—	1	—	—	—
X-Ray Analysis	71	—	—	—	—	—
Irradiation Cell	—	—	—	3	—	—
Borehole Logging	2	—	—	40	—	—
Radiation Gauge	12	—	—	443	2	—
Nuclear Moisture/Density Gauge	—	—	—	165	2	—
Industrial Radiography	100	—	—	42	—	—
Veterinary	371	—	2	7	—	—
Calibration	—	—	—	105	1	—
Teaching	14	—	—	101	2	—
Other Industrial	30	—	1	174	—	—
Research	6	—	—	27	—	1
Other Medical	7	—	—	8	2	1
Mammography	154	4	—	—	—	—
OPG/Cephalometric	237	1	1	—	—	—
Cyclotron	1	—	1	—	—	—
Bone Mineral Densitometry	47	—	1	—	—	—
Mobile Image Intensifier	65	—	2	—	—	—
Condensor Discharge Units	36	1	1	—	—	—
Laboratory Irradiator	—	—	—	8	—	—
Lithotripter	4	—	1	—	—	—
Crawler Guide Sources	—	—	—	4	—	—
Veterinary Dental	7	—	—	—	—	—
Therapy Simulator	3	—	—	—	—	—
Cabinet X-ray Equipment	31	—	1	—	—	—
GC-Electron Capture Detector	—	—	—	24	—	—
Subtotal	4402	30	31	1197	9	2
TOTALS	A status: 5599		P status: 39		T status: 33	
	A status: approved licence		P status: licence to be issued pending payment		T status: application not yet approved - temporary status	

APPENDIX 2c

NUMBERS OF MANAGEMENT LICENCES AS OF 30 SEPTEMBER 1999.

CATEGORY	IRRADIATING			SEALED			UNSEALED			ENDORSED			TRANSPORT			
	Status			Status			Status			Status			Status			
	A	P	T	A	P	T	A	P	T	A	P	T	A	P	T	
Sales	47	—	4	61	—	3	18	—	—	13	—	—				
Industrial	—	—	—	—	—	—	12	—	—	—	—	—				
Hospital	—	—	—	—	—	—	17	—	—	—	—	—				
Pathology	—	—	—	—	—	—	9	—	—	—	—	—				
Education and Research	—	—	—	—	—	—	38	—	—	—	—	—				
Research with Human Subjects	3	—	—	—	—	—	1	—	—	6	—	—				
Radiotherapy	—	—	—	—	—	—	3	—	—	—	—	—				
Nuclear Medicine	—	—	—	—	—	—	46	—	—	—	—	—				
Other Medical	—	—	—	—	—	—	—	—	—	—	—	—				
Government Departments	—	—	—	—	—	—	6	—	—	—	—	—				
Veterinary	—	—	—	—	—	—	8	—	—	—	—	—				
Other Laboratory	—	—	—	—	—	—	1	—	—	—	—	—				
Manufacturer	—	—	—	—	—	—	1	—	—	—	—	—				
Transport													15	—	—	
Transport (Low Level Waste)														7	—	—
Subtotal	50	—	4	61	—	3	160	—	—	19	—	—	22	—	—	
TOTALS	A status: 312			P status: —			T status: 7									
	A status: approved licence			P status: licence to be issued pending payment			T status: application not yet approved - temporary status									

Notes: Endorsed licences are licences which permit use of more than one category of irradiating apparatus, sealed source and unsealed source on the one licence.

