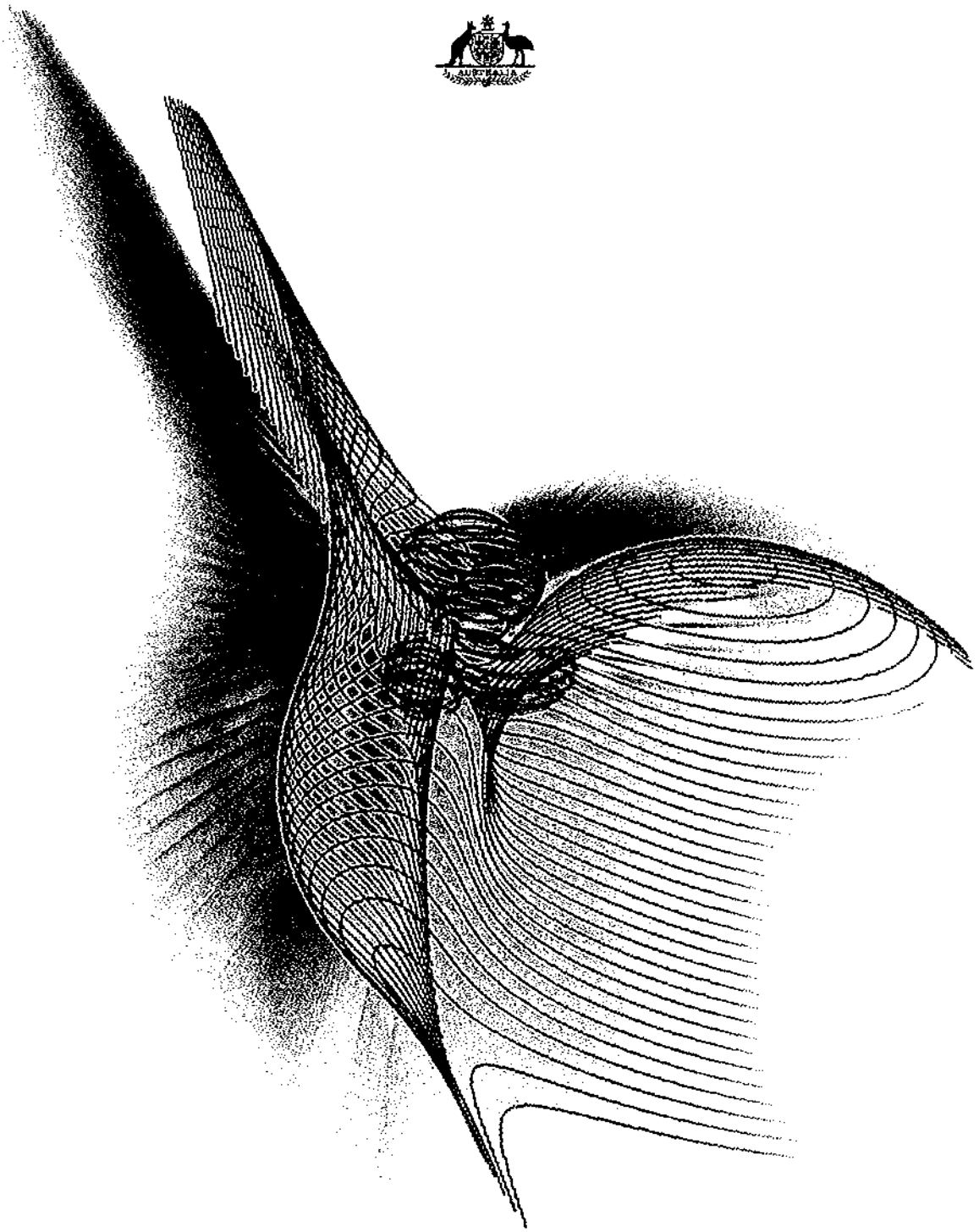
Australian Nuclear Science & Technology Organisation

ANNUAL REPORT 1999 - 2000



ansto

Australian Nuclear Science & Technology Organisation

ANNUAL REPORT 1999 - 2000

Cover Image
Calculated contour lines of electric fields surrounding a molecule of iodomethyphenedate, a new radiopharmaceutical under development at ANSTO.

Iodomethylphenedate binds to specific proteins (or receptors) in the human brain. As it decays, it produces an image of the density and distribution of these proteins, enabling clinicians to diagnose diseases such as Parkinson's and Attention Deficit Hyperactivity Disorder.

The contour lines shown here help scientists understand how iodomethylphenedate binds to proteins in the brain.

ANSTO	Lucas Heights Science & Technology Centre New Illawarra Road, Lucas Heights, New South Wales 2234
Postal Address:	ANSTO Private Mail Bag 1 Menai NSW 2234
Telephone:	(02) 9717 3111
Facsimile:	(02) 9543 5097
Email	communications@ansto.gov.au
Internet Addresses:	Home Page: http://www.ansto.gov.au/ Annual Report http://www.ansto.gov.au/info/annual.html

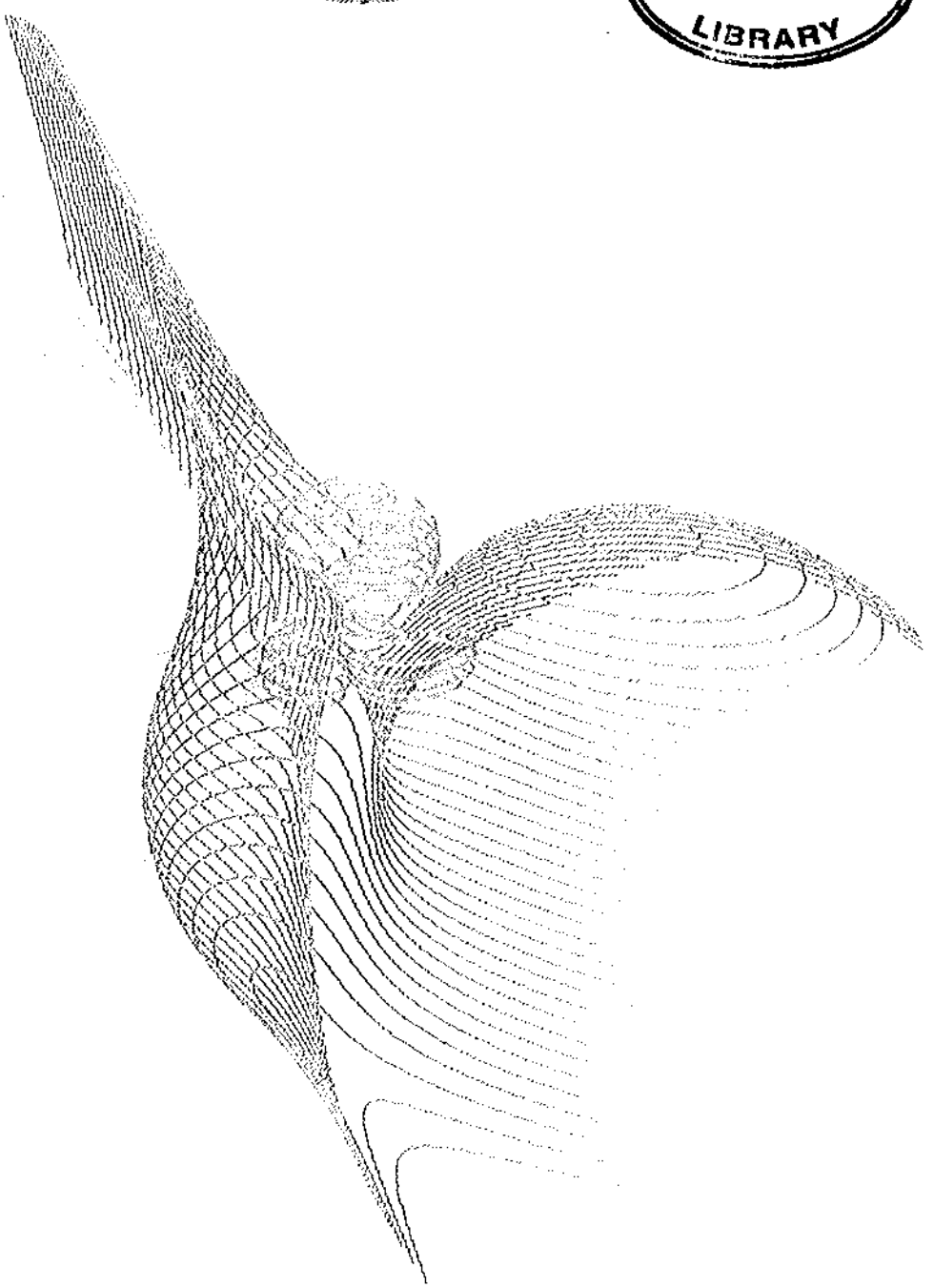
Free guided tours of the ANSTO site and laboratories are available to individuals, groups and schools. For bookings and information, telephone (02) 9717 3168

ANSTO REPRESENTATIVES

CANBERRA	ANSTO Representative Department of Industry, Science and Resources 20 Allara Street Canberra City ACT 2600 Australia
LONDON	Counsellor (Nuclear) Australian High Commission Australia House The Strand London WC2B 4LA United Kingdom
VIENNA	Counsellor (Nuclear) Australian Embassy Mattiellistrasse 2-4 A-1040 Vienna Austria
Washington	Counsellor (Nuclear) Australian Embassy 1601 Massachusetts Ave. NW Washington DC 20036 United States of America

Produced by ANSTO's Government and Public Affairs Division
Photographs by ANSTO photographer Tim Tapsell or staff members, unless otherwise indicated
Printed by Nadley Press, Kirrawee, NSW

ISSN 1031 6655 ISBN 0 642 44911 2



Australian Nuclear Science & Technology Organisation

Annual Report 1999 2000

AUSTRALIAN NUCLEAR SCIENCE
& TECHNOLOGY ORGANISATION

LUCAS HEIGHTS SCIENCE & TECHNOLOGY CENTRE, NEW ILLAWARRA RD LUCAS HEIGHTS, NSW

PRIVATE MAIL BAG 1 MENAI, NSW 2234.
General telephone (61 2) 9717 3111
Facsimile (61 2) 9543 6907

28 September 2000

Senator The Hon. Nick Minchin
Minister for Industry, Science and Resources
Parliament House
CANBERRA ACT 2600

Dear Minister
In accordance with section 9 of the *Commonwealth Authorities and Companies Act 1997*, I am pleased to present the Annual Report of the Australian Nuclear Science and Technology Organisation for the period 1 July 1999 to 30 June 2000.

Yours sincerely

S M Richards
Chairman

ii Chairman's Letter to the Minister
iv Mission
iv Enabling legislation
iv Responsible Minister
iv Location of major activities and facilities
iv Statement of compliance
v Organisation chart
vi Members of the Board
1 Chairman's report
3 Executive Director's report
7 Core business areas
7 International strategic relevance of nuclear science and technology
23 Core nuclear facilities operation and development
41 Nuclear science for environment and sustainability
51 Treatment and management of man-made and naturally occurring radioactive substances
61 Sustainability and international competitiveness of industry
75 Organisational development and support
87 Performance indicator information
91 Safety and environmental protection arrangements at ANSTO facilities
101 Associated organisations
Australian Institute of Nuclear Science and Engineering
107 Financial statements
145 Appendices
145 1. Equality of employment opportunity
146 2. Freedom of information
148 3. Corporate Governance
154 4. Functions and powers of the Organisation under the ANSTO Act
156 5. Status report on the implementation of the conditions arising from the Environmental Impact Assessment of the Replacement Research Reactor
167 6. Index of compliance with reporting guidelines
168 Glossary
170 Index

Mission

ANSTO's mission consists of four components:

- to provide expert scientific and technical advice across the nuclear fuel cycle to government and to support Australia's national strategic and nuclear policy objectives;
- to operate large nuclear science and technology based facilities in Australia and overseas for the benefit of industry and the Australian research and development community, including postgraduate students and staff in higher education;
- to undertake research on specific topics to advance the understanding of nuclear science and the nuclear fuel cycle; and
- to apply resulting technologies and other relevant, unique capabilities to focussed research and development and other scientific activities to increase the competitiveness of Australian industry and improve the quality of life for all Australians.

Enabling legislation

The Australian Nuclear Science and Technology Organisation (ANSTO) is a body corporate established by the *Australian Nuclear Science and Technology Organisation Act 1987*. The functions and general powers of ANSTO are set out in Part 2, Sections 5 and 6 of the Act. See also 'Functions of the Organisation under the ANSTO Act', Appendix 4 of this Report.

Responsible Minister

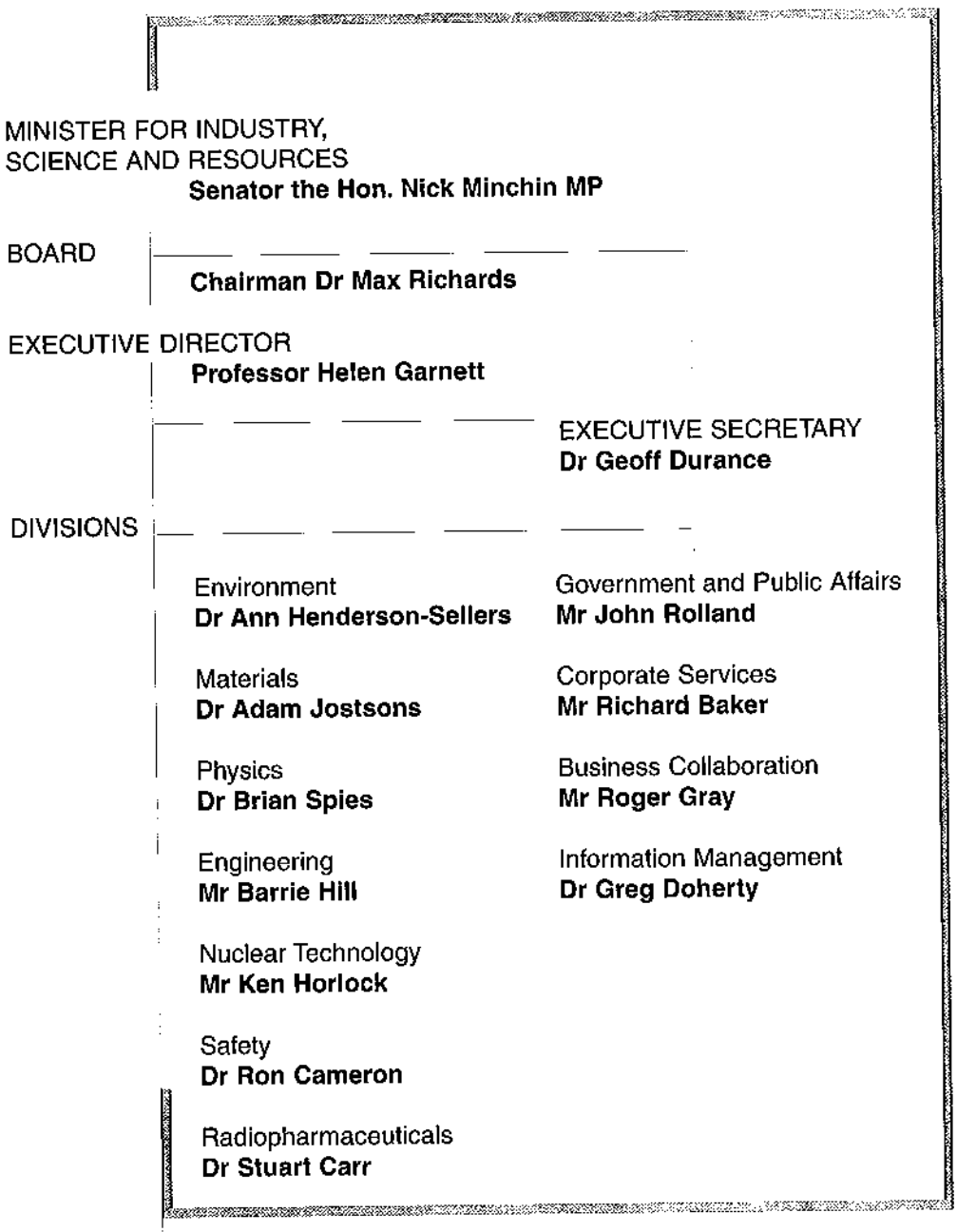
The responsible Minister during the reporting period was Senator the Hon Nick Minchin, Minister for Industry, Science and Resources.

Location of major activities and facilities

ANSTO is located at the Lucas Heights Science and Technology Centre, which is about 40 km south of Sydney city centre. Its major facilities are at this site, and the majority of its activities are carried out there. ANSTO also operates the National Medical Cyclotron, which is located adjacent to the Royal Prince Alfred Hospital, Camperdown, Sydney.

Statement of compliance

This report is written according to the reporting guidelines provided for statutory authorities in Requirements for Departmental Annual Reports, published by the Department of the Prime Minister and Cabinet in 1994 and updated in May 1999. An index of compliance in provided in Appendix 6.


MINISTER FOR INDUSTRY,
SCIENCE AND RESOURCES
Senator the Hon. Nick Minchin MP
BOARD
Chairman Dr Max Richards
EXECUTIVE DIRECTOR
Professor Helen Garnett
EXECUTIVE SECRETARY
Dr Geoff Durance
DIVISIONS
Environment
Dr Ann Henderson-Sellers
Materials
Dr Adam Jostsons
Physics
Dr Brian Spies
Engineering
Mr Barrie Hill
Nuclear Technology
Mr Ken Horlock
Safety
Dr Ron Cameron
Radiopharmaceuticals
Dr Stuart Carr
Government and Public Affairs
Mr John Rolland
Corporate Services
Mr Richard Baker
Business Collaboration
Mr Roger Gray
Information Management
Dr Greg Doherty

Members of the Board
from the top, left to right

Dr Max Richards	Chairman since 1 January 1997. Company director. Appointed on 5 July 1996 until 30 June 2001
Professor Helen Garnett	Executive Director. Member of the Board by virtue of Section 9 (1) of the ANSTO Act. Reappointed 11 May 2000 until 10 May 2005
Associate Professor Fred Khafagi	Nuclear medicine physician. Reappointed on 1 January 2000 until 30 June 2002
Mr John Craker	Appointed on 2 June 1998 until 31 December 2002
Dr Carrie Hillyard	Venture capital partner. Appointed on 21 July 1999 until 21 July 2004
Mr Mike Codd AC	Deputy Chairman since 1 January 1997. Company director. Reappointed on 21 July 1999 until 31 December 2001
Mr John Spasojevic	Deputy Chief Executive Officer, Department of Industry, Science and Resources. Appointed 21 July 1999 until 21 July 2004

This is the 48th Annual Report of ANSTO and its predecessor, the Australian Atomic Energy Commission.

Effective parliamentary appropriation received in 1999-2000 was $80.069 million (1998-99, $78.48 million). This included $3.0 million for the Replacement Research Reactor Project and $9.315 million to fund the removal of HIFAR spent fuel elements. Appropriation for operational and capital expenses for core science and technology activities was $67.754 million, a reduction in real terms compared to the previous year, which impacts significantly on the Organisation's capacity for research and development. This continues a trend that is of increasing concern to the Board.

The Chairman, Dr Max Richards, with the Executive Director, Professor Helen Garnett.

Expenditure on capital equipment and infrastructure was $12.9 million (1998-99, $12.44 million), excluding expenditure on the replacement research reactor. With regard to revenue, ANSTO generated $32.2 million (1998-99, $30.73 million) from external services, representing 30% of total income excluding capital use charge. Approximately half the revenue was derived from radioisotope sales.

Highlights of ANSTO's accomplishments during the year are described below.

- The Replacement Research Reactor project reached the stage where the Argentine company INVAP S.E. was selected as the preferred tenderer for the design, construction, commissioning and demonstration of performance. INVAP's Australian alliance partners are John Holland Construction and Engineering Pty Ltd and Evans Deakin Industries Ltd. The tendering process was independently audited and confirmed to be of the highest standard.

- 308 HIFAR spent fuel elements (approximately 20% of the site inventory) were packaged for safe transport and transferred to COGEMA in France for processing.

- ANSTO's contribution to nuclear waste management through application of its synroc technology took further positive steps during the year with ANSTO partnering COGEMA, Burns and Roe, and Battelle to develop a bid for the design of an immobilisation facility to handle the disposal of excess weapons plutonium in the United States. The outcome of this competitive process is expected to be known in the course of the next financial year

- On-site, intermediate-level radioactive liquid waste from the production of molybdenum-99 is being converted successfully to a highly durable solid waste stored in stainless steel vessels with a design life of at least 50 years.

- ANSTO's expertise in waste management extends to mine products, and it was invited to become a Research Member of the International Network for Acid Prevention (INAP) Ltd. INAP is an industry-based initiative that aims to coordinate research and development in the management of sulphidic mine wastes.

The year has been extraordinarily demanding for ANSTO; it has been handled in an extremely professional manner by all staff. The Board records its appreciation of the leadership and dedication shown by the Executive Director, Professor Helen Garnett.

Dr Max Richards
Chairman

The period from July 1999 to June 2000 has, yet again, been both exciting and challenging. Our most important project is the Replacement Research Reactor Project - important not only for the future of the Organisation but also for the maintenance and development of a range of scientific and technological expertise that will underpin Australia's socio-economic development in the knowledge era. In August 1999 this project received unanimous approval from the bipartisan Public Works Committee.

ANSTO immediately released the Request for Tender to the four prequalified vendors. All vendors, in alliance or partnership with Australian engineering companies, submitted proposals on the closing date of January 3rd, 2000. These proposals were reviewed and evaluated by internal and external experts, culminating in the final recommendation that INVAP SE, in alliance with John Holland Construction and Engineering Pty Ltd and Evans Deakin Industries Limited, be awarded the contract for the detailed engineering design, construction and commissioning of the replacement research reactor at the Lucas Heights Science and Technology Centre. After obtaining all relevant approvals, the contract was signed early in July and marked by a ceremony involving many of the people who had contributed to the process. The tender selection process was audited from start to finish and the relevant audit and review reports posted on ANSTO's website as part of our community advice. As this Annual Report goes to press the project is well underway.