APPENDIX 3

SUMMARY OF RADIATION SAFETY TESTING — MAY 1984 TO 30 SEPTEMBER 1999

TYPE	TOTAL	NUMBER INSPECTED	% INSPECTED
61—Radiology (Hospital)	446	314	70.4
62—Radiology (Private)	489	193	39.5
63—CT Scanner	120	35	29.2
64—Linear Accelerator	30	7	23.3
65—Radiotherapy	36	7	19.4
66—Dermatology	4	2	50.0
67—Ophthalmology	20	12	60.0
68—Dental	1985	886	44.6
69—Chiropractor	80	60	75.0
70—Medical (GP)	84	71	84.5
71—X-Ray Analysis	71	9	12.7
72—Irradiation Cell	3	1	33.3
73—Borehole Logging	42	6	14.3
74—Radiation Gauge	457	209	45.7
75—Nuclear Moisture/Density Gauge	167	118	70.7
76—Industrial Radiography	142	42	29.6
77—Veterinary	380	143	37.6
78—Calibration	106	6	5.7
79—Teaching	117	2	1.7
80—Other Industrial	205	34	16.6
81—Research	34	2	5.9
82—Other Medical	18	7	38.8
83—Mammography	158	100	63.3
84—OPG/Cephalometric	239	80	33.5
85—Cyclotron	2	0	0
86—Bone Mineral Densitometry	48	10	20.8
87—Mobile Image Intensifier	67	15	22.4
88—Condensor Discharge Units	38	15	39.5
89—Laboratory Irradiator	8	6	75.0
90—Lithotripter	5	3	60.0
91—Crawler Guide Sources	4	0	0
92—Veterinary Dental	7	1	14.3
93—Therapy Simulator	3	1	33.3
94—Cabinet X-ray Equipment	32	8	25.0
95—GC-Electron Capture Detector	24	0	0
TOTALS	5671	2405	42.4

NB: This list only applies to units registered (or for which applications have been made) at the time of preparation of this summary. It does not take account of units that were inspected and have subsequently been de-registered through being sold, dismantled, destroyed or placed in storage.

APPENDIX 4

SUMMARY OF RADIATION SAFETY
COURSES — 1991 TO 30 SEPTEMBER 1999

COURSE	NUMBER OF COURSES		NUMBER OF ATTENDEES			
	98/99	Total Since Inception	Individuals		Companies/Institutions	
			98/99	Since Inception	98/99	Since Inception
Industrial Radiation Gauges	2	21	12	228	9	91
Nuclear Moisture/Density Gauges	1	15	3	124	1	57
Industrial Radiation Safety Officer	2	2	14	14	11	11
Unsealed Source Laboratory	0	4	0	43	0	10
Transport	0	10	0	78	0	18
General Practitioner Radiography	1	12	11	254		

Radiation
Advisory
Committee
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Report
1999

SUMMARY OF RADIATION SAFETY
EXAMINATIONS — 1986 TO 30 SEPTEMBER 1999

COURSE	NUMBER OF EXAMINATIONS		EXAMINATION DETAILS			
	98/99	Total Since Inception	98/99		Since Inception	
			Attempts	Passes	Attempts	Passes
Radiation Protection in Industrial Radiography	6	65	44	23	477	306
Radiation Protection in Industrial X-radiography	2	9	4	1	27	23
Radiation Protection in Fixed Enclosure Industrial Radiography Sites	4	15	7	5	42	28
Nuclear Moisture/Density Gauges	7	40	58	44	385	322

APPENDIX 5

REVIEW OF *HEALTH ACT* 1958

RESPONSE FROM RADIATION ADVISORY COMMITTEE

Introduction

The Victorian Radiation Advisory Committee (RAC) was established in 1983 to advise the Minister or the Chief General Manager (the Secretary) on any matters relating to the administration of the provisions of the Health Act relating to radiation safety. A key element of its role is the provision of advice on minimising the radiation exposure of the people of Victoria. It is on this basis that the RAC has reviewed the discussion document, particularly the issues raised in discussion boxes in Section 6, parts 1 to 6.

1. Licensing & Registration

Very high exposure to ionizing radiation has the potential to cause death in a few weeks, or after several years for lower doses. The International Commission on Radiological Protection (ICRP) has formulated a framework for radiation protection based on these principles:

- (i) the use of ionizing radiation must be justified (no other process not using ionizing radiation could produce the desired effect or information);
- (ii) all radiation exposures must be kept as low as reasonably achievable; and
- (iii) all doses must be kept below certain prescribed dose limits.

These principles provide the basis of radiation protection world wide. The International Atomic Energy Agency (IAEA) has, in its published Basic Safety Standards (No. 115) recommended that the regulatory regime for radiation protection should include the three principles of notification, licensing, and registration. Such a system is seen as international best practice in radiation protection.

To operate ionizing radiation equipment, knowledge of these concepts is an essential requirement.

Under the current legislation, people wishing to use equipment capable of producing ionizing radiation must hold a valid operator licence. To obtain a licence, the applicant must provide evidence of appropriate training, experience and/or academic qualifications in the field for which the licence is sought.

Certain specific exemptions from the requirement to hold a licence or register an apparatus or source may be granted. Some examples of exemptions are situations where relatively small sources are used and where a person is in training in a medical field and that person is under close supervision.

Restricted licences have also been issued under carefully defined conditions. These include licences issued to paramedical occupations who would otherwise not be issued with a licence but work in remote areas of Victoria where health service provision may be difficult. Such licences are usually restricted to a limited range of procedures on a given X-ray unit at a given location.

Registration of sources and X-ray equipment is of equal importance. Such registration enables the RSU to know what sources of ionizing radiation there are in the State, where they are located, how they are stored or otherwise kept safe, and most importantly how they are disposed of. Over the years, there have been several incidents, including some in Victoria, where radioactive sources have been mislaid, stolen or forgotten and have fallen into the hands of people who didn't understand what they were. In some of the overseas cases, deaths have occurred.

Registration is the only effective way for sources and equipment to be tracked and

monitored. Prior to the promulgation of the *Health (Radiation Safety) Regulations* 1984 and the introduction of a registration system for the first time, the incumbent licence only system was found to be inadequate. Many individual irradiating apparatuses and/or radioactive sources were simply unknown to the Department even though a given institution held a licence to possess the equipment and, as such, were required to keep the Department advised of their inventory at all times.

2. Costs and Benefits of Current Licensing System

ICRP have developed the concept of detriment as a single measure of the deleterious effects of exposure to ionizing radiation. Radiation detriment includes the long term probability of illness, death and disability. The unit used to estimate detriment is the person-sievert (p-Sv).

Several authors have calculated the monetary cost of health detriment. In a paper prepared for the Victorian Department of Human Services which was used in the Department's Regulatory Impact Statement in 1994, Robotham derived a figure of \$30,000 per p-Sv. The Victorian collective radiation dose (excluding radiation therapy) is about 5000 p-Sv.

Thus the gross cost of health detriment in Victoria is about \$150M per annum.

This figure must be discounted by the direct health benefits of improved diagnosis and treatment. Estimated, in Victoria, to be about \$100M per annum. Thus, in broad terms the net health detriment cost in Victoria is about \$50M per annum.

How or if this figure would rise if licensing and registration requirements were relaxed is difficult to quantify.

Some indication can be obtained by comparing Australian and New Zealand experiences, for a period when New Zealand

did not have a comprehensive code of practice for radiation control in medical practice.

Comparison of Some Patient Doses in Australia and New Zealand.

<i>Procedure</i>	<i>Entrance skin dose Australia (1985-89)*</i>	<i>Entrance skin dose New Zealand (1983-84)*</i>
Skull	3.6 mGy	5.6 mGy
Lumbo-sacral spine	28 mGy	33 mGy
GI tract	24 mGy	36 mGy
Chest	0.4 mGy	0.83 mGy

* Taken from UNSCEAR 1993

New Zealand exposures were about 50% higher. A relaxation of regulatory controls in Australia (and similarly in Victoria) of the same order could lead to an increase in detriment cost of about \$25M per annum.

The Committee also noted that a National Review of radiation protection legislation under the National Competition Principles was to be conducted via the National Uniformity Implementation Panel (Radiation Control), and that the findings from the Health Act Review in respect of licensing and registration in particular, would be relevant to the national review.