ANSTO staff are to be commended for their professionalism and dedication throughout the replacement research reactor project to date. They have worked tirelessly and met all major milestones under their control. It was heartening to learn that our comprehensive and independently audited consultation program during the environmental assessment phase of the replacement research reactor project was acclaimed by two awards from the Public Relations Institute of Australia.

All of us at ANSTO appreciate the very considerable support and encouragement we have received from government, individuals, companies and professional societies across the science, engineering, medical and policy spectra. We look forward to working with our stakeholders to ensure that the scientific instruments developed for the various beamlines on the reactor are capable of delivering world class outcomes.

During the past year current ANSTO's core nuclear facilities have been in strong demand. Staff and students from universities across Australia have accessed the facilities through AINSE, there being around 160 AINSE-supported university projects in the past year. ANSTO staff not only facilitate the execution of these projects but also undertake research to underpin other important elements of ANSTO's mission. Such projects are frequently carried out in collaboration with national and international teaming partners.

Some of the highlights from the list of outcomes reported in this Annual Report include:

Knowledge development – exciting science and technology

- ANSTO scientists were amongst the first to accurately determine the contribution of fossil fuel to the global atmospheric methane budget, methane being second in importance only to carbon dioxide as a greenhouse gas.
- Technology developed by ANSTO, under the auspices of the CRC for Waste Management and Pollution Control, for removing arsenic from water without employing strong chemical oxidants was successfully demonstrated in the western United States, where new regulations will require dramatically lower arsenic levels in drinking water.
- A provisional patent was lodged for the use of sol-gel matrices for the encapsulation and controlled-release of pharmaceuticals. A research partnership involving the University of Sydney and the Sydney Cancer Centre has subsequently been established to facilitate pre-clinical studies of the suitability of the technology as a targeted delivery system for tumour treatments.

Knowledge application – effective solutions

- ANSTO's know-how and radiotracer capability was used to reveal the mixing patterns for sewage effluent flowing into Victoria Harbour in Hong Kong under different tidal conditions and to determine the patterns of sediment transport at the Port of Songkhla in Thailand. These were just two examples of radiotracers providing solutions to environmental problems.
- The technical viability of a major new rare earth deposit was enhanced through the development by ANSTO of processes to remove thorium and other naturally occurring radioactive materials.
- ANSTO has developed new cover design strategies to control pollution generation in sulfidic mine waste piles at several mines including the site of PT Kaltim Prima Coal, one of the world's biggest coal mines. This work was assisted by the computational tool SWIM^{HEAPCOV}, which was developed jointly by ANSTO and CSIRO. Monitoring the effectiveness of these cover strategies will provide an important case study for the management of sulfidic wastes in the tropics.
- A total of 1812 litres of intermediate-level liquid waste from historical radiopharmaceutical processing operations were removed from storage and solidified using an ANSTO-developed process. This has resulted in a more than fifty-fold reduction in the waste mass.

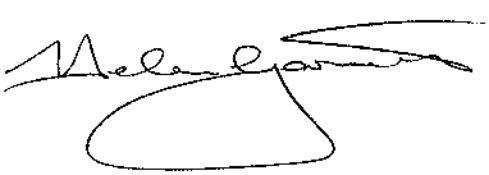
Business development – value from ANSTO's intellectual property in focused areas

- The choice of an ANSTO-developed titanate ceramic as the material of choice for immobilising US surplus weapons plutonium led to ANSTO being involved, through COGEMA-ANSTO LLC, with the US engineering group, Burns and Roe, and the Battelle Memorial Institute in preparing a proposal to the US Department of Energy for the design of the Plutonium Immobilisation Facility scheduled for construction at Savannah River.
- An ANSTO-developed dry-bed technetium generator, Gentech®, was commercially released in February. The new generator yields a number of benefits including more efficient labelling of tracer molecules and improved radiation and occupational safety. This will augment ANSTO's provision of radiopharmaceutical services, more than 435,000 patient doses being supplied during the year for therapy and diagnosis.
- The release by ANSTO of Quadramet, a samarium-based radiopharmaceutical, is improving palliative care for cancer sufferers and the treatment of bone marrow cancer patients.

Organisational development - the learning Organisation

- The results of ANSTO's environmental monitoring program again showed that the Organisation was in full compliance with all relevant regulations and guidelines and that operations at Lucas Heights had no adverse effect on the safety and environment of the community during the year. Controls, monitoring and assessment ensured that off-site exposures from airborne emissions from ANSTO were less that 1% of the public dose limit. Notwithstanding its consistent attention to health, safety and environmental issues, ANSTO has initiated a new project, Environmental Management Action Plan (EMAP), to review current practices and implement forward-looking environmental management systems accredited to the International Standards Organisation (ISO) 14001.
- A project to develop a flexible competency-based human resource framework for the Organisation continued. Management and core competencies were defined and, although still in draft form, have been incorporated into the recruitment process, adding further transparency and rigour.
- A major initiative during the year was the introduction of the Learning Environment for New Strategies (LENS) Program. Phase 1 of this teamwork and cultural change training program was trialed with 150 staff from across the Organisation. The program has strong support and is already contributing to the ongoing learning and continual improvement program within ANSTO.

During the year ANSTO contributed to Working Groups for the Innovation Summit and the Summit itself and made a submission to the Science Capability Review. ANSTO is currently involved in a Pricing Review with the Department of Finance and Administration. It is hoped that the outcome of these various processes may lead to a reverse of funding trends, with adequate investment for ANSTO to develop knowledge and know-how and contribute, through the innovation cycle, to Australia's economic development. We believe, like many, that investment in basic, strategic and tactical research and development as well as investment in world class infrastructure is essential to underpin Australia's future. With adequate Government support, ANSTO can and will continue to add value through its research and development activities, its services and business developments.



Professor Helen Garnett
Executive Director

ANSTO's Chairman, Dr Max Richards (left), with Executive Director, Professor Helen Garnett and IAEA Director-General His Excellency Dr Mohamed ElBaradei.

International strategic relevance of nuclear science and technology

Driver: Government

OBJECTIVES *To provide government with quality scientific and technical advice on the nuclear fuel cycle, including reactor operations, reactor safety and the safeguarding of nuclear materials, and to take a leading role in promoting the implementation of appropriate nuclear-related guidelines and practices nationally and internationally.*

To make significant contributions to international research and development in selected nuclear fields commensurate with the Government's nuclear non-proliferation and other nuclear-related interests associated with the nuclear fuel cycle, and to be recognised as an international leader in the application of knowledge in these fields.

To ensure effective dialogue with the community on the intent and outcomes of ANSTO's activities.

OUTCOMES

- ANSTO's broadly based multidisciplinary nuclear expertise continued to underpin Australia's influence in international initiatives and fora addressing nuclear non-proliferation and nuclear safety.

- ANSTO's active program of participation in international expert and policy review meetings, training activities and missions contributed to Australia playing an influential and respected role in relation to International Atomic Energy Agency (IAEA) and regional nuclear issues.

- ANSTO's role as the designated lead country coordinating the IAEA RCA project "Managing the marine coastal environment and its pollution" enabled the effective pursuit of a number of regional nuclear-related activities associated with studies of the fate and behaviour of contaminants and sediments in the coastal zone.

- ANSTO continued to act as a proving ground for the IAEA Department of Safeguards in implementing new procedures and technologies to reduce the possibility of nuclear proliferation. This included short notice inspections of various buildings on site, plans for the installation of power monitors in the HIFAR reactor and smear tests of laboratories to confirm the accuracy of the historical activities on site as declared by ANSTO.

- ANSTO's research and expertise in the application of accelerator mass spectrometry (AMS) to advance nuclear safeguards techniques provided support to the Australian Government's continuing commitment to strategies that will strengthen the international nuclear safeguards system.

- ANSTO's role as the lead country in the Regional Cooperative Agreement project in radiation protection enabled it to play a major role in the development and implementation of a range of activities that strengthened radiation protection infrastructures in regional centres.

- ANSTO's expertise and leadership in safety culture in the region was recognised by the IAEA through an invitation to help organise and provide a key lecturer at the first IAEA workshop on Safety Culture in Research Reactors, which was held in Budapest in April.

- Public access to information on a wide range of ANSTO's activities, including the tender process for the replacement research reactor, was facilitated through the ongoing development of its Home Page. The Home Page also provided public and internal access to the ANSTO Library's comprehensive electronic information services. The use of ANSTO's Home Page, as measured by the number of external hits, increased by 42% over the previous year.

- The high quality of ANSTO's community consultation activities during the environmental assessment of the replacement reactor was recognised by two awards by the Public Relations Institute of Australia. This comprehensive and independently audited consultation program included community mailouts, a 1800 hotline, community meetings, site tours, displays, and regular public reports.

ACTIVITIES AND OUTPUTS

Services to the Australian Government and other national stakeholders

ANSTO continued to provide information on a range of nuclear issues to government departments and agencies, other organisations, the media and members of the public. Information requested included details of nuclear power programs and electricity production, nuclear research and fuel cycle facilities, and background information related to topical events such as the first shipment from the United Kingdom of mixed uranium-plutonium fuel to Japan, the criticality accident in Japan and the accident in Thailand involving a radioactive source. ANSTO officers also prepared briefing papers for the annual bilateral nuclear consultations Australia held with Japan and the Republic of Korea.

ANSTO's Power Reactor Status Summary, available to the public on the organisation's Internet website, was regularly updated to reflect changes to the numbers of reactors being brought into, or retired from, operation, construction starts, orders placed and announced plans for new reactors. Nuclear power continued to be a major source of the world's electricity. At the end of 1999, sixteen countries, including Japan and the Republic of Korea, were using nuclear power to generate more than 30% of their total electricity. In Europe, nuclear power output increased by 3%, despite the closure of one of Sweden's reactors. In March, for the first time, the operating licence for a commercial nuclear power station in the United States was extended for twenty years. In 1999-2000, four power reactors were connected to the grid, one each in France and the Slovak Republic, completing the current power reactor construction programs in those countries, and two in India. Pakistan's second power reactor achieved initial criticality. Major construction began on six power reactors during the year - two Russian-supplied pressurised water reactors in China, two Korean Standard Nuclear Power Plants in the Republic of Korea, and two pressurised heavy water reactors in India. One reactor order was placed: the multinational Korea Peninsula Energy Development Organisation signed a US$4.6 billion final contract with the Korea Electric Power Corporation to supply two Korean Standard Nuclear Power Plants to North Korea.

During the year, ANSTO also provided reports to Government on nuclear-related accidents around the world. One report involved a criticality accident at the JCO Co uranium fuel processing plant at Tokai in Japan. The three JCO workers in the building at the time criticality was reached suffered acute radiation syndrome. The cause of the accident was the deliberate violation of proper procedures by the exposed workers. Two of the workers subsequently died. They were the first people to die of radiation

exposure in more than forty years of nuclear research and development in Japan. ANSTO does not operate such fuel processing facilities at Lucas Heights.

Cooperative research to enhance the safety of nuclear facilities and safeguards for nuclear materials

Results of research into new methods to strengthen the international nuclear safeguards system were reported to the IAEA, the Australian Safeguards and Non-proliferation Office (ASNO) and the scientific community. Through ultra-sensitive analysis of environmental samples such as soil, water and aerosols taken from within or around nuclear installations, the nature of the processes carried out at the installation can be deduced and compared with that expected from its declared functions. The use of accelerator mass spectrometry (AMS) for these analyses was investigated and the usefulness of measurements of the very rare radioisotope uranium-236, a signature of irradiated uranium, demonstrated. Low concentrations of uranium-236 were measured for the first time in samples containing uranium at trace (one part per million) levels. Plutonium and the fission product iodine-129 were also measured by AMS at ultra-trace levels in environmental samples.

As part of its local safety culture project, ANSTO conducted safety culture surveys of its staff and had the results analysed by consultants from the University of NSW. The results provided detailed information on the level of safety culture implementation and understanding at ANSTO. This information was then used in developing a series of safety culture awareness sessions, both for new staff and for staff undergoing refresher training. A shorter questionnaire, based on various IAEA reports, was also developed and completed by all workplace safety committees. This enabled a better understanding of the implementation of safety culture at the workplace level and indicated several areas for follow-up, particularly regarding lines of communication.

A third project concerned the development of ANSTO's RadCon code, a software program designed to help scientists assess the radiological consequences to particular groups of people of an accidental release of radionuclides to the atmosphere in the Australian and South East Asian region. RadCon also makes it possible to identify the effects of factors such as soil-to-crop transfer, crop-to-animal transfer and food processing, thus highlighting the factors that have a greater impact on the final dose. The model is capable of handling a wide range of variables and can be used in climate zones ranging from temperate to tropical. A senior scientist attended the IAEA Biosphere Modelling and Assessment (BIOMASS) workshop in Vienna, in October, to evaluate the performance of various radiological consequences codes, including RadCon, in estimating caesium-137 uptake by plants, animals and people in an area contaminated by the Chernobyl accident of 1986. The results of this intercomparison workshop will be published in an IAEA technical document.

International Atomic Energy Agency activities

The International Atomic Energy Agency (IAEA) is the world's main intergovernmental forum for nuclear scientific and technical cooperation. In its current Medium Term Strategy, it has described its activities under three headings: nuclear non-proliferation safeguards; nuclear safety; and making available the benefits of nuclear science and technology.

The IAEA continued to invite ANSTO staff to participate in its Program Performance Appraisal System, which reviews IAEA programs. A senior ANSTO staff member served as a rapporteur for the evaluation of IAEA activities relating to research reactors and low energy accelerators. This evaluation covered the activities of several IAEA departments dealing with facility utilisation, fuel and waste management and safety.

The Executive Director was appointed as an inaugural member of the Agency's Standing Advisory Group for Nuclear Applications (SAGNA). This Group, which held its first meeting in June, advises the IAEA Director General on the Agency's activities in the application of nuclear technologies carried out in the programs of food and agriculture, human health, marine environment, water resources and industry, and physical and chemical sciences. The Director, Government and Public Affairs, is serving a second term as member of the Standing Advisory Group on Technical Assistance and Co-operation (SAGTAC), which provides advice to the IAEA Director-General on the Agency's Technical Cooperation Program.

ANSTO maintains a broad technical interaction with the IAEA, which is facilitated through membership of various IAEA committees. The Director, Materials, chaired the Fourth IAEA International Radioactive Waste Technology Advisory Committee (WATAC) in Vienna in September. Eight ANSTO scientists participated in IAEA consultants' meetings during the year. In March, an ANSTO officer chaired the first Open-ended Meeting of Technical and Legal Experts to undertake exploratory discussions on an international Code of Conduct on the Safety of Radiation Sources and the Security of Radioactive Material. That group will meet again in July to finalise the Code. The same officer also chaired a technical session of the International Conference on the Safety of Radioactive Waste Management, held in Spain in March.

The safety of research reactors is a growing field of interest for the IAEA. ANSTO participated in and presented eight papers at the IAEA International Symposium on Research Reactor Utilisation, Safety and Management held in Lisbon in November. ANSTO was asked to help organise and provide a key lecturer for the first IAEA workshop on Safety Culture in Research Reactors, which was held in Budapest in April. This course was conducted under the European Regional Program and was attended by 29 participants from 13 countries: Belarus, Bulgaria, Czech Republic, Georgia, Hungary, Kazakhstan, Latvia, Poland, Portugal, Romania, Russian Federation, Ukraine and Uzbekistan.

ANSTO staff participated in Advisory Group Meetings preparing documentation for the IAEA Safety Guide "Building competence in radiation protection and the safe use of radiation sources" and the Safety Report "Training in radiation protection and the safe use of radiation sources".

ANSTO scientists continued to participate in five ongoing IAEA Coordinated Research Programs (CRPs). As its contribution to the CRP on "The classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants", ANSTO, in collaboration with the Northern Territory Department of Primary Industry, planted

various food crops at the Douglas-Daly research station near Darwin. The uptake of radionuclides of caesium, strontium and zinc will be measured over several growing seasons in the oxidised soils of this region. ANSTO is also involved in an inter-laboratory comparison of standard materials to ensure that participating nations produce high quality and consistent data.

As part of the CRP on "Improvement of safety assessment methodologies for near-surface disposal facilities for radioactive waste", ANSTO reviewed quality assurance procedures used in near-surface waste repositories around the world.

Three other CRPs also concerned radioactive waste management: "Chemical durability and performance assessment of spent fuel and high level waste forms under simulated repository conditions"; "Ageing of materials in spent fuel storage facilities"; and "Treatment of liquid effluent from uranium mines and mills during and after operation (post decommissioning /rehabilitation)". Officers also began working on a sixth CRP, "To update and expand the IAEA reliability data for research reactor probabilistic safety assessment", launched during the year.

Australia assists the IAEA's Technical Cooperation Program by hosting training courses, placing IAEA fellows at suitable venues to receive specialist training and providing specialists for lecturing and expert assignments. Of the five IAEA training events hosted by Australia during the year, three were undertaken at ANSTO.

An IAEA expert mission was undertaken in Thailand to advise on meteorological and radiological monitoring programs associated with the new nuclear research centre at Ongharak. The concepts of ISO 14001 were introduced and Thai Office of Atomic Energy for Peace (OAEP) personnel displayed great enthusiasm for acquiring this knowledge and implementing an effective environmental management and monitoring system.

ANSTO and OAEP experts undertook an expert mission in the Philippines to demonstrate industrial column-scanning technology used to identify malfunctions of petroleum distillation columns during operation. A mission was also sent to Malaysia, to advise on an off-shore modelling problem and validation associated with a conventional power station, and to Indonesia to assist with remaining-life studies.

ANSTO coordinates the placement and management of all IAEA fellowship holders undergoing training in Australia. During the year, 50 fellowship applications were considered; 26 were placed and 14 were deferred to the next financial year. Ten applicants were not accepted for training at the Australian institute they nominated. ANSTO hosted IAEA Fellows from Brazil, China, Kazakstan, the Republic of Korea, Mongolia, the Philippines, Thailand, Vietnam and Yemen.

ANSTO continued to act as a national centre for distributing information through the IAEA's International Nuclear Information System (INIS), with 1300 new Australian documents being indexed and abstracted. The INIS database captures all relevant

Australian publications pertaining to the peaceful application of isotopes and nuclear techniques across all scientific disciplines and now contains over 34 000 documents authored by Australian scientists or published in Australia and over two million records in total. During the year, the database was made available via the Internet to all ANSTO and CSIRO staff at the Lucas Heights site. ANSTO's library assumed responsibility for document delivery services within Australia of the INIS scientific and technical reports included in the database since 1997. This material is not readily available through normal commercial channels.

ANSTO worked with the Thai Office of Atomic Energy for Peace, the Thai Harbour Authority, the Prince of Songkhla University and the Unisearch Water Research Laboratory in a study of sediment migration at the Port of Songkhla, Thailand. This IAEA-funded study is also part of a regional training program designed to demonstrate the role of tracers in validating numerical computer codes for predicting the off-shore transport of sediments. Model outputs can be used to plan dredging activities and other aspects of port development. ANSTO continued to make field electronic systems for measuring radioactivity available to the IAEA under commercial arrangements.

IAEA Regional Cooperative Agreement activities

Australia has been a member of the IAEA Regional Cooperative Agreement (RCA) for Research, Development and Training Related to Nuclear Science and Technology since 1977. The objective of the RCA program, which embraces 17 countries in the Asia Pacific region, is to promote and coordinate cooperative research, development and training projects in nuclear science and technology.

John Rolland is the Director of ANSTO's Government and Public Affairs Division.

Australia participates actively in RCA activities to reinforce its commitment to provide the benefits of nuclear science and technology to other countries consistent with its obligations under the Nuclear Non-Proliferation Treaty.

The Director, Government and Public Affairs, is the National RCA Representative and attended the RCA General Conference meeting in Vienna in September and the RCA Meeting of National Representatives in India in February/March. At both meetings Australia continued to take a leading role with initiatives and proposals to achieve increased self-reliance among Member States. These reforms will further strengthen RCA regional management and decision-making arrangements, and reflect the growing maturity of the program. The Director, Government and Public Affairs, also participated in the tripartite meeting for the regional agreements for the Asia Pacific region, Africa and Latin America, which was held in Vienna in September.

The Director, Safety, is chair of the Coordination Group that is providing regional management of Phase 3 activities of an RCA program in radiation protection over the period 1998-2002. He chaired and represented Australia at the mid-term review meeting held in Bali in February. Australia is the lead country for radiation protection within the Regional Cooperative Agreement. A proposal by Australia for additional evaluation and review activities was accepted by the IAEA and later implemented. The program involves 16 of the 17 member countries of the RCA.

Over the past 20 years, Australia has provided substantial financial and technical contributions to support its RCA membership and has actively participated in the development and management of the RCA program through the formal National RCA Representative and National Coordinators' networks. In June, Australia completed its current commitment of providing A$1.663 million over three years to support the RCA through a project entitled "The application of radioisotope technology to sustainable development in Asia and the Pacific". This brings Australia's total extrabudgetary direct financial contribution provided through AusAID to the RCA to around $5 million.

The Australian-funded project has three sub-projects. The first "Managing the marine coastal environment and its pollution", is coordinated by ANSTO in conjunction with the Unisearch Water Research Laboratory and involves 14 countries in the Asia Pacific region. Launched in 1998, the project aims to develop a marine radioactivity database for the region, build a capability within RCA countries for investigating off-shore pollution, model off-shore contaminant and sediment transport and address concerns about harmful algal blooms. During the year, regional training and demonstration activities were held in Thailand (2), Pakistan, the Philippines (2), India and Australia. In July, ANSTO and the University of Tasmania hosted a regional training workshop on "Sedimentation and algal cyst studies".

The second sub-project is contributing to the safe application of nuclear technologies and helping to strengthen national radiation protection infrastructure in the region. The third is concerned with the training of nuclear medicine technologists. In October, as part of the second sub-project, ANSTO organised and conducted an IAEA/RCA Regional Workshop, "Participation in a research reactor emergency response exercise", which was timed to coincide with a HIFAR emergency exercise. Thirteen participants from eight countries attended. In December an IAEA/RCA external dosimetry intercomparison, in which ANSTO has participated, was finalised at an Expert Advisory Group Meeting in Mumbai, India. Discussions at the meeting confirmed the effectiveness and accuracy of ANSTO's dosimetry system for measuring personnel exposure.

ANSTO staff played a leading role in lecturing and safety inspections for the IAEA/RCA regional training course on Radiation Safety in Industrial Radiography, which was held in Indonesia. Expert missions on radiation protection were undertaken to Mongolia, and on environmental monitoring to Thailand.

ANSTO staff member Celia Hacker (standing) works with Professor Eun Joo Hahn from Korea on distance learning material.

ANSTO staff continued to review and trial a range of distance learning material on radiation protection. Trials and student evaluation seminars were conducted in Australia, Indonesia, the Republic of Korea, Mongolia, New Zealand, the Philippines and Thailand. A country supervisors' evaluation meeting was held in Sydney in November and as a result of the enthusiasm shown by students and supervisors, the trials were extended. Translation of the material into local languages is planned.

ANSTO circulated within the region an IAEA/RCA questionnaire on naturally occurring radioactive material (NORM) and subsequently provided information on industries where NORM is a significant issue. This information will be used to develop radiation protection guidelines for use in the region by industries handling such material.

In July 1999 a senior ANSTO officer and the Counsellor (Nuclear) attended a meeting of RCA lead countries in Vienna to review and revise the work program for a major joint UNDP/RCA/IAEA project entitled "Better management of the environment, natural resources and industrial growth through isotopes and radiation technology". An ANSTO officer was selected by UNDP to lead the team undertaking the mid-term review of this project.

Regional Nuclear Cooperation in Asia

Australia has been an active participant in the restructuring of the activities and management of the regional nuclear cooperation being conducted under the Forum for Nuclear Cooperation in Asia (FNCA), which evolved from the International Conference for Nuclear Cooperation in Asia (ICNCA) following the tenth ICNCA in 1999. The other members are Indonesia, Japan, China, the Republic of Korea, Malaysia, the Philippines, Thailand and Vietnam, all of whom are signatories to the Nuclear Non-Proliferation Treaty.

The first Coordinators' Meeting under the Forum was held in Tokyo in March. The Australian delegation was led by ANSTO's Executive Director. All nine participating FNCA countries attended. The meeting reviewed progress in the FNCA's seven active Regional Nuclear Cooperation in Asia (RNCA) project areas and discussed and approved recommendations for a rolling workshop program for the next three years. They agreed on the importance of cooperative activities for developing basic infrastructure in nuclear science and technology.

ANSTO initiated, and is the lead agency for, the RNCA project on Nuclear Safety Culture. This is focused on an annual workshop attended by all countries at which indicators of safety culture in each country are assessed and the country's safety culture activities described. ANSTO conducted the third annual regional workshop in Malaysia, at which four countries presented the results of an ANSTO-developed safety culture questionnaire that the countries had used to assess their research reactors.

ANSTO representatives also met with Japanese nuclear experts to formulate a three-year plan and a ten-year vision for the FNCA Safety Culture Project, both of which were accepted by the FNCA members.

ANSTO staff also participated in FNCA Workshops on Public Acceptance, held in Tokyo in October; Radioactive Waste Management, held in the Philippines in November; and Utilisation of Research Reactors, held in Mito City, Japan, in December. All workshops involved discussions and formulation of proposals for the future three-year program, and the meeting reports were tabled at the first Coordination Meeting. Planning work began for the next Australian supported workshop on nuclear safety culture, which will be held in China in September 2000.

OECD Nuclear Energy Agency activities

The Organisation for Economic Cooperation and Development (OECD) has a relatively homogeneous membership comprising industrialised countries with shared democratic principles and free-market economies. Participation in the activities of the OECD's Nuclear Energy Agency (NEA) enables ANSTO to keep abreast of current trends and developments in this technologically advanced community. ANSTO has direct access to the OECD document database in Paris and contributes to OECD/NEA programs on nuclear safety, radiation protection and public health, nuclear science and radioactive waste management. ANSTO's Counsellor (Nuclear) London regularly participates in meetings of the NEA Steering Committee and various NEA Standing Technical Committees.

The Secretary-General of the OECD has identified nuclear energy as an option for dealing with problems of climate change and sustainable development. The NEA is placing increasing emphasis on the need for the nuclear industry to interact with the community - work that ANSTO is following with interest. The NEA is also continuing its program for enhancing cooperation, particularly in nuclear safety, with non-member states in central and eastern Europe. The NEA continued with its task of implementing the widespread changes to its structure discussed in last year's report.

ANSTO staff members continued to participate in NEA activities. During the year one officer was a member of a technical team assessing and selecting measured values of chemical thermodynamic constants for radionuclides of relevance to radioactive waste disposal. Another was a member of a small technical direction team for the Sorption Forum, conducted under the aegis of the NEA's Nuclear Science Committee. The Forum is examining the applicability of different types of chemical models for the movement of radioactive substances in the sub-surface environment. Through these activities, ANSTO continued to contribute to the scientific understanding of the migration of contaminants in the environment. An ANSTO officer was also a member of a working party on "Beneficial uses of radioisotopes".

Bilateral cooperation

In November, as part of the ninth round of the Australia-Republic of Korea Nuclear Policy Consultations, a meeting was held at ANSTO to review the implementation of technical cooperation activities between the Republic of Korea and Australia. This meeting involved representatives from ANSTO, the Korea Atomic Energy Research

Institute, the Korean Institute of Nuclear Safety, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the Australian Safeguards and Non-proliferation Office (ASNO).

The Chairman of the Indonesian National Atomic Energy Agency (BATAN), Dr Iyos Subki, visited ANSTO in late February to discuss bilateral cooperation. In March a BATAN engineer received four weeks training on reactor in-service inspection during the HIFAR extended maintenance shutdown.

The Chairman of the Vietnamese Atomic Energy Commission, Professor Tran Huu Phat, and its Director, Internal Relations and Planning, Dr Dang Thanh Luong, visited ANSTO in November as part of an IAEA scientific visit concerned with upgrading radiation protection infrastructure.

Australia is party to a number of other bilateral cooperative arrangements, including ones with nuclear and scientific institutes in France, Japan, China, Russia, the United States and the United Kingdom. The arrangements include cooperative projects with institutions in the United States and France that involve research and development of waste management technologies.

ANSTO took part in a delegation attending a high level strategic forum in Jakarta on the topic of mining and mine site rehabilitation. The forum was held under the terms of a bilateral agreement for scientific cooperation between Australia and Indonesia. ANSTO provided expertise in the management of mine wastes.

Further meetings were held in Washington DC with the US Department of Energy (USDEO) to progress a proposal for an inter-agency agreement between ANSTO and the USDOE.

External representation

ANSTO continued to maintain specialised overseas representation through three Counsellor (Nuclear) posts located in the Australian diplomatic missions in Vienna, London and Washington DC. These posts facilitate technical contacts with the IAEA and OECD/NEA and provide essential links between ANSTO and those geographical regions most active in nuclear science and technology. ANSTO also retains a Canberra Liaison Officer position to facilitate contacts with Canberra departments and agencies.

Symposium on the Scientific Basis for Nuclear Waste Management

ANSTO officers began organising the 24th Symposium on the Scientific Basis for Nuclear Waste Management, to be held in Sydney in August 2000. Conference sessions will cover a wide range of waste issues, including materials for encapsulating waste, waste conditioning, engineered barriers; repository studies; performance assessment, migration, and natural system studies. After the conference, delegates representing France, Japan, Russia, China, Czech Republic, France, Korea, Slovakia, and Spain will attend an IAEA Co-ordinated Research Project (CRP) meeting on the performance of spent fuel and other high level waste forms under repository conditions. This meeting is being organised and chaired by ANSTO.

Nuclear-powered warship visits

ANSTO continued to provide operational health physics support and technical advice to the States and Commonwealth for visits of nuclear-powered warships (NPWs) to Australian ports. This year there were 12 such visits to Brisbane, Gladstone, Hobart and Perth. ANSTO provided radiation monitoring and a 24-hour on-call emergency response service for the duration of each visit and provided training for State and Commonwealth emergency personnel at three of the ports.

Field trials of ANSTO's new Nuclear Powered Warship Early Warning System were carried out in Sydney and Brisbane. The new system is expected to become fully operational in the coming year.

ANSTO staff participated in three Visiting Ships Panel (Nuclear) (VSP(N)) meetings. The VSP(N) Committee carried out a revalidation of the Port Brisbane safety plan for NPW visits.

Epidemiological study on the effects of low doses of ionising radiation

ANSTO continued to participate in an international study of cancer risk among radiation workers in the nuclear industry. The study, which commenced in 1995, is being undertaken by the International Agency for Research on Cancer (IARC), Lyon, France. Australian input has been prepared by the University of New South Wales (UNSW) and was submitted to IARC in November. The data are also being analysed by UNSW as the basis for a local study.

Nuclear safeguards

The Australian Safeguards and Non-Proliferation Office (ASNO) continued to conduct monthly audits of ANSTO's holdings of nuclear materials. International Atomic Energy Agency (IAEA) safeguards inspectors, together with ASNO inspectors, conducted routine quarterly inspections to verify ANSTO's nuclear materials.

Australia, through ANSTO, continued to take a leading role in the implementation of strengthened safeguards under the IAEA's 93+2 Program. As part of this program ANSTO was asked to provide the IAEA with "Complementary Access" to two buildings on site, where environmental samples were taken by the IAEA with two hours notice for the purpose of verifying the absence of undeclared nuclear material or activities. ANSTO complied with these requests well within the required two-hour period. All results reported to ANSTO of complementary access inspections were satisfactory. Such inspections assisted in demonstrating the efficacy of the new, strengthened international safeguards approach by showing that these types of inspections can be accommodated without undue disruption to normal operational activities.

Work began on revising ANSTO's manual on Accounting and Control Procedures for Safeguarding Nuclear Material and Associated Materials. The roles, responsibilities and training needs of Authorised Officers and improved audit trails for nuclear materials accountancy and control form part of this review.

A Regional Training Course on National Safeguards Systems, commonly referred to as a SSAC (State System of Accounting and Control) course, was held at ANSTO from 27 March to 5 April. The course was run jointly by the IAEA and ASNO, with

assistance from ANSTO. Around 30 participants from the Asia Pacific area attended the course, with lectures being given by the IAEA, ASNO and ANSTO.

Communications

In keeping with the general trend towards providing information via the Internet, ANSTO's Home Page was further developed as a key interactive communications mechanism. The Home Page, which is at http://www.ansto.gov.au/, provides public access to information on a wide range of ANSTO's activities, including the tender process for the replacement research reactor. It also provides public and internal access to ANSTO Library's comprehensive electronic and other information services. ANSTO also maintains the Australian Institute of Nuclear Science and Engineering (AINSE) Home Page, which facilitates electronic submission of grant applications.

Staff use of ANSTO's internal web service, or Intranet, as an interactive information instrument was enhanced through increased use of electronic information circulars, staff briefings, online forms and so on. Internet-based internal file management and information systems were also progressively introduced.

Consisting of an internal server protected by a firewall and an external server, ANSTO's Home Page contains approximately 2,600 files, of which 500 are accessible externally. It received approximately 47,000 external hits, an increase of 42% over the previous year.

One of the conditions of the environmental approval for the replacement reactor is that ANSTO must develop a specific program for ongoing community consultation and dissemination of information during the design, construction and commissioning phases of the reactor, to the satisfaction of the Minister for the Environment and Heritage. To address this condition, ANSTO's community liaison program continued to be updated as the project moved ahead in identifying the preferred tenderer for the replacement research reactor.

Another condition was that ANSTO should place high priority on finalising a Community Right to Know Charter. To facilitate this, ANSTO engaged a respected and experienced mediator, Mr John Woodward. Mr Woodward devoted considerable time and effort to the task of achieving an agreed resolution on the Charter but, despite his efforts, final agreement was not possible. As Mr Woodward said in his report in May, the stumbling block was disagreement on the extent of information to be provided under a Charter. Community members argued that the Charter should require ANSTO to provide additional information that would not be available to the public under the *Freedom of Information Act 1982*. Such information could be relevant to national security and Australia's relations with other countries, or be particularly sensitive in some other way. If ANSTO were to agree to the inclusion of such a provision, other government departments would not be able to trust the organisation to keep such information secure. ANSTO could not, therefore, agree to its inclusion. ANSTO regrets that agreement on a Community Right to Know Charter was not achievable. However, much of the content of the proposed charter - including time-lines for responses to

inquiries and provisions for periodic review - was incorporated last year into ANSTO's Service Charter.

ANSTO's media activities continued to aim at achieving balanced and proactive reporting of the organisation's achievements and issues. Particular attention was given to providing information to the national and international press, science magazines and journalists, and popular magazines, in addition to community press and radio. Regular media information including releases and updates, a monthly news column, "What I do at ANSTO", and advertorial information, supported the aim. Three editions of ANSTO update, a newsletter-style handout describing science and technology work carried out by the organisation, were published.

In June the Minister for Industry, Science and Resources and ANSTO's Executive Director announced at a media conference in Parliament House, Canberra, that the preferred tenderer for the replacement research reactor was an Argentine company, INVAP S.E. Media coverage was extensive. Media kits and question-and-answer information was provided, and information was posted on the ANSTO website.

Dr. Ross Jeffree with a lifesize model of a famous, now deceased, crocodile, Sweetheart, which was a major attraction at ANSTO's Royal Easter Show exhibit. ANSTO scientists are studying the metal content of the real Sweetheart's osteoderms.

Exhibitions and displays provide practical opportunities for the public to learn about the work, research and technical applications of ANSTO technology. Most importantly, visitors are able to meet with scientists and specialists, ask questions and learn more about the organisation's work.

The success of ANSTO's exhibit at the Sydney Royal Easter Show in 1999 encouraged the organisation to exhibit again. Staffed by volunteers from across the organisation, the exhibit showed a broad range of ANSTO's science and technology applications. A mock gamma camera, which produced sample head, chest and abdominal scans, again proved most popular and attracted long queues. Similar themes and information were displayed at the Australian Science Festival in Canberra and the SciFest in Sydney. Staff also began preparing for an exhibition at a local Home Show in July 2000.

These temporary exhibitions are an extension of ANSTO's permanent display in its Reception Centre. With a strongly interactive focus the centre includes computer-based quizzes, a demonstration of radiation half-life, the previously described simulated gamma camera, a display showing the radioactivity of everyday items and a cutaway Van De Graaf accelerator. The display was upgraded continually during the year, providing fresh insight into ANSTO's activities for visitors to Lucas Heights.

The Reception Centre is also the meeting area for ANSTO's public tours, an initiative hosting some 4000 people each year. The three-hour tours, which include a visit to HIFAR, are free of charge and led by experienced professionals. They are popular with schools, special interest groups, community groups and overseas tourists.

The Director of Physics Division, Dr Brian Spies (left), with IAEA Director-General His Excellency Dr Mohamed ElBaradei.

For members of the public unable to visit the Lucas Heights site, ANSTO again offered a speaker program, with staff delivering talks to community groups. Subjects ranged from the general activities of ANSTO to the replacement reactor.

As ANSTO employs some 800 people, internal communication is of key importance in maintaining strong relationships between Divisions at all levels. Such communication was supported by ANSTO's inhouse newsletter, Lucas Heights News. During the year 39 editions were produced and distributed to employees. Special quarterly editions were sent to former employees who have requested this. Copies were also made available to the general public at ANSTO's reception desk.

Employees who had served ANSTO for 25 years were featured in a presentation "25 years at ANSTO" book and each given a souvenir copy.

Ministerial and other VIP visits

The Director-General of the International Atomic Energy Agency, His Excellency Dr Mohamed ElBaradei, visited ANSTO on 9 February. ANSTO also received visits from senior officials of the Korea Atomic Energy Research Institute, the Vietnam Atomic Energy Commission, the Indonesian Atomic National Nuclear Energy Agency, the Asia Cooperation Centre, the Chinese Environmental Protection Administration and the South African Academy of Science.

Other visitors during the year included the Hon Alexander Downer, Minister for Foreign Affairs and Trade, as well as senior officers from the Department of Industry, Science and Resources, the Department of Foreign Affairs and the Department of Defence. ANSTO also welcomed a group of representatives from Greenpeace.

Signing of the contracts for the construction of Australia's replacement research reactor took place on 13 July 2000.
Left to right,
ANSTO's Executive Director, Professor Helen Garnett; ANSTO's Chairman, Dr Max Richards; the Ambassador for the Argentine Republic, His Excellency Nestor E Stancanelli; and INVAP Chief Executive Officer and General Manager, Mr Hector Otheguy.

Core nuclear facilities operation and development

Drivers: Government, universities (through the Australian Institute of Nuclear Science and Engineering), other external customers and ANSTO.

OBJECTIVES

To operate national nuclear facilities and associated infrastructure in Australia and overseas for the benefit of the Australian research and development community and industry.

To enhance and improve the efficiency and effectiveness of these facilities in order to yield high quality research, products and services.

To provide effective access by Australian scientists to synchrotron facilities.

OUTCOMES

- HIFAR's irradiation service for mineral ore samples and silicon generated an income of $2 million. The slight reduction in revenue compared to the previous year was due to the loss of 85 days while HIFAR was shut down for its four-yearly maintenance and inspection program.

- On-site reactor fuel handling and storage continued in a safe manner. In November 1999, 308 HIFAR spent fuel elements (approximately 20% of the site inventory) were packaged for safe transport and transferred to COGEMA in France for reprocessing.

- The availability of intense cold neutron beams on ANSTO's Replacement Research Reactor, which is scheduled to start operating in 2005, will open up new possibilities for Australian scientists for research into soft matter, including polymers, complex fluids and biological systems. The reactor will initially feature eight leading-edge neutron scattering instruments, a cold-neutron source and neutron wave guides to transport the cold and thermal neutrons into a large, modern guide hall, with very low neutron losses.

- Carbon dating by ANSTO's AMS group of wax samples from seals on letters associated with the Spanish conquistador Pizarro and the conquest of the Incas of South America confirmed that the letters were from the right historical period. The letters suggest the conquest of Peru involved more intrigue and bloodshed than was previously thought.

- An analysis by ANSTO scientists of fish otoliths provided age and growth data to the New Zealand Ministry of Fisheries, via the Australian Bureau of Rural Science. Estimates of these parameters are necessary for stock assessment models of commercially important fish types. The AMS results are based on the radiocarbon bomb pulse (see p47) and provide a validation of fish ages based on presumed otolith annual increments.

ACTIVITIES AND OUTPUTS

HIFAR research reactor

Operation and general utilisation

Operation of the HIFAR research reactor enables ANSTO to maintain the expertise that underpins its other core business activities, including operations to support national and international objectives. Over the year, the reactor operated for approximately 5,491 hours (96.7% of its scheduled time) at an average power of 10.05 MW. During February, March and April the reactor underwent a major shutdown for its four-yearly maintenance and inspection.

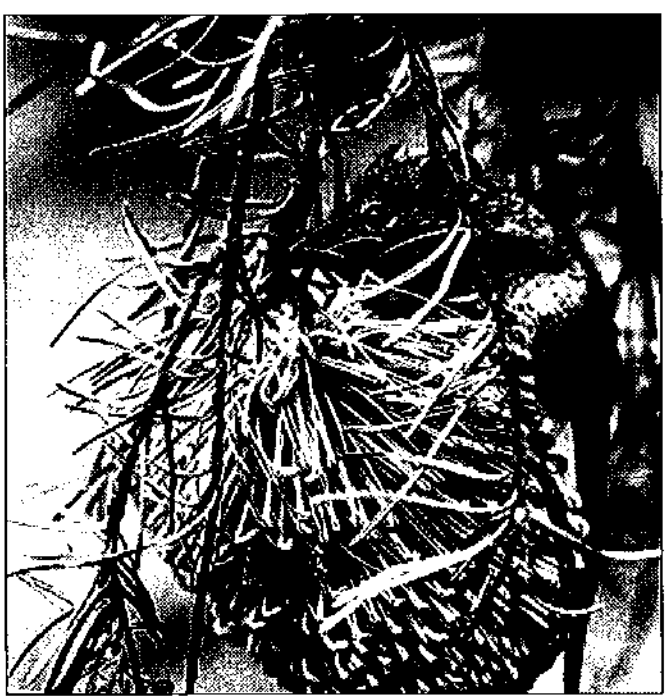
The reactor was used to irradiate 1654 targets to produce medical and industrial isotopes. It was also used to irradiate 807 batches of silicon targets and 17,000 mineral samples for commercial customers.

University projects funded by the Australian Institute of Nuclear Science and Engineering (AINSE) used 409 instrument days, and internal ANSTO researchers used 154 instrument days on HIFAR neutron beam lines. ANSTO research involving collaboration with international research organisations, university groups and training of PhD students used a further 140 instrument days.

The neutron scattering group provided beam time to holders of 21 AINSE research and training grants and to four AINSE postgraduate award holders, and assisted with data processing and interpretation (549 instrument days in total). AINSE work with universities included several collaborative projects relating to materials of high technological significance (see also HIFAR utilisation, Neutron scattering developments, p.29).

Maintenance and support

The HIFAR Quality Management System continued to be certified to AN/NZS ISO 9001:1994 International Standard. The external accreditation body, Quality Assurances Services Pty Ltd, undertook a surveillance audit in November 1999 and a Re-Certification (Triennial) Audit in May 2000. Both audits were successfully completed and resulted in a recommendation that the existing certification be continued. This result reflected ANSTO's continuing commitment to address and maintain the requirements of the International Standard for the business practices covered by the certificate of registration.



ANSTO scientists are using stable isotopes to measure the protein requirements of the West Australian Honey Possum.