3. Alternate Control Mechanisms

Negative licensing is inappropriate. To stop somebody from using ionizing radiation after they have caused radiation damage is not going to help the irradiated worker or patient. Radiation protection is based on prevention not cure.

A certification scheme without minimum standards could lead to poorly trained people exposing patients and workers to unnecessary radiation doses. This has been a continuing

problem in the non-destructive testing industry.

There is no reason to believe self-regulation would operate more effectively in the radiation industry than in other fields. Failure to self-regulate could lead to overservicing and overexposure.

Reliance on existing law is both cumbersome and time consuming in both the detection and the prosecution of offenders.

Some of these options were considered in the 1994 Regulatory Impact Statement and rejected for reasons which are still valid.

Any lessening of current restrictions could lead to a greater exposure of the Victorian public with subsequent increase in health detriment costs. The RAC does not believe that removing the present restrictions on competition in provision of radiation services will be of benefit to the Victorian community.

4. Relationship Between Licensing System and Professional Registration Acts

The RAC agrees that the Secretary should be able to refuse to issue a licence on the grounds of failure to be registered under the health practitioner legislation.

5. Variation, Suspension or Cancellation of Licence or Registration

The RAC agrees that a licence may be suspended, varied or cancelled if the licensees have ceased to be registered under health practitioner legislation.

6. & 7. Appeals Provisions

The RAC agrees that there should be uniform appeals provisions as appear in section 387 and agrees that VCAT is an appropriate forum.

8. Penalties

The RAC considers the present penalties to be inadequate and in the interests of both deterrence and uniformity they should be brought into line with the Environment Protection Act.

9. Regulations

The RAC reviewed the 1994 regulations in some considerable detail. It is considered that they achieve an appropriate balance between protection of the Victorian community and the efficient and effective use of ionizing radiation in industry, medicine, research and teaching.

10. Radiation Advisory Committee

The Victorian RAC has had the opportunity to consider its own effectiveness and compare its work with its counterparts in other States. Its current terms of reference and composition are appropriate for its tasks.

11. Non-Ionizing Radiations

The Act currently provides power to control prescribed classes of non-ionizing radiation emitting apparatus. The control available appears to be basically through the mechanism of licensing and/or registration. Regulations using these powers have not been implemented at this time, however, the Committee believes that the need for control of some areas of non-ionizing radiation should be assessed and has requested the RSU report on possible NIR controls. High powered lasers is one area where controls may be needed. The Committee's view is that there may need to be an additional power to make regulations which could, for example, require compliance with a standard limiting emissions from an apparatus, or provide for regulations on other safety matters, without necessarily requiring licensing or registration.

12. Conclusion

It is the Committee's view that the current Victorian legislative requirements provide for effective control and management of occupational and public exposure to ionizing radiation. It is possible that some minor adjustment may be necessary as a result of national uniformity and national competition principles review of the legislation. Some additional power may be necessary in relation to non-ionizing radiation.

APPENDIX 6

REQUIREMENTS FOR PERSONAL DOSIMETERS

Requirements for a monitoring service for the provision of personal monitors to determine the radiation exposure of workers.

than $H_p(10)$, the dosimeter should be capable of measuring equivalent dose at a depth of 7 mg cm^{-1} in soft tissue.

Dosimeter Requirements

1. The personal dosimeter must be of the integrating type.
2. The personal dosimeter must have adequate accuracy for all radiations and all measurement conditions of relevance.
3. The type of radiations and measurement conditions for which the personal dosimeter is offered for use must be clearly specified for each detector type.