Considerable effort was expended on preparing licensing documentation for the continued operation of HIFAR. The existing authorisation to operate HIFAR, issued by the Nuclear Safety Bureau, the predecessor to ARPANSA, will be replaced by a Facility License issued by ARPANSA. The document index of the existing authorisation was updated to take account of revised HIFAR quality system procedures.

All HIFAR instrumentation and associated equipment was fully assessed for Year 2000 computer date change (Y2K) compliance last year. No critical HIFAR plant, equipment, or systems were identified as susceptible to Y2K-induced failure. Notwithstanding ANSTO's confidence that HIFAR was not vulnerable to a Y2K-induced failure, the reactor was shutdown 10 minutes before midnight on 31 December 1999 as a precautionary measure in case of problems with external utilities. A few minutes

after midnight, operations staff confirmed the availability of water supplies, electrical power and emergency communications systems and then resumed normal operation.

Engineering staff began manufacturing two new hollow fuel element rigs. One will be used for trial irradiations of a new uranium metal foil target to be used in the production of molybdenum-99. The second rig will be fitted with self powered neutron detectors and used to measure thermal neutron fluxes in hollow fuel elements. Both rigs will contribute to improving the productivity of HIFAR and provide information that is useful in developing facilities for the Replacement Research Reactor.

ANSTO continued to irradiate ingots of single crystal silicon in HIFAR for overseas customers. The process modifies the electrical properties of the silicon, which is then returned to the customers for use as raw material in the production of semiconductor devices. Engineering staff overhauled the silicon irradiation facilities during the year, replacing the rotating inner liner of one facility and worn components in several of the shield boxes. Replacement components designed by ANSTO were manufactured on site.

Installation of an additional storage block for silicon ingots, begun last year, was delayed by the HIFAR major shutdown and other projects of higher priority. The installation work will now be completed in the coming year. The additional storage block will permit increased production of neutron transmutation doped silicon and irradiation of mineral samples for neutron activation analysis.

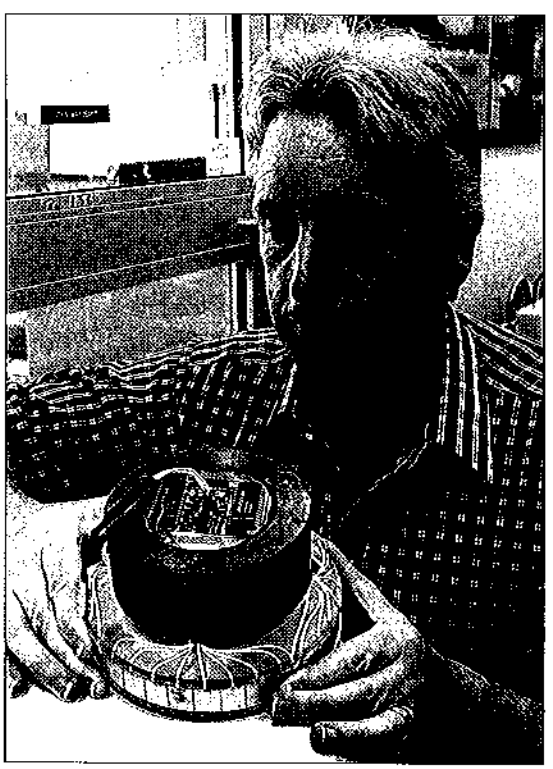
Materials were selected and inspection protocols developed for the manufacture of replacement sacrificial plates for HIFAR's primary cooling circuit.

Research continued into techniques for assessing the structural integrity of engineering components such as those used in HIFAR. Staff also continued to develop expertise in using computer software to analyse plant and equipment. Three dimensional modelling and simulation software was used to analyse steel structures for seismic stability and to conduct more complex solid geometry stress analysis on various HIFAR components.

Major shutdown work

In accordance with mandatory requirements of the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) the reactor was shut down between 7 February and 2 May for its major maintenance and inspection program, which is undertaken on a four- to five-year basis. During the shutdown the reactor tank was inspected, using closed circuit television and ultrasonic measurement equipment, and found to be in good condition. ARPANSA monitored the work undertaken during the shutdown and agreed at its conclusion that HIFAR could resume normal operation. The inspection and test results were presented to ARPANSA in a preliminary report for verification and agreement.

The shutdown involved 120 staff, 334 tasks and 2580 person days. Twelve projects, including modifications to the reactor cooling systems and reactor instrumentation, were completed by ANSTO personnel during the shutdown.



Materials researcher Richard Blevins with the ultrasonic array he helped design. The array was used to measure the thickness of the downcomer pipe in HIFAR's cooling system.

A number of tests were performed to confirm the integrity of the reactor aluminium tank, the main component of the reactor primary circuit. The inspections involved examining the reactor aluminium tank for the presence of corrosion damage, mechanical damage, defects and debris accumulation, or any other condition that could affect future safe operations. Additionally, the inspections tracked changes in materials properties caused by neutron irradiation. Specialised equipment was developed for these inspections, which were conducted in a high radiation environment with difficult access. Inspections were also conducted on the reactor steel tank, which forms part of the secondary containment.

Major activities included a thorough visual inspection of the reactor aluminium tank and internal facilities, replication of surface features that had been observed during previous Major Shut Downs (MSDs), inspection of the reactor aluminium tank plenum plate-to-skirt weld using an ultrasonic technique developed for this work by ANSTO, re-measurement of the wall thickness of one of the reactor aluminium tank downcomer pipes inspected during the previous MSD, a visual inspection of the inside of the plenum chamber, and hardness and thickness measurements of selected areas of the reactor aluminium tank. The results obtained were consistent with the measurements made during the previous MSD. Staff also inspected the reactor steel tank drain line and the reactor steel tank to reactor aluminium-tank gland sealing areas, and carried out ultrasonic measurements on the reactor steel-tank extensions. The inspections indicated that these areas were in good condition and fit for continued service.

The inspections showed that the condition of the reactor aluminium tank and other components had changed very little since the previous MSD, or indeed since HIFAR was commissioned. It was concluded that HIFAR could be safely returned to service.

Radiological safety staff assisted both during and prior to the shutdown with assessing safety submissions, providing specialised radiation safety training, preparing appropriate monitoring equipment and providing health physics monitoring personnel. Radiation exposures were monitored, assessed and reviewed at each stage of the shutdown for all personnel involved. Suggestions from staff on methods to minimise

doses were encouraged and implemented, where possible. As a result, doses to staff were lower than for previous shutdowns.

Probabilistic Safety Assessment and Remaining Life Study

In response to a recommendation in the 1998 Probabilistic Safety Assessment and Remaining Life Study of HIFAR (known as the PSA), staff studied the beneficial effects of ANSTO's top shield cooling system in a hypothetical situation where there was a loss of HIFAR main coolant flow. In previous event modelling, no benefit had been assumed for this cooling system in order to ensure the most pessimistic predictions. These studies revealed that the top shield cooling system could reduce the need to flood the core in any incident resulting in a loss of main coolant flow. This additional benefit of the top shield cooling system was found to become significant after a few hours of loss of main coolant flow, as at that point it would remove about half the reactor decay heat.

The PSA considered that loss of flow to the main fuel element storage block would be a significant event because of a perception that, if emergency cooling failed, insufficient time would be available for remedial action before fuel was damaged. An examination of the supporting analysis, but with more attention to detail, demonstrated that times available for remedial action actually exceed, by considerable margins, the time considered to be adequate in the PSA.

Fuel management and handling

During the year, 308 HIFAR spent fuel elements were safely packaged and transported to COGEMA, France, for reprocessing. As part of this work, two independent criticality assessments were performed for ANSTO's first use of a French-owned spent fuel element transport cask. Both assessments showed that HIFAR spent fuel elements loaded into the cask were highly subcritical (very safe) under normal and postulated abnormal conditions.

Activities to monitor the condition of stored fuel and inspection and preparation of fuel for the next overseas fuel shipment continued.

Reactor analysis

Thermal-hydraulic research and development

A Laser Doppler Velocimetry (LDV) system, funded by a Research Infrastructure Equipment and Facilities Grant to ANSTO, the University of Newcastle, and the University of Technology, Sydney, was installed and commissioned in ANSTO's large scale experimental water tunnel laboratory. Scientists used the LDV system to obtain flow-field data around a simulated radioisotope production can. This flow-field data was used to validate computer simulations being developed to support strategies for increasing radioisotope production. Related computational thermal simulations are also being developed to support these strategies. Additionally, ANSTO developments to existing theories on the onset of sub-cooled boiling, a phenomenon that limits the operating power of research reactors, are being incorporated into computer codes used for thermal-hydraulic analyses.

Similar computational and heat transfer simulations were applied to the development of low enriched uranium radioisotope production targets under consideration for a molybdenum target and process project.

HIFAR utilisation

Neutron scattering developments

Improvements were made to the sample furnaces used to study materials at elevated temperatures on neutron powder diffractometers at HIFAR and a compact high-pressure/stress cell was developed in collaboration with the University of Newcastle.

Monte-Carlo simulations were made to assist the designers of the proposed neutron reflectometer for HIFAR. Staff continued to collaborate with the Diffraction Group at the Brookhaven Research Laboratory (BNL) in the United States on developing a new monochromator for ANSTO's High Resolution Powder Diffractometer (HRPD). The principal components for the monochromator were fabricated at BNL, with the involvement of ANSTO staff on attachment. The new monochromator will enable HRPD to gather data at twice the present rate without a loss in quality.

Several improvements were made to the long wavelength polarised diffractometer (LONGPOL) instrument. A new time delay module was produced and prepared for testing. This facility will enable scientists to operate the instrument in real time mode for dynamic studies of problems such as flux leakage in superconductors.

Scientists began developing a new control program for the area detector on ANSTO's four-circle neutron diffractometer (2Tan A) to enhance the capability for finding new scattering peaks during phase transitions in crystals.

Staff began planning and designing new digital signal processing modules, which will be capable of making faster and more accurate measurements for the neutron beam instruments to be used with the replacement reactor.

ANSTO neutron scattering researchers presented papers on their work to the 18th International Union of Crystallography Congress and General Assembly in Glasgow, Scotland, in August, and to the European Conference on Neutron Scattering in Budapest, Hungary, in August/September. Staff visited leading neutron scattering laboratories, including the Risø laboratories in Denmark, the Paul Scherrer Institute at Villigen, Switzerland, and the Argonne, Brookhaven and Oak Ridge National Laboratories in the United States, in order to gain advice and information regarding neutron guides, optics, instrumentation and cold neutron sources for the Replacement Research Reactor Project. Officers also gave lectures at the "Third AINSE Winter School for Nuclear Techniques Applied to Natural Processes" and helped students to set up and measure a powder diffraction pattern from steel, using ANSTO's high resolution powder diffractometer.

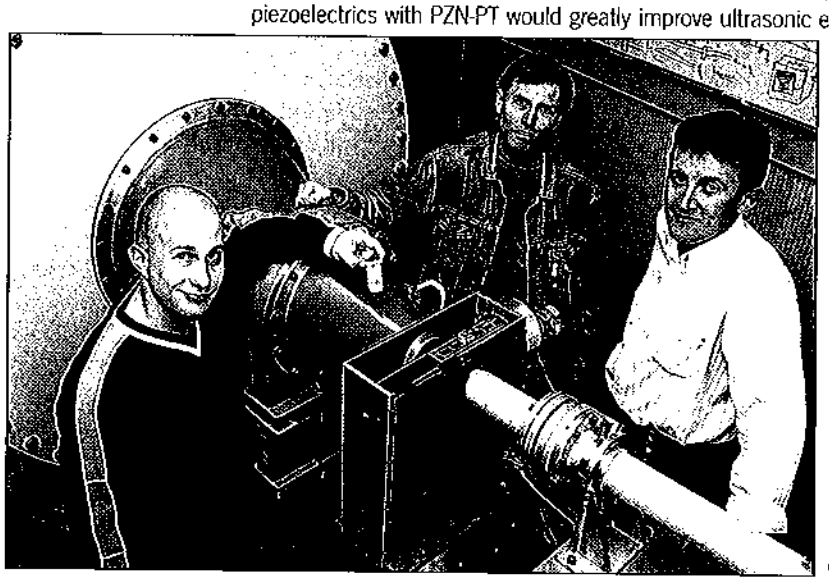
Dr Robert Robinson, formerly of Los Alamos National Laboratory in the United States, joined ANSTO in December as leader of the Neutron Scattering and Synchrotron

Radiation Group. Dr Robinson also holds the post of Adjunct Professor in the School of Physics of the University of New South Wales.

ANSTO staff participated in a US Department of Energy review panel assessing the proposed US$1.4 billion spallation neutron source to be located at Oak Ridge National Laboratory in the United States

Neutron scattering applications

Piezoelectric materials are commonly used as sensors and tranducers for ultrasonic equipment such as that used in medical ultrasound scanning. The material PZN-PT has the greatest known efficiency of all piezoelectrics and replacement of conventional piezoelectrics with PZN-PT would greatly improve ultrasonic equipment. The reason why PZN-PT is so efficient is not presently known. In an attempt to answer that question, researchers from ANSTO and the University of Newcastle used single-crystal neutron diffraction to study the effects of a large electric field on the material. Preliminary results of the experiment could not be interpreted using existing models and further measurements will be carried out.



Postgraduate student John Paglia (left) and Dr Craig Buckley, both from Curtin University, load a sample into the Australian Small Angle Neutron Scattering facility (AUSANS) with the assistance of ANSTO's Dr Shane Kennedy.

Scientists from ANSTO and the University of Sydney used high-resolution powder neutron diffractometry and synchrotron x-ray diffraction to study the mineral hydroxyapatite, Ca10(PO4)6(OH)2. The work seeks to understand the chemistry of apatite and its derivatives and could possibly lead to the design of new materials that mimic teeth and bones in their ability to encapsulate lead.

In another collaboration between ANSTO and the University of Sydney, researchers used neutron scattering to probe perovskite, a major component of the radioactive wasteform synroc. The work centred on a perovskite, SrTiO3, that immobilises strontium. The scientists used powder neutron diffraction methods to track changes in the crystal structure of the compound and observed that the symmetry of the crystal changed as the titanium atoms were replaced by zirconium.

ANSTO and Monash University's Pulp and Paper Institute carried out a collaborative project to determine how water from the atmosphere combines with the cellulose in paper. The work could point to ways of modifying paper at the molecular level to make

it more resistant to humidity, thus reducing problems such as paper jams in office copying equipment. Using spectrometric methods, the transition point at which the paper swells and becomes more supple was seen to occur at lower humidity than expected. Further, using the Australian Small Angle Neutron Scattering facility (AUSANS) attached to HIFAR, the team was also able to see that the water was absorbed preferentially into the amorphous regions of the cellulose.

Replacement research reactor

The Replacement Research Reactor project

The Government announced on 3 September 1997 that it would fund ANSTO to construct a replacement research reactor located at the Lucas Heights Science and Technology Centre, subject to the applicable environmental assessment process. The multi-purpose replacement reactor will provide ANSTO and Australian stakeholders with access to a state-of-the-art facility that provides a high level research and isotope production capability consistent with Australia's future requirements. The replacement reactor facility will be a national centre for world class research in neutron science, and will enhance and expand the wide range of other activities presently supported by HIFAR.

ANSTO responded to the announcement by setting up a three-phase Replacement Research Reactor project.

Phase 1, which was completed in August 1999, involved environmental assessment, prequalification of reactor vendors, preparation of tender documents, application to ARPANSA for a siting approval licence and application for approval by the Parliamentary Public Works Committee.

Phase 2 involved the issue and evaluation of tenders leading to the selection of a preferred tenderer and ultimately to contract award.

Phase 3 will involve the detailed design, construction and commissioning of the replacement research reactor.

Project activity during the year centred on the completion of the tender process, which culminated in the selection of a preferred tenderer and the commencement of pre-contract negotiations. The significant activities and events that occurred in the process are described below.

Preparation and issue of the request for tender

Preparation of the request for tender, which had been begun in January 1999, was carried out by a project team comprising ANSTO staff and specialist consultants.

The Beam Facilities Consultative Group (BFCG), a team of experts established by ANSTO to advise it on areas of research to be conducted at the replacement reactor and on the neutron scattering facilities to be installed there, held its eighth meeting in June 1999 and subsequently gave its agreement to the final neutron beam and instrument specifications to be included in the reactor tender specifications. At a

meeting in February 2000, the BFCG provided valuable comments to ANSTO in the way of a 'mid evaluation review' during the tender evaluation period.

Neutron scattering experts established a draft protocol to assess tender compliance against the requirements for neutron beam facilities. As part of this work, they prepared a formula for evaluating the performance of each tender against expected values of neutron flux and spectra. Neutron scattering staff also participated extensively in the tender evaluation itself.

The Request for Tender was issued on 27 August 1999 (with a closing date of 3 January 2000), following the consideration by Parliament of the Public Works Committee Report.

Public Works Committee Report

The bipartisan Public Works Committee prepared a unanimous report, which was tabled in both Houses of Parliament on 25 August 1999. The necessary expediency motion was agreed on 26 August. The report covered the scope of the project, the applications of the reactor and reviewed its potential impacts. It also covered the environmental asssessment process, safety and regulatory aspects, the management and cost control of the project, the degree of community consultation and the opportunity for Australian industry involvement.

The report contained a series of conclusions and ten recommendations. One of those recommendations was that ANSTO should report in its Annual Report on compliance and implementation of all recommendations in the Environmental Assessment Report. That report can be found in Appendix 5. The final recommendation stated that "the Committee recommends the construction of a replacement research reactor at Lucas Heights at an estimated cost of $286.4 million at 1997 prices".

Site facility licence

In April 1999 ANSTO applied to ARPANSA for a Facility Licence to prepare the site for the replacement research reactor. ARPANSA sought public comment on the Application over a six-week period, and on 22 September issued a Facility Licence to ANSTO to prepare the site subject to certain limitations and conditions.

Government Facilitation Group

Two meetings of the Government Facilitation Group, consisting of representatives of interested Commonwealth Government departments and agencies, were held. These meetings provided an opportunity to review progress and plan future actions within the project.

Liaison with the scientific community

ANSTO officers visited several leading overseas institutions for discussions related to the tender process and evaluation and to the design and construction of neutron beam facilities. Centres visited included the Paul Scherrer Institute, Villigen, Switzerland (where staff also attended a conference on neutron optics); the FRM-II research reactor project at the Technical University of Munich, Garching, Germany; and the Hanaro research reactor at the Korea Atomic Enegy Research Institute (KAERI), Taejon, Replublic of Korea. Seminars were given on ANSTO's replacement reactor project during the Munich and Taejon visits and also to the IAEA "International

Symposium on Research Reactor Utilization and Management", Lisbon, Portugal, and at the European Conference on Neutron Scattering in Budapest, Hungary, and the 18th International Union of Crystallography Congress and General Assembly in Glasgow, Scotland, in August.

Tender evaluation and selection

Following the receipt and registration of tenders, the project team undertook an initial evaluation of tenders and prepared an Initial Compliance Report. This was followed by a detailed technical and commercial evaluation of each tender against pre-determined evaluation criteria, with the safety of the replacement facility being the condition precedent.

Scientists used generic models of light water cooled research reactors to develop techniques for assessing the neutronics of reactors proposed by the prequalified replacement reactor tenderers. As part of the evaluation process, these techniques were then used to generate detailed neutronics models of the reactors. The studies were complemented by an evaluation of the thermal-hydraulic performance of the tendered reactors.

Detailed clarification meetings were held at ANSTO with each tenderer as part of this process. Tenderers then made their final pricing submissions to ANSTO, and a detailed financial analysis of each tender was completed.

The performance of the evaluation process was reviewed by the Tender Selection Review Committee, which was led by the Deputy Chairman of the ANSTO Board and comprised independent members with a broad range of private enterprise and government experience, both within Australia and overseas, in relation to major and complex projects. In its report to the Board, the Committee stated the performance of the tender evaluation process was of a high standard.

The ANSTO Board subsequently approved the preferred tenderer.

On 6 June 2000 the Minister for Industry, Science and Resources announced that the Argentine company INVAP S.E. had been selected as the preferred tenderer for the detailed design, construction, commissioning and demonstration of performance of the replacement research reactor at Lucas Heights.

Commencement of pre-contract negotiations

Following the Minister's announcement, ANSTO and INVAP S.E., with the support of their Australian alliance partners, John Holland Construction and Engineering Pty Ltd and Evans Deakin Industries Ltd, entered into pre-contract negotiations with a view to entering into a contract in July 2000.

Audit activities

The development of the project was undertaken against the background of comprehensive audit activities in relation to process, probity and risk.

Process audit activities were undertaken throughout the tender preparation and evaluation stages by an independent consultant with significant and relevant experience, engaged through Total Logistics Management Pty Ltd. In addition, the Australian National Audit Office (ANAO) was consulted throughout the process. As part of this consultation, ANAO reviewed the relevant ANSTO documentation for fitness for purpose. This documentation comprised the project directive, the tender selection plan, the tender evaluation procedure and the tender evaluation working group instructions.

Probity audit activities were undertaken over an extended period beginning before completion of the pre-qualification process and continuing through the Tender Evaluation Management Group sessions that made recommendations in relation to the preferred tender and the less preferred tenders. The Senior Government Solicitor, Business and Commercial, Australian Government Solicitor's Office undertook this role throughout the entire process.

Internal audit activities, including an assessment of project risk, were undertaken throughout the tender evaluation stage by ANSTO's consultant Internal Auditor, Clark Corporate Consulting Pty Ltd.

The reports from each of these three audit processes were provided to the Tender Selection Review Committee and the auditors were interviewed and questioned by this committee.

Schedule and budget The tender preparation and evaluation process was completed on time to a demanding schedule and within the allocated funding.

Tenderers' performance Each of the tenderers - AECL, INVAP S.E., Technicatome Baulderstone Hornibrook JV and Siemens Transfield JV - and their Australian industry partners performed with distinction and professionalism throughout an intensely competitive tender process.

Moata Staff continued to provide documents needed for the decommissioning of the Moata Research Reactor, which was shut down in 1995. A Radioactive Materials Inventory Assessment and a Decommissioning Options Study were issued. An ANSTO engineer visited Europe and the United States to discuss decommissioning of research reactors, gaining important knowledge and making useful contacts. The reactor remained with the fuel removed and the coolant drained. The fuel will be included with a shipment of HIFAR spent fuel at a date to be determined.

Accelerators for medical products and scientific and industrial research

National Medical Cyclotron The National Medical Cyclotron (NMC) is a major national facility that provides isotopes for research, clinical evaluations and routine nuclear medicine procedures. It is operated by ANSTO and located adjacent to Sydney's Royal Prince Alfred Hospital,

Camperdown. It produces gallium-67, thallium-201, iodine-123 and fluorine-18 fluordeoxyglucose (FDG) on a regular basis for clinical applications in hospitals and medical practices in Australia, New Zealand and Asia.

During the year the radiopharmaceutical production sections at the NMC and Lucas Heights were combined, organisationally, to allow closer alignment of output with clinical demand.

Staff produced extensive documentation for the FDG Drug Master File, which lists all methods and procedures needed for full evaluation by the Therapeutics Goods Administration. A project was established to improve efficiency of production of thallium-201, a long-established radionuclide enjoying a resurgence of interest as a scanning agent for heart studies.

Changes made to the operation of the iodine-123 production facility resulted in a more consistent product and better yields. A new process was implemented for the manufacture of iodine-123 labelled metaiodobenzylguanidine (mIBG), which is carried out at Lucas Heights using cyclotron-produced iodine-123. This new process is more reliable and involves aseptic dispensing of the product. This is the first product to be aseptically dispensed at Lucas Heights.

Further development of the NMC's FDG plant continued. New FDG synthesis modules and an automated dispenser were purchased and installed to cope with the increased demand for these products. The aim was to increase FDG production to four days per week with two production runs on each day. However, problems encountered with the FDG synthesis modules necessitated ANSTO introducing a range of studies. The results confirmed that ANSTO had been operating the modules in accordance with the manufacturer's specifications.

ANTARES tandem accelerator

The Australian National Tandem Accelerator for Applied Research (ANTARES) continued to operate safely and reliably, meeting the needs of ANSTO and external users. Additional storage capacity was installed in the insulating gas handling plant to reduce maintenance turnaround time, and the two sputter ion sources were modified to increase reliability.

Accelerator mass spectrometry

ANSTO's Accelerator Mass Spectrometry (AMS) facility, which is based on ANTARES, routinely undertook high quality analyses for Australian and other researchers. Most analyses were of radiocarbon, where the throughput was about 1000 samples per annum. Analyses provided information on Australian Aboriginal prehistory, Pacific Island and South East Asian archaeology, global climate change and palaeo-environments. Accuracies of 0.4 percent were routinely achieved for oceanographic and tree-ring- based research, providing information on global climate change. The past year saw a doubling in demand for analysis of other cosmogenic isotopes, namely, beryllium-10, aluminium-26 and chlorine-36, in projects related to the earth sciences and the study of our changing landscape and climate. About 300 such

samples were measured for six AINSE-supported and internal ANSTO strategic projects.

ANSTO was strongly represented at the 8th International Conference on AMS in Vienna, Austria, a 3-yearly event that is regarded as the most important international conference for researchers in this field. Thirteen papers were presented at the conference, demonstrating the breadth and significance of AMS-related scientific research undertaken and supported at ANSTO.

Work continued on improving the quality of the preparation procedures for AMS analyses. The capability for aluminium-26 analyses for earth science applications was improved to complement the present beryllium-10 capability. The radiocarbon background for the combustion/graphitisation process was reduced to a level corresponding to an age of more than 50,000 years. Some automation was introduced to reduce manual labour and increase throughput in the preparation areas. Rear pressing of cathodes for radiocarbon analyses has led to improved measurement reproducibility and has reduced the number of failures due to surface problems.

A new, large multi-anode gas ionisation detector for chlorine-36 was received from the University of Pennsylvania AMS facility, commissioned and put into routine operation. The instrument significantly improves the rejection of the sensitivity-limiting sulphur-36 isobar. The ionisation detector for radiocarbon measurements was also replaced, providing improved energy resolution and reduced background interference.

Ion beam analysis

The ion beam analysis facilities based on ANSTO's 10 MV Tandem and 3 MV Van de Graaff accelerators continued to provide high quality quantitative routine analyses for industry, local councils and university researchers around Australia and overseas. Thirty-six accelerator-based AINSE projects were completed utilising the ion beam facilities on these accelerators.

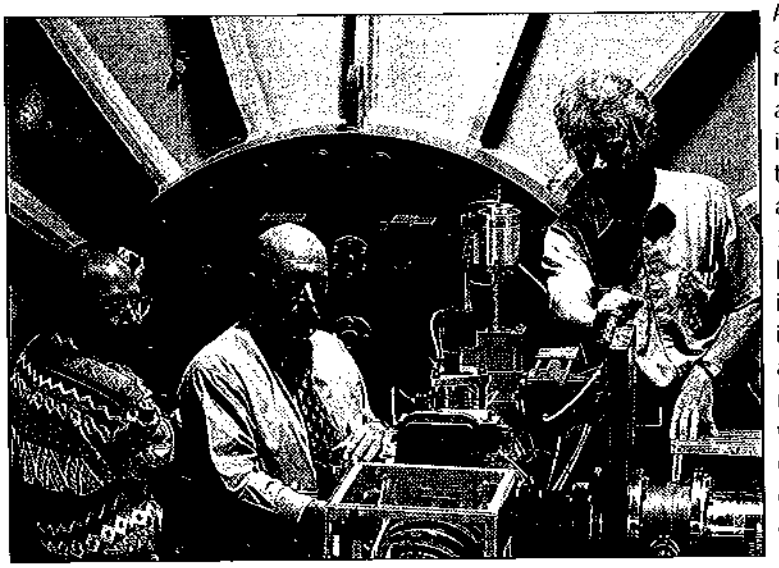
ANSTO representatives hosted and chaired the 11th Conference on Nuclear Techniques of Analysis in conjunction with the 5th Vacuum Society of Australia Congress. This biannual event is the premier national conference in the field and brings together all key researchers and industry groups working in the area.

ANSTO, in partnership with Australian universities, was successful in obtaining through AINSE an ARC Research Infrastructure, Equipment and Facilities (RIEF) program grant to replace the ANSTO 3 MV Van de Graaff accelerator. This accelerator has served ANSTO and AINSE groups for more than 35 years and replacement parts are becoming difficult to obtain. The total grant was for $2.5M with $1M coming from ARC and the balance from AINSE and ANSTO. The replacement accelerator will be used for ion beam and accelerator mass spectrometry studies related to Australian research in environmental and heritage issues. It will be available to all Australian universities and to industry groups throughout Australia.

ANSTO, in collaboration with the Department of Zoology at the University of Western Australia, was successful in obtaining a large ARC grant for further research into the link between nitrogen metabolism and reproduction in the Australian marsupial honey possum. The study will help mining interests in Western Australia to manage their native fauna and flora restoration responsibilities.

High energy heavy ion microprobe

The high energy heavy ion microprobe installed last year on the tandem accelerator was fully commissioned and its capabilities expanded to meet increasing demand from ANSTO-driven strategic projects and Australian university researchers. The total scan area for heavy ions was increased from 300 x 300 (m to more than 1000 x 1000 (m and the spot size reduced from 15 μm to 3 μm for a range of heavy ions. These improvements greatly increased the range of applications for the microprobe. During the year it was used to help understand, on a microscopic scale, the distribution and accumulation of heavy metal pollutants in living organisms such as fresh water mussel shells, dugongs and crocodiles. This new knowledge is being used to quantify the timing and scale of past pollution events. It also provides valuable insights into trace element distributions, on a microscopic scale, that can assist wildlife management in Australia.



ANSTO scientists (left to right) Dr Ugo Zoppi, Dr Claudio Tuniz and Dr Ewan Lawson with the ANTARES tandem accelerator (p35)

Australian Synchrotron Research Program

ANSTO continued to manage the Australian Synchrotron Research Program (ASRP), which provides access to a comprehensive range of synchrotron x-ray research capabilities for Australian science in the fields of physics, chemistry, materials science, structural biology, polymer research, environmental science and geo-physics. The other members of the ASRP are the Australian National University, the University of Sydney, the University of Canberra, the University of NSW, the University of Melbourne, Monash University, the University of Queensland, and the CSIRO.

The ASRP operates synchrotron radiation research facilities for Australian scientists at two overseas laboratories: the Photon Factory in Japan and the Advanced Photon Source in the United States. ANSTO continued to provide staff at these facilities, two at the Photon Factory in Japan and three at the Advanced Photon Source, to assist visiting Australian research teams.

A meeting of ASRP users, the first to be held, took place at ANSTO in September 1999 and was attended by over 70 participants. The meeting was very successful and it was decided it should become an annual event. A second meeting was held in June 2000.

ANSTO's ASRP staff completed their role as leaders in the preparation of a proposal for an Australian synchrotron facility. The final proposal included preliminary specifications for the storage ring, insertion devices and initial beamline complement.

The ASRP operates a post doctoral fellowship scheme to foster synchrotron radiation based research in Australia. Three ASRP postdoctoral fellowships were awarded in January, to ANSTO, the University of Queensland and the University of New South Wales.

The Australian National Beamline Facility

The Australian National Beamline Facility (ANBF) at the Photon Factory, Tsukuba Science City, Japan, hosted 45 Australian research groups during the year, including groups from ANSTO's Physics, Materials and Environment Divisions. The techniques in greatest demand continued to be x-ray absorption fine-structure spectroscopy (XAFS) and powder diffraction. The ANBF continued to attract new synchrotron users, with nine first-time groups using the facility. ANSTO-led projects performed at the ANBF included XAFS studies of self-assembled metal oxide thin films, which have important applications in environmental catalysis and as ceramics, and an x-ray fluorescence study of the leaching properties of synroc.

An electrochemical facility was added to the ANBF. The facility includes a precision potentiostat, a device that facilitates the preparation and measurement of electrically active systems. The new facility will enable scientists to use synchrotron x-ray techniques such as x-ray absorption spectroscopy to measure the surface and interfacial properties of, for example, electrode systems used in electroplating, batteries and fuel cells, catalytic systems and corrosion.

Last year the ASRP obtained preferential access for Australian scientists to a soft x-ray beamline at the Photon Factory. As part of this arrangement, the Photon Factory funded an Australian post-doctoral fellow who is stationed at the Photon Factory to assist Australian users of the beamline. In April the first experimental results were obtained. The experiments, on a range of oxide systems, were carried out collaboratively by ANSTO, the ASRP and the University of NSW.

The Advanced Photon Source, Argonne National Laboratory

The Australian Synchrotron Research Program maintains facilities at three Collaborative Access Teams (CATs) at the Advanced Photon Source in Chicago. They are the Synchrotron Radiation Instrumentation CAT (SRI-CAT), the structural biology Consortium for Advanced Radiation Sources (BioCARS) and the Chemistry and Material Sciences CARS (ChemMatCARS).

The SRI-CAT beamlines were fully operational and available to Australian users during the year. Twelve Australian experiments, including three from ANSTO, were performed. Access to the micro-probe beamline, which is in high demand from many non-traditional synchrotron research fields such as environmental science and cell biology, was again over-subscribed. ANSTO-led projects included micro-beam x-ray analysis of synroc, aerosols and mineral samples.

The three BioCARS protein crystallography beamlines were fully operational and available to Australian users, and were used for 12 Australian experiments during the year. Two protein structures were solved by Australian groups using data obtained at BioCARS. The work included research by scientists from the Biomolecular Research Institute into the human insulin receptor.

Construction of the ChemMatCARS beamline facilities was completed. The first experiments are scheduled for the second half of 2000, with Australian experiments expected to be accepted in this initial phase.

Environmental scientist Dr Kate Harle

Nuclear science for environment and sustainability

Drivers: Government, other science organisations such as the Australian Antarctic Division, the Bureau of Meteorology, the Australian Geological Survey Organisation, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), universities and industry.

OBJECTIVE *To apply nuclear-based techniques in research projects that are integral to national and international programs on understanding natural processes and the impact of human activities on the environment.*

OUTCOMES

- ANSTO scientists were among the first to accurately determine the contribution of fossil fuel use to the global atmospheric methane budget. Methane is second in importance to carbon dioxide as a greenhouse gas yet the relative strengths of the production rates of the known sources of methane have been uncertain. This work will enable a fuller understanding of the effect of anthropogenic activities on the global climate.

- ANSTO has achieved recognition within Australia and abroad as having a high-quality Accelerator Mass Spectrometry facility for earth science studies in glacial chronology and landscape evolution using surface exposure age dating with in-situ cosmogenic radioisotopes. The success of recent research resulted in university projects that involved ANSTO staff as co-principal investigators being awarded three Australian Research Council grants totalling $200K for further work during the next three years.

- ANSTO contributed to a comparison of sites being considered for a national repository for low level radioactive waste by working with CSIRO to determine radionuclide retardation properties of drill core samples.

- In a study commissioned by Environment Australia, accelerator-based and other specialised analytical techniques at ANSTO were used to establish the background concentrations of a range of metals in estuarine crocodiles from the catchments of the Kakadu National Park. Further analysis of the data has shown that these multi-element metal concentrations can be used to determine the provenance of individual crocodiles. These catchment-specific signatures will provide a tool in the assessment of crocodile population dynamics in the Northern Territory, a significant wildlife management issue.

- Implementing sustainable development policies, both in Australia and overseas, was facilitated by the availability of data from ANSTO's extended range of radiotracer studies. New projects include investigations of the uptake of selected radionuclides into certain food crops in the Northern Territory; a study of sediment transport at the Port of Songkhla, Thailand; and a detailed study of the mixing of sewage effluent flowing into Victoria Harbour, Hong Kong, over several tidal cycles. Data from the studies are used to validate mathematical models that can predict behaviour under a range of conditions. In none of these cases would it have been possible to obtain comparable experimental data using alternative, non-nuclear methods.

- Radiometric sediment dating with cesium-137 and lead-210 was used to support studies of the natural history of harmful marine algal blooms as a guide to understanding the factors that promote their occurrence. Scientists developed predictive models that relate the onset and persistence of such blooms to readily measurable hydrographic and meteorological variables. Harmful algal blooms can cause significant economic loss to aquaculture and pose health risks to affected populations. The work is being carried out as part of an IAEA project, Management of the Marine Coastal Environment and its Pollution.

- Research by ANSTO scientists into natural archives (organic lake and swamp sediments) of past changes in water quality, vegetation, climate and land use provided an improved understanding of the varying roles of natural climate variability and human activity in the shaping of the Australian landscape over the past 500 years. ANSTO scientists worked on this project with researchers from a number of universities including Monash, Wollongong, the Northern Territory University, the University of Tasmania and the University of Technology, Sydney, utilising lead-210 and carbon-14 dating techniques as well as trace element, microfossil and other sediment characterisation methods.

- In collaboration with CSIRO and the Bureau of Meteorology, ANSTO researchers applied nuclear techniques to test data required by mathematical models used in the prediction of climate change. Radon concentration was explored as a novel indicator of soil moisture, a significant parameter in global climate modelling but one that is difficult to measure directly.

ACTIVITIES AND OUTPUTS

Radionuclide environmental pathways

The Radionuclide Environmental Pathways Project, which was launched in July, is a study of the biogeochemical processes that affect the migration and storage of radionuclides in the environment. The project focuses on the processes, or pathways, involved in areas such as ecologically sustainable development, sewage outfall and sediment dynamics, and on processes that are important for assessing the environmental impact of nuclear facilities in Australia and the Asia Pacific region.

One of the specific areas the project is investigating is the factors that control the migration and transfer of radionuclides in unsaturated soils and underlying weathered rock in arid and tropical areas. In collaboration with CSIRO, ANSTO measured the radionuclide retardation properties of drill samples from sites being assessed for the national radioactive waste repository in the central north of South Australia. The radionuclide sorption of cesium-137 and cobalt-60 was measured, and the results compared with the migration of the radionuclides in laboratory columns of unsaturated material.

Researchers established a trial site in the Northern Territory for field measurement of the rate of transfer of radionuclides to plants growing in local soil. The plot was labelled with radioactivity in October and seeded in December. This experiment is also

part of an international program to investigate soil-to-plant transfer factors and compare the effect of different soil types in different countries.

The Pathways project also covers the investigation of the impact of large river systems and attendant human development on tropical coastal zones, the focus of the international Tropical River-Ocean Processes in Coastal Settings (TROPICS) project. TROPICS Project activities have been supported by ANSTO, AIMS, CSIRO, the Australian Commonwealth Department of Industry, Science and Resources (DISR), AusAID, the Australian Synchrotron Research Program (ASRP), the US National Science Foundation (US-NSF), the Japan Geological Survey Organisation (JGSO) and the Indonesian Institute of Science (LIPI).

As part of this work, a collaborative (ANSTO/CSIRO/AIMS (Australian Institute of Marine Science)) expedition completed a series of oceanographic studies in the Sepik River/Bismarck Sea and Fly River/Coral Sea regions off Papua New Guinea. ANSTO contributed specialised expertise in the off-shore sampling and measurement of radionuclides and trace elements. Scientists used natural uranium series isotopes to investigate the role of particle flux in controlling the concentrations of elements in coastal waters. As an extension of this work, ANSTO researchers used the Australian National Beamline Facility at the Photon Factory in Tsukuba, Japan, to apply a new method using synchrotron radiation to determine the oxidation state of elements in sediment particles as they are transported from the rivers to the ocean.

In an effort to develop an integrated river-ocean particle pathway model, a series of polonium-210 and lead-210 radiotracer experimental studies were also carried out in collaboration with the IAEA Marine Environment Laboratory, Monaco. It was found that the higher the biological productivity, the greater the rate of biogeochemical cycling and removal of these nuclides.

Radiotracer work was also carried out as part of an IAEA-funded program designed to demonstrate the role of tracers in validating numerical computer codes for predicting the off-shore transport of sediments. In addition, four commercial radiotracer projects were completed using tritium and gold-198 to assess the dispersal of sewage from outfalls in Hong Kong. The work was managed either by Montgomery Watson (HK) or by Mouchel (Asia) for the Environmental Protection Department of the Government of Hong Kong Special Administrative Region. All projects were undertaken in collaboration with the survey company EGS (Asia). The Water Research Laboratory of the University of New South Wales was involved in all but one of the projects.

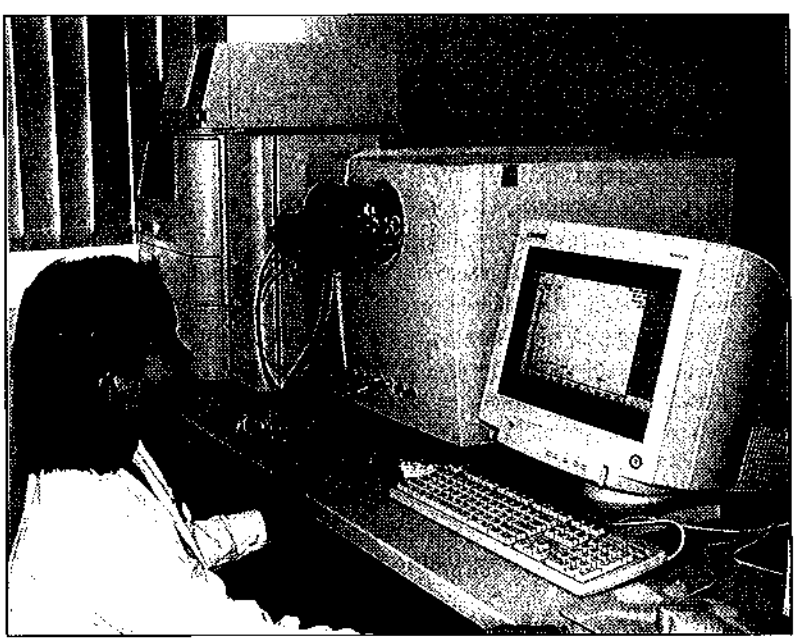
Scientific computing staff worked with scientists in modelling and predicting the transit time and concentration of contaminants at outlets in metropolitan sewerage systems. They also investigated and compared the use of neural networks and conventional techniques in modelling complex systems such as Sydney's Southern Metropolitan Sewerage System and demonstrated that such models could predict the arrival of ANSTO effluent at the outlet from the Cronulla Sewerage Treatment Plant. Models such as these are used by ANSTO in an on-going effort to better understand

the fate and behaviour of low level aqueous effluent released from the Lucas Heights site.

Human activity and climate variability

The Human Activity and Climate Variability project, which commenced in July, focuses on the Asia-Australasian region and consists of three parallel research streams looking at the past, present and future in terms of climate variation.

The 'past' stream of the project uses natural archives to determine whether human impact can be distinguished from climate variability over the past 50 to 100 years. It utilises various techniques, including isotope dating and microfossil, trace element and stable isotope analyses. The research team began establishing a base-line climate description for the East-Australian region prior to 1850. It also began investigating the climate variability as deduced from proxies such as geochemical and microfossil indicators that are found in sediment records. The isotope dating work is being carried out by ANSTO; the proxies are being studied by university collaborators. This research was identified in the Commonwealth Government's Greenhouse strategy document.



Year-in-industry student Liwan Liow working at a liquid chromatograph mass spectrometer used to investigate the movement of radionuclides bound to organic matter in the environment.

The 'Present' stream of the project investigates the relative proportions of natural to human-produced aerosol particles in air masses and fingerprints their sources. The research involves participation in a major international project called ACE-Asia (Asian Regional Aerosol Characterisation Experiment), which was instigated by the International Global Atmospheric Chemistry Project (IGAC) to improve understanding of both direct and indirect influences of aerosols on climate change. ACE-Asia is being carried out in the Northwest Pacific Ocean, and studies the evolution of both natural and anthropogenic aerosols from Asia. ANSTO is analysing fine particles and characterising air samples using radon concentrations. This will build on fine particle and radon data currently being gathered in the Australian region to produce a global picture of anthropogenic climate change.