Radiation Quantity Reported

1. The dosimeter should be capable of measuring the radiation quantity Personal Dose Equivalent $H_p(d)$ the equivalent dose in soft tissue, at an appropriate depth, d , below a specified point in the body.
2. The specified name for the unit of personal dose equivalent is sievert (Sv) and doses must be reported in this unit.
3. Any statement of personal dose equivalent should include a specification of the reference depth, d expressed in mm.
4. For weakly penetrating radiation, a depth of 0.07 mm for the skin and 3 mm for the lens of the eye shall be employed.
5. For strongly penetrating radiation a depth of 10 mm shall be employed.
6. In most situations reporting measurement of $H_p(10)$ is sufficient. If radiation fields contain sufficient amounts of weakly penetrating radiation such as beta particles, electrons and photons below 15 keV causing $H_p(0.07)$ to be significantly larger

Calibration and Traceability

1. Calibration of the intensity of the radiation fields used shall be traceable to the national standards for radiation exposure held by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) on behalf of the National Measurement Laboratory.
2. Ionization chambers and electrometers used to quantify the intensity of a radiation field must be calibrated by ARPANSA, or by an accredited secondary standards laboratory or be traceable to the national standard held at ARPANSA.
3. The intensity of a radiation field used for calibration should be determined in terms of air kerma or exposure (free-in-air), with the field collimated to minimise unwanted scatter.
4. For calibration purposes the personal dosimeters must be exposed in an aligned and expanded field incident in the anterior posterior direction and perpendicular to the backscatter medium.

Calculation of Personal Dose Equivalent

1. For each dosimeter and for each beam quality, conversion coefficients are required to relate the air kerma or exposure (free-in-air) to personal dose equivalent at a specified depth in soft tissue.
2. The conversion coefficients are required for various photon energies, angles of incidence and for size, shape and composition of the backscatter medium.

3. The conversion coefficients determined in 1 and 2 including their variability with energy, angle of incidence and backscatter medium must be specified. The specification must include the uncertainty in the coefficients.

Measurement Service Requirements

1. The measurement service must have a quality system in place.
2. The measurement service must be staffed with appropriately trained personnel with appropriate qualifications.
3. The measurement service must have suitable processing equipment and other relevant resources and facilities to maintain the service.
4. Dosimeter processing and dose reporting must take place within a time-scale prescribed by the regulatory authority.

APPENDIX 7

PAPERS RELATED TO BIOLOGICAL EFFECTS ASSOCIATED WITH POWER FREQUENCY ELECTROMAGNETIC FIELDS CONSIDERED IN THE PAST YEAR

1. Cell Studies

- De Mattei M, Caruso A, Traini GC, Pezzetti F *et al.* (1999). Correlation between pulsed electromagnetic fields exposure time and cell proliferation increase in human osteosarcoma cell lines and normal osteoblast cells in vitro. *Bioelectromagnetics*, 20, 177-182.
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- Singh N, Lai H. (1998). 60-Hz magnetic field exposure induces DNA crosslinks in rat brain cells. *Mutation Res.*, 400, 313-320.
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- Bakos J, Nagy N, Thuroczy G, Szabo LD. (1999). Urinary 6-sulphatoxymelatonin excretion of rats is not changed by 24 hours of exposure to a horizontal 50-Hz 100- μ T magnetic field. *Electro-Magnetobiol.*, 18, 23-31.
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APPENDIX 8

SUMMARY OF EPIDEMIOLOGY PAPERS (1998—1999)

Authors	Country	Year Published	Type of Study	Subjects	Health Outcome	Measure of Exposure	Results	Comments
Hatch <i>et al.</i>	USA	1998	Case-control	640 cases and 640 controls	Childhood Acute Lymphoblastic Leukemia	Use of electrical 17 appliances, 'never vs. ever' with time categories for 'ever'.	No dose-response pattern found. Significant elevated risk for 3 of the 17 appliances investigated.	Large study with good power, but little evidence for an association between EM fields and acute lymphoblastic leukemia.
Belanger <i>et al.</i>	USA	1998	Prospective cohort	2,967 pregnant women	Spontaneous abortion	Wire codings, electric bed use.	Electric blanket use adjusted for other factors OR=1.74 (0.96-3.15). No increased risk for heated water beds or wire codes.	Exposure assessment was crude. Authors conclude that study does not support hypothesis that use of electric beds or residence in high current configuration wire code homes increases risk of spontaneous abortion.
Verkasalo <i>et al.</i>	Finland	1997	Cross-sectional	12,063 persons in two nationwide data sets	Depression	Distance of residents from overhead power lines for fields calculated $\geq 0.01 \mu\text{T}$	OR=4.83 (1.16-20.2) for severely depressed and highly exposed ($\geq 0.50 \mu\text{T}$), based on 2 subjects. All other Odds Ratios non-significant.	This study agreed with results of McMahan <i>et al.</i> (1994), that proximity to high voltage power lines is not associated with depression.
Savitz <i>et al.</i>	USA	1999	Retrospective cohort	138,903 male electric utility workers.	Cardiovascular disease mortality	Job exposure matrix based on 2,842 time-weighted dosimetry measurements	Increased risk to Arrhythmias RR/ μT -year=1.08 (1.03-1.12) and AMI, non-significant risk to Atherosclerosis and CHD.	Mechanism highly speculative but results suggest an association with some forms of cardiovascular disease. Control of confounders such as smoking and diet inadequate.