The 'Future' stream of the project will contribute to the prediction of future climate change by supplying new and potentially important parameterisations to various global

climate models, including the World Climate Research Programme's (WCRP) Project for Intercomparison of Land-surface Parameterisation Schemes (PILPS). Research focuses on the study of radon flux as a possible proxy for soil-moisture. Soil moisture to depths of a few metres is climatically important. Soil moisture also affects radon flux, which means that the radon concentration in air that has passed over land reflects the average amount of soil moisture. By observing the radon concentrations in air masses with widely different overland paths, it may be possible to estimate soil moisture changes over large areas. Researchers began studying the 15-year record of radon concentration at Cape Grim, together with climate data for Australia and air mass movements, to determine the validity of this application of radon. If the hypothesis is confirmed, radon measurements could be used as an indicator of long-term soil moisture changes, without the need for remote sensing and spot measurements.

Global climate change - application of nuclear techniques

Global baseline pollution

Accelerator-based ion beam analysis methods developed at ANSTO were used to establish seasonal variations in fine particle concentrations at Cape Grim, Tasmania, for the years 1995 to 1999. The research found that more than 40% of fine aerosol is anthropogenic in nature. Quantitative seasonal variations for radon (Rn) and condensation nuclei (CN) over several years were established, together with hourly wind speed and direction. This has greatly assisted research defining unique elemental source fingerprints, which include Rn and CN parameters, for the airsheds at the Global Baseline site at Cape Grim site. The results were presented at a national workshop in Melbourne on the Cape Grim results, while other research was published and presented at local and international meetings. This work has produced a better understanding of the anthropogenic and natural contributions, and their seasonal variability, to the fine particle concentrations in the southern regions of Australia.

Long-lived radionuclides in Antarctic ice cores as tracers and chronometers in global climate change studies

This 3-year project, completed in late 1999, has made a valuable contribution to the development of tools for monitoring and managing global climate change. These achievements were made possible by the ongoing collaboration with CSIRO Atmospheric Research and with Australian Antarctic Division (AAD) Glaciology. During the project a collaboration with the National Institute of Water and Atmospheric Research (NIWA), New Zealand, was also initiated, enabling aspects of the project to proceed.

A highlight of this project was the first accurate determination of the contribution to the global atmospheric methane budget arising from the exploitation of fossil fuels. This was made possible through the application of accelerator mass spectrometry, using the ANTARES accelerator, to methane samples derived from old air (circa 1942) retrieved from the ice sheet near Casey Station, Antarctica.

The accuracy of a reconstruction of the Earth's atmospheric composition from the ice core record is determined by the ability to allow for the effects of gaseous diffusion in the porous firn overlying the ice and of the process of bubble formation as the firn is compressed to ice. Nuclear weapons testing in the middle of the past century resulted in a sudden doubling of radiocarbon dioxide in the atmosphere, and using the measured "radiocarbon bomb pulse" in air retrieved from bubbles in the ice has proved an excellent means of tuning the numerical model developed by CSIRO to study these processes. The work accomplished during this project has further refined ANSTO's ability to utilise the radiocarbon bomb pulse for this purpose. The scientists have also determined that, in general, in situ cosmic-ray produced carbon-14 does not interfere with the atmospheric signal for Law Dome ice, using current air extraction techniques.

Radiochemist Robert Chisari (left) and Dr Henk Heijnis prepare a corer for subsampling at Lake Cygnus, Tasmania, as part of the Human Activity and Climate Variability Project.

ANSTO scientists developed in-house methodologies and techniques for the AMS measurement of beryllium-10 extracted from snow and ice. They were able to show that, for recent times, the beryllium-10 concentration is effectively independent of precipitation rate, implying that most beryllium-10 is wet-deposited. Under these conditions, the important implication is that the beryllium-10 concentration cannot be used as a proxy for snow accumulation rate.

Southern Hemisphere glaciation studies

By measuring exposure ages on glacial terraces at Lake Te Anau in the Southern Alps of New Zealand, researchers were able to identify a 10 000 year chronological sequence commencing at the Last Glacial Maximum (LGM) some 20 000 years ago. The results enabled scientists to determine the rate of glacial ice retreat, and to show that ice volume and extent at the LGM were larger than previously assumed. This study provides evidence of impressively rapid climate change from full glacial to interglacial conditions within (at most) 3-5,000 years. In contrast, exposure ages from both the Central Plateau and West Coast Ranges of Tasmania show that, in this area, the last ice age was less severe at the LGM. The Tasmanian results also provided evidence for a more developed and older sequence of glaciation covering the past 800 000 years. Exposure ages obtained at the Northern Prince Charles Mountains in Antarctica showed the East Antarctic Ice Sheet to be dynamic and unstable as late as 2 million years ago when other ice sheets were rigid and stable. To confirm this controversial finding, researchers are measuring samples from the Southern Prince Charles Mountains, which protrude through the ice sheet 800 km inland.

The 3-year Southern Hemisphere Glaciation project, which ended in December, was initiated by ANSTO and carried out in collaboration with the Australian Antarctic Division and the universities of Melbourne, Auckland, Tasmania and New England. It produced eight papers, which were presented at specialist international conferences.

The collaboration between ANSTO and the universities of Auckland, Newcastle and Melbourne will continue exposure age research. Melbourne University has allocated two full-time post-doctoral positions and a dedicated geochemistry laboratory to the project. The group has obtained a substantial 3-year Australian Research Council (ARC) grant to determine the LGM in the Southern Hemisphere and to search for the Younger Dryas, and two smaller ARC grants to apply cosmogenic radioisotopes to the study of landscape geomorphology.

Atmospheric fine particle aerosol research

ANSTO, Clarkson University and the State University of New York, at Fredonia in the United States, obtained funding for a collaborative 2-year project, "Effects of Fossil Fuel Electricity Generation on Air Quality in Western New York State". The project uses the unique fine particle characterisation techniques developed at ANSTO on its 3 MV Van De Graaff accelerator to determine sources of fine atmospheric pollution.

ANSTO's expertise in sampling and analysing air quality continued to be used by local councils in New South Wales in providing data for their State of the Environment reporting to Government. ANSTO provided the councils with units that collected the air samples and then used nuclear techniques to carry out source pollution characterisation for up to 25 different chemical species. Several councils are now approaching their tenth year of involvement with ANSTO in this atmospheric pollution monitoring.

Secondary ion mass spectrometry

Secondary Ion Mass Spectrometry (SIMS) is a powerful tool for the characterisation of the composition of materials on a micro-scale. It is widely used for the in-situ determination of isotopic ratios, and for assessing in-depth compositional structures within multi-layer specimens. SIMS is used at ANSTO to study a wide variety of materials, including nuclear wasteforms, minerals and biological samples. ANSTO's SIMS facility, the only one of its type in Australia, is made available to universities through the Australian Institute of Nuclear Science and Engineering (AINSE).

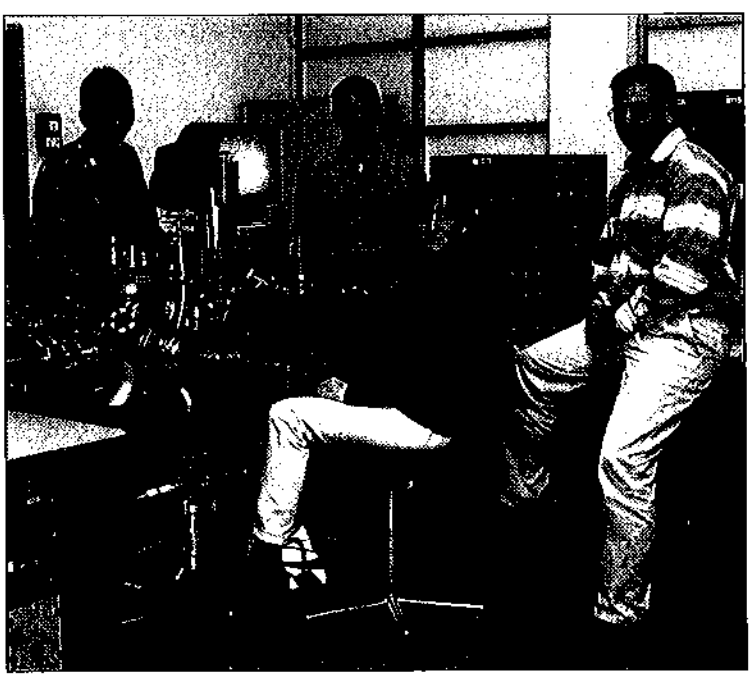
ANSTO work using SIMS included the characterisation of uranium-238 content in laterite ores from the Ranger Uranium Mine in the Northern Territory, and the analysis of atomic layer epitaxy films grown at ANSTO as a means of in-house quality control. Research staff continued to investigate the usefulness of SIMS as a means of determining sulfur-34 mobility within sulfidic mine wastes, and a pilot project commenced examining the feasibility of using oxygen-18 signatures as a means of predicting extreme weather events.

During the 1999 calendar year, 17 university researchers accessed the SIMS facility and several collaborative papers were published. Twenty-six university projects utilising

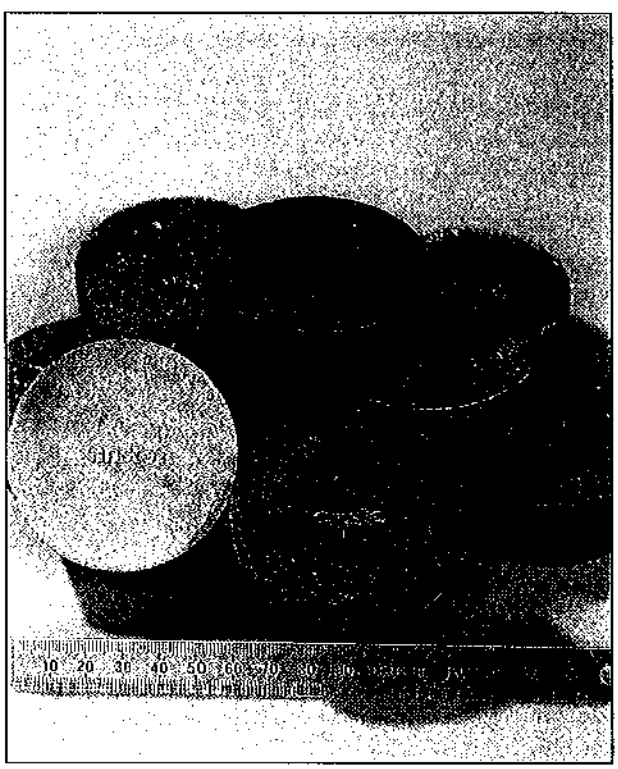
the SIMS facility obtained funding under the AINSE grant scheme for 2000. Six applications involving SIMS were submitted to the Australian Research Council for funding in 2001. Three contracts for industrial clients were completed.

Laboratory quality assurance

ANSTO laboratories maintained a "Superior" rating with the US National Oceanographic and Atmospheric Administration program for Quality Assurance in analytical chemistry.



ANSTO's Secondary Ion Mass Spectrometry (SIMS) team: Rob Russell (left), Patrick Burke, team leader Dr Kathryn Prince, and Ian Kelly.



Titanate-rich ceramic pellets developed by ANSTO for the immobilisation of excess US weapons plutonium.

Treatment and management of man-made and naturally occurring radioactive substances

Drivers: Government, ANSTO and industry

OBJECTIVES

To provide government with expert scientific and technical advice on radioactive waste management, including environmental impacts of uranium mining.

To refine, develop and implement new approaches to safely immobilise and dispose of radioactive waste and to minimise the environmental impacts from the nuclear and mining industries.

To provide environmentally sensitive and cost-effective waste management in accordance with relevant standards and appropriate risk management strategies.

OUTCOMES

- As a further development of ANSTO's research and development collaboration with the French Atomic Energy Commission and COGEMA, a Limited Liability Company, COGEMA-ANSTO LLC was formed in January 2000 between ANSTO Inc and COGEMA Inc. This brings together ANSTO's expertise in ceramic wasteform development and COGEMA's experience in ceramics processing and in undertaking technology projects for the US Department of Energy.

- Processes for the removal of thorium and other non-radioactive contaminants were developed for a complex rare-earths flowsheet. These processes will enhance the technical viability of a major new mineral processing development.

- A total of 1812 litres of intermediate-level liquid waste from radiopharmaceutical production operations were extracted from storage for processing. Two solidified batches were produced, resulting in a more than fifty-fold reduction in waste mass.

- ANSTO fulfilled its obligations under the IAEA Joint Convention on the Safety of Spent Synroc-based Wasteforms by completing its inventory of radioactive wastes and spent fuel.

ACTIVITIES AND OUTPUTS

Synroc-based wasteforms

ANSTO has collaborative agreements with major international organisations working in radioactive waste management in the United States and Europe. ANSTO continued to collaborate with these groups to develop solutions for specific waste streams and to bid for particular projects in the emerging waste remediation market.

Following agreement by the superpowers to significantly reduce their stockpiles of nuclear weapons, a synroc-based pyrochlore-rich titanate ceramic, developed by ANSTO and US collaborators, was chosen in 1998 by the US Department of Energy (USDOE) for the immobilisation of some of the US surplus weapons plutonium. Over the 18 months since then, ANSTO has participated in the integrated development and testing program for the plutonium immobilisation project as a member of a team, led by Lawrence Livermore National Laboratory (LLNL), that also includes the Westinghouse Savannah River Company, the Argonne National Laboratory and the Pacific Northwest National Laboratory (PNNL).

The superpower agreements reflect a strengthening of the global non-proliferation efforts. The United States believes that disposition of the surplus plutonium will serve as a non-proliferation and disarmament example, encourage similar actions by Russia and other nations, and foster multilateral or bilateral disposition efforts and agreements.

During the year ANSTO completed the final LLNL contract, which involved experimental work on ceramic wasteforms for plutonium immobilisation. A key element of this work was the extensive characterisation of a broad envelope of

wasteforms to support the qualification process for regulatory acceptance for eventual geologic disposal of the material. Income from the various contracts from LLNL, for the USDOE's Office of Fissile Materials Disposition, came to more than $1.8 million.

The wasteform qualification process that this technology will have to undergo in the United States is likely to produce further opportunities for the use of other ANSTO-developed titanate ceramic formulations in US radioactive waste remediation projects.

Significant progress was made in developing business opportunities for ANSTO's synroc technology. A subsidiary company, ANSTO Inc, was formed in the United States to develop strategic alliances with major engineering and technology organisations involved in radioactive waste management projects. Such alliances enable ANSTO to be active in the international market for applications of synroc technologies, including the disposal of excess weapons plutonium, where ANSTO Inc has formed a limited liability company with COGEMA Inc to submit a proposal, together with Burns & Roe and Battelle for the design of the proposed immobilisation facility. The successful bids are expected to be announced by the USDOE later in 2000. The facility will be placed under IAEA safeguards and will have the most advanced and transparent materials accountancy provisions available.

The pyrochlore-rich ceramic ANSTO has developed for immobilisation will be processed by ceramic technologies similar to those used in industrially mature mixed-oxide fuel plants in Europe. The process involves ceramic powder milling/blending, cold pressing and sintering at about 1350°C. During the year ANSTO commissioned a double-acting cold press and successfully produced full-size pellets of the pyrochlore-rich ceramic with plutonium simulated by rare earths and thorium.

ANSTO continued to pursue collaborative research and development contracts with US national laboratories to increase the acceptance of ANSTO's technologies for waste immobilisation.

Staff worked on two collaborative projects with US Department of Energy laboratories. In the first, under a cooperative Research and Development Agreement, staff worked with Argonne National Laboratory-West in Idaho in the United States to demonstrate ANSTO's proprietary hot-isostatic pressing cans under different conditions. In the second project, staff worked with PNNL in a USDOE Environmental Management basic science research project involving the University of Michigan and LLNL, to investigate the solubility of radionuclides and neutron absorbers in a range of wasteforms.

ANSTO continued to collaborate with the French Atomic Energy Commission (CEA) to develop new titanate/glass composite wasteforms. The project exploits ANSTO's capabilities in formulating specific wasteforms and the CEA's cold-crucible technology. CEA scientists visited ANSTO in April to discuss and review the joint program.

These composite wasteforms use some of the known crystalline phases of synroc to immobilise long-lived radionuclides. The glass is designed to incorporate most of the non-radioactive process chemicals that have been used in the past to neutralise acid high level waste streams from past US defence programs, in preparation for extended storage in tanks. The cold-crucible melter can operate at higher temperatures than conventional glass melters, enabling the production of durable titanate ceramic/glass composite wasteforms with high waste loadings.

A research cold-crucible melter was commissioned and used to prepare kilogram scale melts for characterisation. In addition, more than two hundred platinum crucible melts were prepared and characterised to define a process envelope for titanate ceramic/glass wasteforms for ZrO2 and Al2O3-rich wastes.

Work continued on a study of the effects of alpha decay damage on titanate wasteforms. Specimens of pyrochlore, zirconolite, brannerite and perovskite were prepared and irradiated by ion beams to simulate accelerated damage. Plutonium-238, which has a half-life of 87 years, will be incorporated in further accelerated radiation damage experiments. Uranium- and thorium-containing minerals with well-defined geological history provide additional insights into the long-term integrity of titanate wasteforms, and these will also be studied. Highly sophisticated instrumental techniques were applied to the continuing development of quantitative models of the long-term durability of titanate ceramics in potential repository environments.

ANSTO's wasteform development program continued to benefit from access to unique international research facilities such as the Australian National Beamline Facility at the synchrotron in Tsukuba, Japan, the combined ion irradiation/transmission electron microscope facility at the US Argonne National Laboratory, Chicago, and the Stanford synchrotron facilities. ANSTO also recognises the value of the scientific interactions with specialists at these facilities.

Removal of radioactivity from mineral products

In the processing of ores containing low levels of uranium and its daughter products, a knowledge of radionuclide deportment is vital in assessing treatment options for unwanted contaminants in the final products and/or waste streams.

To capitalise on its long-term expertise in this area, ANSTO began a three-year strategic research project on natural radioactivity in mineral products, the NORMS (Natually Occuring Radioactive Materials) project. Staff established contacts with the IAEA and industry organisations in order to review existing regulations and guidelines on the classification of radioactive materials transport, worker exposure, and allowable limits in saleable products and wastes. Researchers began examining techniques to determine the mineralogical location of parent and daughter radionuclides, using the Australian Synchrotron Program's x-ray microbeam at the Argonne National Laboratory in the United States.

Collaboration with industry is a major focus of the project and two industry-funded projects were begun. Ashton Mining in partnership with Lynas Corporation approved

work to support a bankable feasibility study on its Mt Weld rare earths project in Western Australia. Preliminary laboratory work was completed on the separation of thorium-sourced radioactivity and other contaminants at several points in the proposed process for the production of cerium concentrates, and an extensive pilot program was begun at ANSTO. The client has now proposed to include in the project the production of a high purity neodymium oxide by multi-stage solvent extraction, and ANSTO is undertaking this work in collaboration with the Cooperative Research Centre for Hydrometallurgy.

Cleaner technology for uranium mining and milling

The primary objective of the "Cleaner technology for uranium mining and milling" project, which began in July, is to identify, investigate and develop technologies that will lead to cleaner and more environmentally sustainable operations in the uranium mining sector. Success will be measured through the adoption by industry of technology developed from this research, reduced environmental impact from uranium mining and milling, cost savings, and greater international competitiveness for the Australian mining industry.

An experimental study was carried out to assess oxidant-consuming reactions during uranium leaching. As part of this investigation, ANSTO developed a simple process that can achieve a 20%-50% reduction in oxidant consumption in the laboratory. An investigation was begun into oxidant behaviour during acid in-situ leaching. The work is being carried out in collaboration with the Beverley uranium mine, one of two South Australian mines that plan to use acid in-situ leaching technology. In this preliminary investigation, some of the less understood oxidation processes that occur during leaching are being investigated.

A commercial contract to develop a process flowsheet for uranium and carry out a laboratory evaluation of the plan was successfully completed. Interestingly, all the primary constraints on the flowsheet were environmental factors. The flowsheet was required to have the smallest feasible physical footprint, to dispose of all wastes underground, to completely recycle process water, and to minimise consumption of any chemicals that had to be transported to the mine site. All these requirements were met, demonstrating the industrial relevance of the cleaner technology project.

Many Australian mining operations have access to only poor quality water containing high levels of dissolved salts, including chloride. The presence of chloride in sulfate leach liquor interferes with the solvent extraction of uranium. A laboratory to program define the limits of tolerance to chloride in the conventional uranium solvent extraction process was undertaken and investigations begun into alternative chloride-tolerant extraction systems. The aim is to develop a robust solvent extraction system that can tolerate the natural levels of chloride in mine waters. If successful, this will allow greater flexibility and efficiency in the management of water on uranium mine sites.

A project to develop a new magnetic resin-in-pulp process for recovery of uranium, gold and other metals directly from leach slurries was planned and an agreement signed between ANSTO and Orica Pty Ltd to carry out this work. The process utilises

novel magnetic resins (MIEX(r)), developed by Orica and the CSIRO Division of Molecular Science, in combination with resin-in-pulp technology. The process, if successful, will lead to smaller processing plants, lower operating and capital costs and the consumption of fewer chemical reagents. In addition, the magnetic resin-in-pulp process will reduce uranium losses due to uranium adsorption onto tailings. Tests completed this year indicate that potentially up to 15% more uranium could be recovered using this technology. The same resin also has potential in gold processing. Pilot work indicates the process is faster and has higher yields compared with conventional technology. This aspect of the work is being carried out in collaboration with CSIRO.

Work began on geochemical and mineralogical characterisation of old uranium tailings from the Rum Jungle uranium mine in the Northern Territory to provide a bench mark for traditional uranium tailings forms. This work will underpin future investigations of novel uranium tailings forms such as paste tailings and provide data for use in comparing the geochemical behaviour of different tailings forms.