Authors	Country	Year Published	Type of Study	Subjects	Health Outcome	Measure of Exposure	Results	Comments
Wartenberg	Various	1998	Meta-Analysis	Children exposed to EM fields	Childhood Leukemia	Wire codes, distance from power lines/other, spot/24-hour and calculated magnetic field measurements	Studies (N=7) using wire codes (LCC) & distance: $OR_{\text{fixed effects}}=1.41$ (1.16-1.72)	Review provided support for a weak elevated risk of leukemia for children living in proximity to power lines.
McBride <i>et al.</i>	Canada	1999	Case-control	399 cases and 399 controls	Childhood Leukemia	Personal 48-hour EMF dosimetry measurements, 24-hour positional EMF measurement in bedrooms, two different wire code schemes.	$OR=0.95$ (0.72-1.26) for childhood leukemia and $OR=0.93$ (0.70-1.25) for acute lymphatic leukemia.	Good exposure assessment and power, ie designed to detect odds ratios as low as 1.6. Provides little support for a relation between EMF and leukemia.
Meinert & Michaelis	Various	1996	Meta-Analysis	Children exposed to EM fields	Childhood cancer	Wire codes, distance and flux density (μT)	$OR=1.37$ (0.94-2.00) for all cancers. $OR=1.66$ (1.11-2.49) for leukemia and $OR=1.5$ (0.52-3.37) for CNS tumors.	Frequency data for 13 studies was aggregated. Matching criteria and confounding not addressed. Support for association between EMF (wire codes) and leukemia, but not CNS tumors.
Green <i>et al.</i>	Canada	1999	Case-control	201 cases and 406 controls	Childhood Leukemia	Personal EMF dosimetry, interior and exterior EMF spot measurements, three different wire code schemes	Odds Ratios calculated for leukemia & wire codes all non-significant, but $OR=3.45$ (1.14-10.45) for perimeter spot measurements $\geq 0.15 \mu T$ and children <6 years.	Inconsistent results across all exposure metrics and no dose response. Results do not support association between leukemia and close proximity to power lines.

APPENDIX 9

PAPERS RELATED TO BIOLOGICAL EFFECTS ASSOCIATED WITH RADIOFREQUENCY RADIATION CONSIDERED IN THE PAST YEAR

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6. ABBREVIATIONS & DEFINITIONS

A/m
amps/metre, a unit of magnetic field

ACPSEM
Australasian College of Physical Scientists and
Engineers in Medicine

ALARA
As Low As Reasonably Achievable

ANSTO
Australian Nuclear Science and Technology
Organisation

AP
antero-posterior

ARPANSA
Australian Radiation Protection and Nuclear
Safety Agency

ARPS
Australasian Radiation Protection Society

ARL
Australian Radiation Laboratory

ARS
Australian Radiation Services

Bq
becquerel, a unit of radioactivity
(1 Bq = 1 disintegration per second)

CT
computed tomography

DEXA
dual energy X-Ray absorptiometry

DMBA
dimethylbenz[a]anthracene

DNA
deoxyribonucleic acid

DPIE
Department Primary Industry and Energy

EEG
electroencephalogram

EMF
electric and magnetic field

ENU
N-ethyl-N-nitrosurea

EPA
Environment Protection Authority

GI
gastro-intestinal

GHz
gigahertz, a unit of frequency
(1 GHz = 1,000,000,000 Hz)

GM
geiger-müller

GP
General Practitioner

H_p(d)
The equivalent dose in soft tissue, at an
appropriate depth, d, below a specified point
in the body.