Separation processes for radionuclides

The long-term aim of the "Separation processes for radionuclides project" is to develop technologies that can be used for separating the different radionuclides present in hydrometallurgical or radioactive waste streams. Two membrane technologies were singled out for investigation: hollow-fibre-contained liquid membranes and nanofiltration.

A study of simple mass transfer in hollow fibre modules was completed. A range of hollow fibre membrane contactors was constructed, hydrodynamically characterised and successfully operated continuously for 72 hours. The experimental data were incorporated into a working model describing mass transfer to enable the performance of this new technology to be compared with more conventional alternatives. Part of this work was presented at the 27th Australasian Chemical Engineering Conference.

Nanofiltration showed considerable potential for the treatment of uranium mill effluent to remove uranium and other dissolved species such as manganese, sulfate and radium. This work was presented at an IAEA technical committee meeting in Vienna. A continuous crossflow nanofiltration apparatus has been commissioned to further evaluate this process.

Waste Management Action Plan

ANSTO's Waste Management Action Plan implements ANSTO's Waste Management Policy. Its objectives include safe treatment and storage of radioactive wastes, maintenance of waste inventories, waste minimisation and upgrading of waste management facilities, where required. During the year, the plan focused on solidifying intermediate-level liquid wastes, treating and packaging wastes in preparation for transport to the planned national radioactive waste repository and minimising wastes from radiopharmaceutical operations.

Waste inventory and database

ANSTO completed an inventory of its radioactive wastes and spent fuel to include in data required by Australia to fulfil its obligations under the IAEA 1997 Joint Convention

on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Staff continued to extend the database and barcoding system for stored low-level solid wastes. When completed, the drum barcoding will enable individual drums of stored waste to be tracked and will facilitate the locating of any drum within the system. Work also began on a general database for all types of radioactive waste. This will enable any wasteform to be tracked from the point of generation through to processing and pre-disposal packaging.

Monitoring of spent fuel storage facilities

Routine monitoring of spent fuel dry storage facilities continued. This involved measuring humidity, oxygen concentration and radioactivity in the gas space of each fuel storage tube. The program confirmed that the spent fuel continued to be stored in a safe condition. With the shipment in December of 308 elements of spent fuel to France, three spent fuel storage tubes were emptied, bringing the number of empty tubes to 11 out of 50. These tubes were visually monitored to confirm they remained in a fit state for future use.

Waste minimisation

Sources of noble gas emissions were analysed during each stage in the processing of irradiated targets for molybdenum-99 production and total emissions were quantified. On the basis of this data, modifications were made to the way waste is transferred during the processing, resulting in a significant reduction of emissions, which were already well below public dose limits. Work continued on developing instrumentation that will quantify the emissions at each stage, making further reductions in emissions possible.

Liquid waste treatment

Intermediate-level radioactive waste from the production of molybdenum-99 is stored as a liquid in shielded tanks. Last year ANSTO staff began converting this liquid into a highly durable solid waste form suitable for long-term storage. To date, approximately 34 batches of liquid waste with a total volume of 1812 litres have been processed and converted into two 25 kg batches of solid waste. This solid waste is stored in two high-integrity stainless steel vessels with a design life of at least 50 years.

The longer-term goal is to immobilise the wastes from molybdenum-99 production into a highly durable ceramic waste-form, similar to synroc. Demonstration trials of the process, using non-radioactive materials, have indicated that it is suitable for the immobilisation of the molybdenum-99 waste. Further full-scale studies are planned using simulated waste containing uranium to further quantify the immobilisation process. A new type of ion exchange material was also evaluated for possible application in treating ANSTO's intermediate level liquid waste. The results were promising and further experimental work is planned using actual wastes from molybdenum-99 production.

A new Trade Wastewater Agreement was signed with Sydney Water for a term of three years effective from 18 June 1999. ARPANSA was consulted during the review process leading up to the signing of the agreement and endorsed the discharge limits for radioactivity specified in the agreement.

Solid waste management

Waste compaction services were maintained throughout the year, with all generated low level solid waste being safely transferred to ANSTO's gamma scanning and storage facility. The gamma scanning system identifies the particular radionuclides present in the waste and provides a precise inventory of waste materials destined for the national radioactive waste repository. Approximately 90% of ANSTO's 5000 low-level radioactive solid waste drums have now been scanned using this high sensitivity gamma assay system

Staff began categorising materials currently classified as intermediate level solid waste from a dry storage facility at the Lucas Heights site as part of a program to recover, identify and treat historical radioactive wastes. The first area to be addressed was solid waste generated up to 40 years ago by radioactive laboratory activities. Early indications showed the majority of the solid waste had decayed to a very low level of radioactivity, with some indistiguishable from normal background levels.

Waste water

Work continued on upgrading ANSTO's liquid effluent treatment plant. Three of the five mixing tanks were refurbished by relining the interiors and painting the exteriors to prevent corrosion of the steel walls. Process control improvements included the installation of a new control system on the centrifuge used to remove and concentrate the low level radioactive solids from the low level radioactive waste water, and upgrading of the SCADA (Supervisory Control And Data Acquisition) control system to ensure Y2K compliance.

Plant trials to assess the efficiency of new chemicals in removing radioactivity from low level radioactive wastewaters continued throughout the year. The trials provided information that will assist waste management staff to select new technologies for upgrading ANSTO's low level radioactive waste treatment facility. Pilot plant trials using these technologies will begin in the next financial year. Chromium was replaced with an alternative zinc-based corrosion inhibitor in the HIFAR reactor secondary cooling water circuit. Chromium has been phased out as a corrosion inhibitor because it is now considered to have detrimental effects on health.

Waste treatment and packaging

Work began on a project to build a new facility to treat and package ANSTO's low level and short lived intermediate level radioactive wastes in readiness for disposal in the proposed national waste repository. Tasks carried out in the facility will include evaporating the liquid waste concentrate from the planned new effluent treatment plant; treating non-aqueous wastes; sorting, consolidating and packaging solid wastes; and conditioning wastes in cement. Expressions of interest were sought from

equipment manufacturers, and an architect was engaged to assist staff with preparing specifications for the facility. Construction is expected to begin in the next financial year.

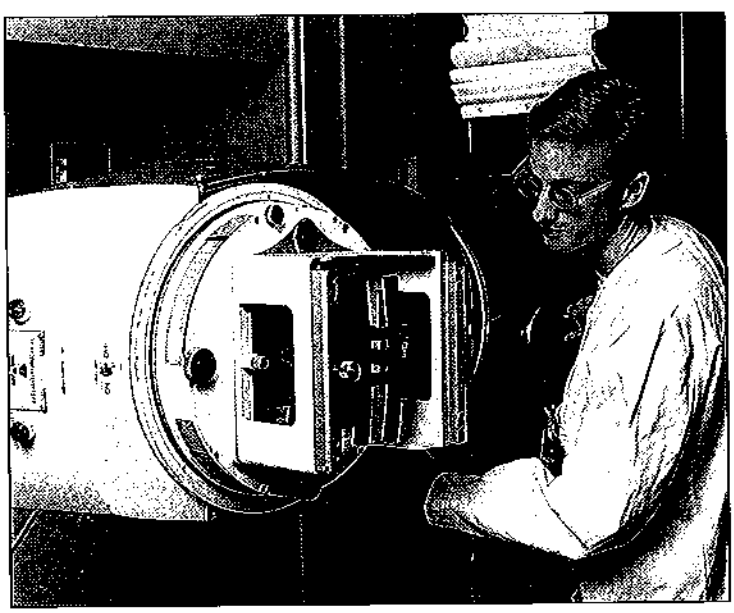
Waste operations and technology development

Staff continued to work towards ISO 9002 accreditation for ANSTO's Waste Operation and Technology Development Quality Assurance system. The majority of the documentation, including work instructions, was completed.

The Waste Operations laboratory continued to provide timely analyses for ongoing routine trade waste discharge effluent. The decontamination centre, used to decontaminate equipment that has been used in radioactive areas or with or near radioactive materials, operated successfully and was used extensively for equipment used during the major shutdown of HIFAR for maintenance.

National radioactive waste repository

The project to establish a repository in Australia for the disposal of low and short-lived intermediate level waste is being managed by the Department of Industry, Science and Resources. ANSTO provided the Department with technical advice on radioactive waste management and the behaviour of radioactivity in the environment and gave a presentation on operating repositories in other countries around the world. ANSTO also participated on working groups addressing technical repository issues for the Commonwealth/State Consultative Committee on the Management of Radioactive Waste.



Medical physicist Justin Davies adjusts the inclination of ANSTO's gamma-ray teletherapy unit, used for dosimetry standards measurements.

Sustainability and international competitiveness of industry

Drivers: Government and Industry

OBJECTIVES

To contribute to the development of critical technologies aimed at enhancing the global competitiveness and sustainability of those Australian industry sectors that can benefit through application of nuclear science and technology and ANSTO's unique mix of technical capabilities.

To provide scientific and technical advice and services to government and industry in applications of ANSTO's nuclear capabilities and technologies.

To supply internationally competitive radiopharmaceuticals and other radioisotopes for medical, industrial and environmental use in Australia and the Asia/Pacific region.

OUTCOMES

- ANSTO became a Research Member of the International Network for Acid Prevention (INAP) Ltd. INAP is an industry-based initiative that aims to globally coordinate research and development in the management of sulfidic mine wastes. Its 16 industry members account for around 40% of mining carried out around the world. ANSTO is the first research organisation to have been invited to join INAP, reflecting international perception of the quality of the research and development being carried out by ANSTO in addressing key environmental questions in the mining industry.

- Techniques developed by ANSTO provided a scientific basis for determining allowable pollutant releases from mine sites to surface waters based on site-specific ecological risk assessment.

- Environmental advice provided by ANSTO to the Indonesian company PT Kaltim Prima Coal (KPC), operator of one of the world's biggest coal mines, will lead to a substantial reduction in long-term environmental risk and liability and be worth millions of dollars to the company. Using the computational tool SWIM^{HEAPCOV}, which was developed jointly by ANSTO and CSIRO, ANSTO identified improvements in cover design strategies for the control of pollution generation in sulfidic mine waste piles at the site. The KPC site will serve as an important case study for the management of sulfidic wastes at other mines in the tropics.

- ANSTO-developed technology for removing arsenic from water was successfully demonstrated in the western United States, where new regulations will require dramatically lower arsenic levels in drinking water. The technology, which was developed by ANSTO and the Cooperative Research Centre for Waste Management and Pollution Control, provides an alternative to the use of strong oxidising agents like chlorine and permanganate.

- ANSTO successfully demonstrated a novel multiple tracer release system it has developed to study industrial gas and vapour plumes. Four perfluorocarbon tracers were simultaneously released from different stacks at an industrial site in Sydney. Detailed dispersion profiles were obtained for each stack and used to identify the principal nuisance source to the public. The system will enable companies to better manage their gaseous releases, helping them to comply with government regulations on hazardous organic compounds and reduce the impact of the compounds on the surrounding community.

- A CRC project led by ANSTO on "Pipeline hydrostatic testing:pressure/temperature correlation" was completed. The results of this project will be used to update and improve the widely used Australian Standard AS1978 on pipeline hydrostatic testing.

- ANSTO provided approximately 430,000 doses of radiopharmaceuticals across Australia in support of essential diagnostic and therapeutic procedures.

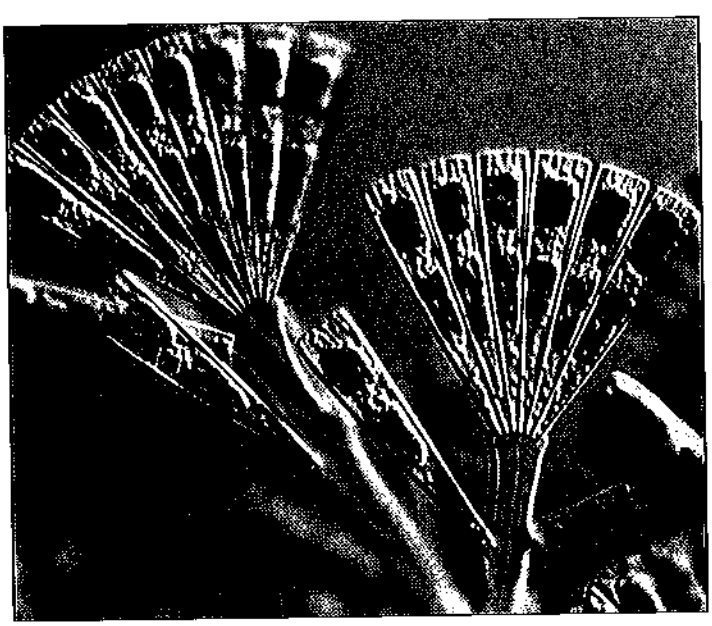
- ANSTO's new dry-bed technetium generator, Gentech®, was approved by the Therapeutics Goods Administration and commercially released in February. Technetium, the most widely used radioisotope in nuclear imaging, is made from the parent isotope molybdenum-99, which is produced in HIFAR. The generators are filled at ANSTO and sent out to nuclear medicine practices, which are then able to generate technetium as needed. The new generator replaces a long-used 'wet-bed' generator that required the addition of saline. The ANSTO-developed technology used for the new generator produces a number of benefits including more efficient labelling, and improved radiation and occupational safety.

ACTIVITIES AND OUTPUTS

Environmental management

Managing mine wastes

As part of ANSTO's work in assessing the effectiveness of earthen covers for waste dumps, scientists developed an instrument that can measure the flux of oxygen into covered piles of sulfidic mine waste. The in-cover fluxmeter is installed at the interface between the sulfidic material and the cover so that any oxygen consumption in the cover, by vegetation for example, is excluded. Measuring the oxygen flux into the sulfidic waste enables the rate of primary pollutant generation to be determined. In-cover fluxmeters were installed by ANSTO at a number of overseas sites.



Diatoms (microscopic algae) were used in the Managing Mine Wastes project as an indicator of water quality. Photo : Professor Peter Tyler, Deakin University.

ANSTO's ecological risk assessment code, AQUARISK, was improved to incorporate a geochemical model that enables it to predict the bioavailable metal concentrations in water, in line with the proposed Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines. The predictions of AQUARISK were found to agree well with biological measures of ecological detriment downstream of the Brukunga mine site, an abandoned pyrite mine in the Adelaide Hills. AQUARISK was released for commercial sale at the Fifth International Conference on Acid Mine Drainage, held at Denver in the United States in May.

Several new computer models of the chemical behaviour of waste heaps were developed. Some of these were based on the CSIRO's "Fastflo" computational engine and have advanced features such as a Local Equilibrium Model, not present in known environmental computational models. A PC version of inverse-solving software, which

infers reaction characteristics from measured temperature distributions in waste heaps, was produced to support external courses conducted as part of the Managing Mine Wastes project.

As a result of the Managing Mine Wastes project's progress in developing ANSTO's capabilities in understanding and dealing with acid mine drainage and related computational tools and instruments, a business unit, Sulfide Solutions, was set up to provide technology and consultancy services to mining companies here and overseas. The unit will start operating in the next financial year.

Advanced oxidation projects

ANSTO completed the first phase of a project entitled "Treatment of arsenic wastes". The work, which was supported by the Australian Mineral Industries Research Association Ltd (AMIRA), involved a review of arsenic wastes generated by the mining sector and of promising treatment technologies. It was found that most of these wastes were in the form of acidic flue liquors and dusts. The review enabled scientists to prioritise and recommend research and development areas for the second phase of the project, which will address treatment of waste at specific sites. Seven mining companies from Australia and South Africa sponsored the project.

ANSTO completed a testwork program for a major Western Australian smelter operator to investigate a process for recovering and stabilising arsenic trioxide from acidic flue liquors. Arsenic-bearing wastes of this type had been identified by AMIRA in the previous project as a significant issue in Australia and this second project provided an excellent opportunity for ANSTO to showcase its expertise in arsenic chemistry and waste management.

A collaborative project with the Cooperative Research Centre for Waste Management and Pollution Control (CRC-WMPC) to refine and scale up advanced oxidation technologies for the treatment of wastes, wastewaters and groundwaters containing arsenic and other toxic contaminants, was completed. The project investigated the technologies and tested them at pilot scale to provide data that could be used for commercialisation.

Two demonstrations of arsenic removal were successfully completed in the United States and these highlighted the potential for applying this technology within that market sector. Over the next year the drinking water limit for arsenic in the United States will be reduced from 50 parts per billion (ppb) to around 5-10 ppb, with the result that much of the drinking water derived from groundwater (underground) supplies will require treatment. This change provides an excellent opportunity for commercialisation of the arsenic oxidation technology in the United States. Technology licence negotiations between ANSTO and the CRC WMPC commenced.

Gas redox and displacement system

ANSTO and Earth Systems Pty Ltd obtained funding under the National Heritage Trust funded RIVERWORKS program to use a jointly developed and novel technique called the Gas Redox and Displacement System (GaRDS) for the control of acid mine drainage problems in abandoned mine workings. The technique employs

biodegrading waste such as sewage sludge, hay and domestic putrescible waste to generate a chemically reducing gas mixture of carbon dioxide and methane, similar to landfill gas or biogas. The reducing gas both physically displaces oxygen and reverses the sulfide oxidation process which is the cause of the acid mine drainage hazard. The technique will be applied to an abandoned mine site in Tasmania.

Improved landfill design and operation project

ANSTO continued to collaborate with Waste Service NSW in the CRC-WMPC project to demonstrate accelerated biodegradation of municipal solid waste. The initial test cell, which was established in 1995 and contains 7000 tonnes of waste, showed that recirculating leachate in a fully contained system would stabilise the waste three to five times more quickly than would occur in a conventional landfill. Two additional test cells were constructed in 1998-99 with the objective of further accelerating the waste stabilisation process. These cells were operated until September 1999. The aim is to use the methane gas generated as the waste stabilises, to produce electricity. The project is advancing bioreactor landfill design as a contribution to sustainable development.

Industry

Radiation technology

Commercial radiation processing in Australia and the Asia-Pacific region was supported through ANSTO's provision of a traceable high-dose dosimeter supply, measurement and calibration service.

ANSTO manufactures and sells ceric-cerous dosimeters (reference and transfer standard dosimeters) and calibrates routine Perspex dosimeters for commercial users. Two blood irradiators were calibrated using ANSTO-prepared Fricke dosimeters. ANSTO began routine use of an alanine dosimetry system, which will extend the range and capabilities of the organisation's current dose measurement services. ANSTO continued to participate in the IAEA's International Dose Assurance Scheme, and its dosimeter calibration facility showed agreement within one per cent with the IAEA's dosimetry standard, which is maintained at the IAEA laboratory in Vienna.

Australian horticultural, agricultural and manufacturing industries and the medical community continued to benefit through ANSTO's unique capability within Australia to irradiate material at a range of temperatures and dose rates.

ANSTO's seven underwater irradiation facilities and its Gamma Technology Research Irradiator (GATRI) were utilised primarily by manufacturers, importers and researchers requiring irradiation to precise dose levels and/or at controlled temperatures for items such as surgical implants, medical devices, plant tissue cultures, electronic components and laboratory equipment. The demand for precision irradiations increased following wider enforcement of regulatory requirements by Australia's Therapeutic Goods Administration and export markets. Up to 10 million pupae of Queensland fruit fly per week, as well as sheep worm larvae and plant tissue cultures, cuttings and seeds, were irradiated, thus protecting and enhancing Australian agriculture.

Following replenishment of the GATRI cobalt-60 source late last year, processing parameters for all customer goods were redetermined and revised specifications were issued. Upgrades to GATRI plant and control equipment continued in order to achieve compliance with the National Health and Medical Research Council 1998 Code of Practice for the design and safe operation of non-medical irradiation facilities.

ANSTO maintained its Therapeutic Goods Administration licence as a single stage manufacturer for radiation sterilisation of health care products and medical devices. ANSTO's Radiation Technology Quality Manual was revised and a systematic review was begun of all Quality documents. ANSTO's Australian Quarantine and Inspection Service licence was also renewed.

Isotope processing facility in Thailand

ANSTO is sub-contracted to General Atomics, a United States research reactor supplier, to design, construct, manufacture, install and commission an isotope production facility for the Thai Office of Atomic Energy for Peace (OAEP). The facility is to be built on a greenfield site at Onhkharak, some 60 km north of Bangkok in Thailand. During the year ANSTO's basic design proposals were accepted and detailed designs of the hot cells, transfer casks, liquid waste systems and irradiation rigs were submitted to OAEP for acceptance. The project experienced delays because of holdups in the granting of construction permits by the Thai authorities.

Polymer research

ANSTO contributed to the formation in July of the Cooperative Research Centre (CRC) for Polymers. The CRC is funded for seven years and divided into four major programs (polymer production, blends and composites, materials processing, and recycling). ANSTO will carry out tasks involving x-ray and neutron scattering, ion beam analysis and microscopy. Other members of the CRC visited ANSTO in February to inspect ANSTO's research facilities and discuss further research options.

Safety and life of welded structures

The CRC for Materials Welding and Joining was superseded by a CRC for Welded Structures during the year. The new CRC, which commenced in September, has a seven-year life and an expanded group of core members, strengthening its interactions with Australian industry. New participants include companies from offshore oil, gas, power and gas pipeline industries.

During the year ANSTO worked on six projects under this CRC. Two were for gas pipeline manufacturers, and involved testing high strength gas pipelines and hydrostatic testing. Two were for the power industry: one involved life estimation of welded pressure equipment and the other the integrity of high energy piping systems. A fifth project involved testing the structural integrity of rail bridges. The final project, for a petrochemical client, was on offshore structures damage mechanisms.