Hz

hertz, a unit of frequency
(1 Hz = 1 cycle/second)

IAEA

International Atomic Energy Agency

IARC

International Agency for Research on Cancer

ICNIRP

International Commission on Non-Ionizing
Radiation Protection

ICRP

International Commission on Radiological
Protection

IEC

International Electrotechnical Commission

JSAC

Joint Scientific Accreditation Committee of
the Australian and New Zealand Society of
Nuclear Medicine

kBq

kilobecquerel (1 kBq = 1,000 Bq)

keV

kiloelectron volts (1 keV = 1,000 eV). The
electron volt is a unit of energy. The energy
required to move an electron through a
potential difference of 1 volt.

kV

kilovolt (1 kV = 1,000 V)

kV/m

kilovolt/metre, a unit of electric field

MBq

megabecquerel (1 MBq = 1,000,000 Bq)

μGy

microgray, a unit of absorbed dose
(1 μGy = 0.000,001 Gy)

μSv

microsievert, a unit of equivalent dose
(1 μSv = 0.000,001 Sv)

μT

microtesla, a unit of magnetic flux density
(1 μT = 10 mG)

MHz

megahertz, a unit of frequency
(1 MHz = 1,000,000 Hz)

mG

milligauss, a unit of magnetic flux density
(1 mG = 0.001 G)

mGy

milligray, a unit of absorbed dose
(1 mGy = 0.001 Gy)

mSv

millisievert, a unit of equivalent dose
(1 mSv = 0.001 Sv)

mT

millitesla, a unit of magnetic flux density
(1 mT = 10 G)

MRTB

Medical Radiation Technologists Board

NAS

National Academy of Sciences

NDT

non destructive testing

NHMRC
National Health & Medical Research Council

NIEHS
National Institute of Environmental Health
Sciences (US)

NIR
non-ionizing radiation

NMDG
nuclear moisture/density gauge

NORM
naturally occurring radioactive materials

NRPB
National Radiation Protection Board (UK)

NSQAC
National Specialist Qualification Advisory
Committee

OR
Odds ratio, the odds of disease in exposed
persons divided by the odds of disease in
unexposed persons. An odds ratio of 1 means
that there is no difference in risk of disease
between exposed and unexposed persons.

PA
postero-anterior

p-Sv
The unit used to estimate detriment.

QA
quality assurance

Q-Value
A parameter that indicates dose efficiency and
imaging performance.

RAC
Radiation Advisory Committee

RACR
Royal Australasian College of Radiologists

RANZCR
Royal Australian and New Zealand College of
Radiologists

REM
rapid eye movement

RF
radiofrequency

RFR
radiofrequency radiation

RMIT
Royal Melbourne Institute of Technology

RSU
Radiation Safety Unit, Department of Human
Services

SAR
specific absorption rate

Sv
sievert, the special name given to the
equivalent and effective dose unit, $J kg^{-1}$

TAFE
Technical and Further Education (College of)

TENORM
technologically enhanced naturally occurring
radioactive material

TBq

terabecquerel
(1 TBq = 1,000,000,000,000 Bq)

TLD

thermoluminescent dosimeter

TPA

tetradecanoylphorbol acetate

VDU

visual display unit

VCAT

Victorian Council of Appeals Tribunal

V/m

volts/metre, a unit of electric field

W/kg

Watts per kilogram - a unit the amount of absorption of radiofrequency radiation energy.

WHO

World Health Organization

UNSCEAR

United Nations Scientific Committee on the Effects of Atomic Radiation