Materials assessment

ANSTO's miniature creep testing facility was expanded and upgraded during the year, increasing test capacity by 50 per cent. This expansion will enable staff to provide more comprehensive remaining life studies for existing and new customers. One new regional Queensland-based customer ordered a study of some of their critical components

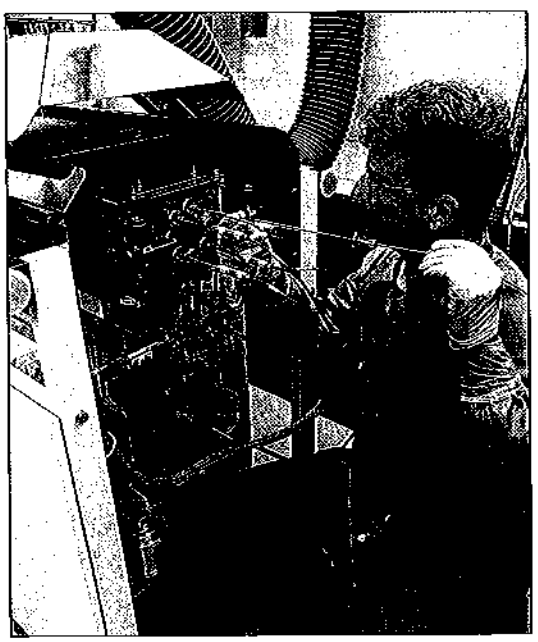
together with the development of algorithms for on-line calculation of consumed creep-fatigue life.

The ongoing collaboration between ANSTO and the University of Bremen, Germany, continued. Two German students spent 6 months working on alumina ceramics at ANSTO and an ANSTO scientist visited the University of Bremen's Institute for Ceramic Materials and Components. During this visit, which was made with support from the Australian Academy of Science under the aegis of the 'German Exchange Program', the scientist surveyed the latest developments in engineering ceramics in Europe. A confidentiality agreement was signed with the University to facilitate the exchange of information in the areas of research into porous ceramics for sensors and for liquid and gas separation.

A 7-year collaboration between ANSTO and the Comalco Research Centre and Comalco Aluminium Smelters was successfully completed during the year. The projects covered mechanical testing and thermal shock testing of carbon anodes.

Surface engineering

Expressions of interest were sought from companies wishing to participate in the commercialisation of ANSTO's patented Plasma Immersion Ion Implantation (PI^3) technology. The PI^3 process can produce hard wear-resistant surface layers in metal components treated at temperatures ranging from 150 to 550°C and is particularly effective in treating austenitic stainless steels, where substantial increases in hardness and wear-resistance can be achieved without compromising corrosion performance. ANSTO's intention is to reach agreement with an appropriate commercial organisation (or organisations) to manufacture and market the equipment under licence and to promote the industrial application of the process. The call for expressions of interest, which was accompanied by articles in relevant industry publications and presentations and displays at appropriate industry fora, resulted in over thirty enquiries. Negotiations to establish the partnership/s will be completed early in the next financial year.



Materials scientist Gerry Triani with the Atomic Layer Chemical Vapour Deposition facility (p68).

Research work, reported at several international conferences, showed why the plasmas used for PI^3 are so effective for nitriding, producing thicker hardened layers at lower temperatures than is possible using more conventional methods. The role of high energy ion bombardment in PI^3 was also clarified. The process was trialed on a range of industrial components and resulted in renewed interest in applying PI^3 to titanium alloys.

Preliminary experiments were undertaken with a commercial organisation to assess the use of PI^3 in the coating of tools. There are several applications for PI^3 in the coating process, including in-situ nitriding prior to coating, high-energy ion bombardment during deposition and post-coating implantation of nitrogen.

Functional materials interfaces

The aim of the strategic research project "Functional materials interfaces", which began in 1997, was to enable interface structures designed for specific applications to be produced by controlled manipulation at the molecular level. Research was focussed on the joining of silicon and alumina at low temperature using sol-gel technologies. The fracture toughness of the silica sol-gel bond obtained by this method at 300°C is equivalent to that achieved by the industry standard technique, which requires temperatures of 600°C. Further refinement of the sol-gel chemistry resulted in this bond strength being achieved at temperatures as low as 60°C.

As a new strategic direction to further develop this advanced technology, ANSTO commissioned an Atomic Layer Chemical Vapour Deposition facility. This digitally controlled process provides monatomic, layer-by-layer deposition through a series of sequentially performed, saturated surface reactions. It is now producing high quality thin films and coatings with a range of strategic applications. This system is the first of its type in Australia and will provide opportunities for collaborative and contract research, nationally and internationally.

A provisional patent was lodged for the use of sol-gel matrices, similar to those developed for the low temperature bonding of ceramics, for the encapsulation and controlled-release of pharmaceuticals. A research partnership with the Sydney Cancer Centre and the Department of Pharmacology at the University of Sydney was established to allow the work to progress to pre-clinical evaluation of the technology and assess its suitability as a targeted delivery system for tumour treatments. ANSTO's radiopharmaceuticals staff will be involved in isotopic labelling/biodistribution studies.

Transfer of nuclear ceramics technology

ANSTO's Functional Ceramics section began collaborating with a leading biomedical company on the development of electrochemical probes for the early detection of diseased tissue. Preliminary work was directed towards the detailed characterisation of electrochemical probes prepared in-house by the company.

An additional commercial project was initiated with an external client. It involves the deposition of thin, oxide coatings on carbon powders for applications in energy-storage systems.

Nanostructures

Staff continued to work on collaborative programs using small angle neutron scattering to investigate the structural evolution of sols and gels for the production of ceramic powders. A collaborative project being carried out by ANSTO and the US National Institute of Standards and Technology (Boulder) is providing fundamental insights into the effect of shearing forces on the structure of gels. Another project, with the French Atomic Energy Commission (Saclay), is investigating the ultrastructure of

the sols and gels during subsequent spray drying and developing scattering techniques for investigating the internal structure of such micro- and meso-porous materials.

Small angle neutron scattering contrast variation techniques were used to investigate the mechanism by which mesostructured transition metal oxides form via surfactant self-assembly and templating. These materials have potential applications in a range of industrial processes including waste remediation, ion exchange and molecular separation and in biomedicine/biosensors and catalysis.

Ion exchangers Work continued on the development of novel, selective inorganic ion-exchangers for removing caesium and strontium from acidic, radioactive waste streams, including the molybdenum-99 tank wastes at the Lucas Heights site. ANSTO has developed a family of ion-exchangers that exhibit good selectivity for both caesium and strontium in acidic solutions. Under comparable conditions, competing commercial ion-exchanger technologies are capable of removing either, but not both, elements. A provisional patent embodying this ANSTO technology was filed.

Safety services

Radiation Standards ANSTO continued to maintain traceability of calibration to a primary standard for the radiopharmaceuticals it produced. Secondary standards were also prepared and supplied to staff for calibration of gamma spectrometers and for experimental purposes. Calibration to the HIFAR neutron fluence was maintained by precise resistivity measurement of neutron-transmuted doped silicon wafers as part of ANSTO's commercial neutron transmutation doping of silicon work.

Secondary Standards Dosimetry Laboratory ANSTO's Secondary Standard Dosimetry Laboratory (SSDL) began operations on 14 June. Staff members were trained in the procedures of calibrating thimble ion chambers at the Yallambie, Melbourne, laboratories of ARPANSA, custodian of the primary standard for dosimetry. Initially the SSDL will calibrate therapy level dosimeters and thimble ion chambers for New South Wales hospitals, providing traceability to the primary standard. In addition the SSDL will participate in an IAEA-sponsored inter-laboratory calibration of thermoluminescent dosimeters.

Digital Coincidence Counting Digital Coincidence Counting (DCC) has been a joint development project between ANSTO and the National Physical Laboratory (NPL) of the United Kingdom. DCC is a PC-based technique for the accurate measurement of radioactivity that could have applications in a wide range of areas including medical tomography. Following the excellent results achieved last year on the prototype system, the project team verified the system's performance and began refining the user software. A second system was also commissioned. Work began on the next phase, which entails careful verification of the software and creation of a marketing and commercialisation plan as a prelude to full commercialisation of the system. This work is also being carried out in conjunction with NPL under a second collaborative agreement, signed in late 1999, in order to jointly market the system. A complete ANSTO/NPL DCC system was shipped to NPL in June for installation at the Bureau International des Poids et Mesures

(BIPM) in Paris in July as a longterm showcase of the system for the members of the BIPM.

Risk and reliability ANSTO safety and reliability analysts provided safety assessments and audits for two gold mines, an alumina plant, an overseas isotope production facility and the in-situ vitrification process being applied to pits containing contaminated material in the area previously used for weapons testing at Maralinga.

Radiation protection instrument calibration The radiation protection instrument calibration facility provided a commercial calibration service for external organisations in sectors such as mining, engineering, emergency services, hospitals and research organisations. Some 110 instruments were calibrated, including a range of gamma dose rate meters, neutron dose rate meters, personal electronic dosimeters and contamination monitors. In addition, "wipe tests" from 36 industrial gauges were counted.

Radiation protection training ANSTO provided 26 commercial radiation protection training courses for external organisations in areas including agriculture, local government, emergency services, defence, minerals exploration, minerals processing, manufacturing, power utilities, medicine and research. The courses ranged from general radiation protection training, often as part of a regulatory accreditation process, to specialist courses for users of specific equipment such as moisture gauges. A total of 257 personnel from 34 organisations were trained. A summary of these courses is given below.

Summary of commercial radiation protection training

Radiation Protection Course	Number	Participants
General Radiation Safety Officer (3 day)	4	44
Industrial Radiation Safety Officer (3 day)	1	7
Industrial Radiation Safety Officer Refresher Training (1 or 1.5 days)	2	10
Safe Use of Nuclear-type Soil Moisture and Density Gauges (1 day)	8	68
Safe Use of X-ray Equipment (1 day)	3	15
Safe Use of X-ray Fluorescence Equipment (1 day)	1	10
Safe Use of X-ray Diffraction Equipment (1 day)	1	20
Safe Use of a Gamma Blood Irradiator (1 day)	1	5
Safe Use of Industrial Radiation Gauges (1 day)	2	25
Radiation Safety for HAZMAT (Hazardous Materials) Technicians (1 day)	2	29
Radiation Safety for Scrap Metal Operators	1	24

Radiation protection consultancies Radiation protection consultancies were provided for external organisations in areas including waste management, site remediation and general radiation protection. ANSTO assisted the EPA in rehousing and reshielding radium-beryllium and

americium-beryllium neutron gauges that had been stored in various containers by the NSW Environment Protection Agency. Advice and support were provided to EnergyAustralia on the safe handling, transport and storage of Zellweger relays. These electronic control units contain trace amounts of radioactivity and are being phased out of service. ANSTO also provided the CSIRO with radiological expertise for the relocation of radioactive material into a purpose-built radioactive store.

A safety training officer conducted a three-day course on safety in laboratories in Melbourne.

Radiopharmaceuticals and radioisotopes

Research and development

A major focus during the year was on more closely aligning research work with the needs of the nuclear medicine community. With this aim, ANSTO formed a Clinical Advisory Group with a core membership of three specialists - a neurologist, an oncologist and a nuclear medicine physician - from three different institutions. All have research activities as a major component of their work. All proposals for radiopharmaceuticals research to be conducted by ANSTO will be vetted by this external group for merit rating before being subjected to ANSTO's own review process. The group met twice in the year, analysing outcomes from projects that are nearing completion and helping to shape major new projects.

Work on a method of labelling the commonly used but highly toxic cancer treatment drugs cis-platin and carbo-platin with reactor-produced radioactive platinum proceeded to the clinical trial stage. ANSTO has patented what seems to be an effective method for producing these radiolabelled products. Potential applications include therapeutic use, and the use of tracer doses of the labelled drugs to determine biodistribution and tumour targeting, thereby minimising toxicity and maximising therapeutic effectiveness for individual patients.

Another project involved creating a radiolabel for the Dopamine transporter in the brain to assist doctors in diagnosing and managing people with disorders like Parkinson's disease. The team's lead molecule was successfully tested in a primate and toxicity studies were begun as a prerequisite for a clinical trial with humans.

Molybdenum-99 is the parent radionuclide of technetium-99m, the workhorse radionuclide in nuclear medicine, which is used in approximately 70% of all diagnostic procedures performed in nuclear medicine around the world. Current molybdenum production in HIFAR is near capacity. To remedy this situation, ANSTO signed a collaborative agreement with the Argonne National Laboratory in the United States to develop a new target system for molybdenum-99 production. The new system will continue to use low enriched uranium as the target material, but will increase production capability. In conjunction with target development, improved process technology for molybdenum-99 purification will be developed. This combined approach, new target design and improved process will assist in ensuring that molybdenum-99 production meets future needs in a safe and reliable manner and

can take advantage of the greater production capacity of the replacement research reactor

Staff continued to work towards full ISO 9001 accreditation for the research and development facilities.

Production and marketing

ANSTO continued to supply radiopharmaceuticals to central radiopharmacies and to public and private nuclear medicine centres throughout Australia, New Zealand and Asia. Supplies of industrial radioisotopes were delivered to customers in Australia, New Zealand and the United Kingdom. The radionuclides used in the medical and industrial products were produced in the complementary facilities of the HIFAR research reactor and the National Medical Cyclotron.

Sales of radiopharmaceuticals and radioisotopes for medical, industrial and research purposes increased by 11.9% to $15.98 million. Sales of technetium-99m generators and iodine-131 continued to show good growth of approximately 10%. Growth in the majority of the remaining generic products such as thallium-201 and gallium-67 was in line with budget predictions.

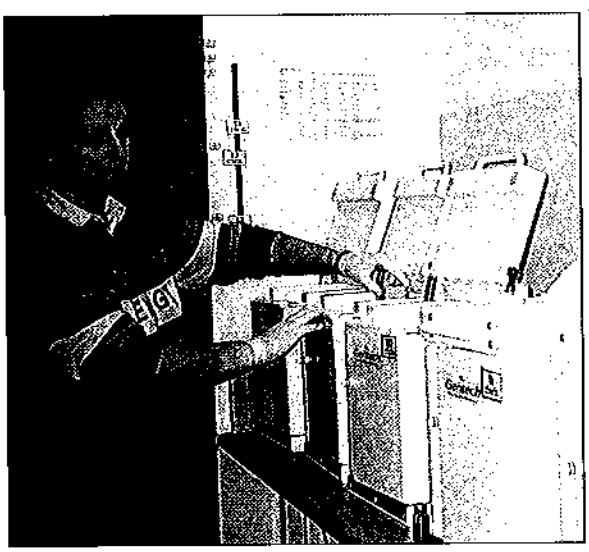
The importation of radioisotopes for medical and industrial applications was necessary during the HIFAR major shutdown (p26). Some radioisotopes could not be imported. Despite extensive planning beforehand to establish back-up supplies, there were disruptions and limitations in the supply of others.

ANSTO's strong relationships with its Asian-based distributors allowed the organisation to weather continuing economic problems in that area without financial loss or reduced sales. Export sales rose by 10% to approach 13% of total sales. A new market was established in Bangladesh.

In January Quadramet®, a radiopharmaceutical used to reduce pain in bone cancer sufferers, was listed as eligible for Medicare benefit, putting it within reach of all Australians. Quadramet® contains samarium-153 (a beta-emitting radioisotope made in HIFAR) and a carrier, methylenediaminetetra-methylenephosphonate. Though currently approved for use in Australia as a palliative agent only, Quadramet® has also shown promise as a less systemically toxic agent to prepare patients with leukaemia for bone marrow transplantation. A clinical trial of its use in this way began at the Royal Brisbane Hospital.

The release in February of ANSTO's new dry-bed technetium generator Gentech(R) was a major logistics exercise. The changeover from the old wet-bed generator to this new generator was carried out over four weeks. While the new user shields (garages) were being distributed and installed, ANSTO's production facilities were modified in readiness for the new product. During the changeover period both old and new generators were produced in parallel.

Major upgrades of radioisotope production and research facilities were approved in principle by the Board and funding allocated. The work will include modernisation of the three ventilation systems in the main isotope production area to meet future licensing safety and production quality requirements, and an upgrade of ventilation and other facilities to allow production of specialised low-volume medical products and to segregate these from research areas. The projects reached the design stage.



ANSTO's new dry-bed technetium Gentech ® generators at Radiopharmacy Service Corporation of Australia. Photo courtesy of Mr William Hladik III.

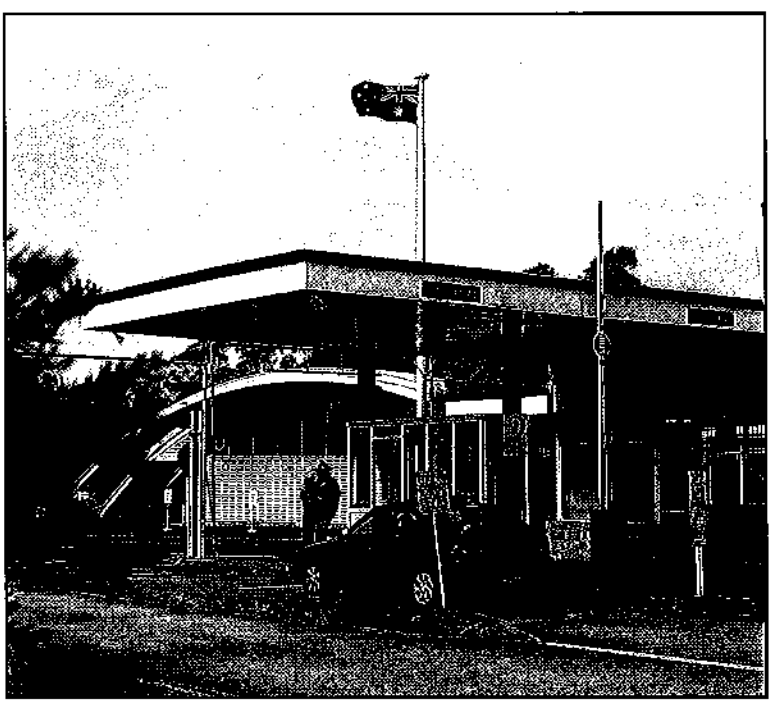
To meet increase demand for the reactor-produced sodium iodide-131, technical staff designed and built a fully automated dispensing machine that fits into a standard hot cell, enabling a much higher throughput of individualised patient-dosed capsules at considerably reduced operator exposure.

In compliance with Good Manufacturing Practices and ISO 9002 requirements, business services staff set up a customer database system that incorporates a database for recording customer complaints. The unit also developed a suite of key performance indicators for each area. In the case of customer service, dispatch and distribution, database information showed these areas achieved a performance level above 99% for processing accuracy and on-time delivery. Each month this section handled, on average, 3,000 orders and delivered 2,600 packages.

In July 1999 ANSTO became the Australian and Asia Pacific distributor for the US Department of Energy range of isotope and stable isotope products that can be imported. In October the organisation also obtained the distributorship for the UK-based AEA Technology Plc Group range of industrial radiography products. Sales revenue increased by approximately $200,000 as a result of this extra business.

A distribution agreement was signed in December between ANSTO and the US company Immunomedics Inc. to allow ANSTO to register and market two diagnostic agents: LeukoScan, which is used to image infection and inflammation, and CEAScan, used for the detection of bowel cancer.

ANSTO contract manufactures yttrium-90 microspheres which, after irradiation in HIFAR, are used in the treatment of secondary liver cancer. The company for whom ANSTO manufactures these devices, SIRTeX Medical Pty Ltd, has submitted a pre-marketing application to the Food and Drug Administration (FDA) in the United States. The FDA requested that ANSTO, as the manufacturer of the device, undergo an audit, and this was carried out in February 2000. The device has been approved for use in Australia by the device section of the Therapeutic Goods Administration. Once approval is received from the FDA, SIRTeX intends to market the device in the States.



Physical protection of the Lucas Heights Science and Technology Centre is the resposibility of the Australian Protective Service, an operational unit of the Attorney General's Department.

Organisational development and support

Drivers: ANSTO and Government

OBJECTIVE *To have best practice business processes, safety systems, information services and human resource management.*

OUTCOMES

- ANSTO and Government budget control and financial planning was enhanced by monthly production and submission of accurate accrual-based financial reports for consolidation into the whole-of-Government set of accounts.
- ANSTO's computerised financial information management system and other associated business systems achieved a smooth transition through the Year 2000 date change following a comprehensive, 3-year planning and systems testing program.
- ANSTO was fully prepared for the introduction of the Goods and Services Tax (GST) on 1 July 2000 following its successful completion of a project to achieve compliance with the requirements of the new tax system.
- ANSTO's data and voicemail infrastructure provided higher capacity, greater reliability, and improved services through a program of continual upgrading.
- Fast and efficient tracking and documentation of the evaluation process for the replacement reactor tenders was achieved with the assistance of a database developed specifically for this purpose.

ACTIVITIES AND OUTPUTS

Finance and supply activities

The main focus during the year was on consolidating activities that had occurred in the previous financial year. The move to full accrual accounting was completed, facilitating monthly production of financial statements for submission to the Department of Finance and Administration for consolidation into a whole of government set of accounts.

Preparing the organisation for the implementation of the Goods and Services Tax (GST) was a key task during the year. A wide cross section of technical and administrative staff assisted in this by identifying and resolving procedural and technical issues. As a result, ANSTO was able to meet its obligation to become GST compliant from 1 July 2000.

Strategic advice and support continued to be provided to all business units and senior management on a wide range of issues including treasury, taxation, procurement, budgeting and financial management. Accounting and payroll services, including budgetary and financial reporting, was provided to the Australian Institute of Nuclear Science and Engineering (AINSE), the Australian Synchrotron Research Program (ASRP) and other government-funded programs.

A major initiative during the year resulted from the organisation's decision to replace its existing financial information management system with a single business information system. The objective is to replace the existing system with a fully integrated, business information, human resources and production management system. The organisation's current and expected future business information requirements were investigated and identified by a project team consisting of

divisional representatives and operating under the overall supervision of a Steering Committee made up principally of division directors. Expressions of interest were subsequently sought from potential vendors of suitable systems. Formal tender action will commence early in the new financial year.

Budget ANSTO is a Commonwealth authority that operates under the *Commonwealth Authorities and Companies Act 1997* and receives government appropriation to carry out the majority of its activities. Funding for 1999-2000 was covered by the 1997-2000 Triennium Funding Agreement between ANSTO and the Government.

In support of the Government's decision in 1997 to replace the HIFAR research reactor, ANSTO is receiving an equity injection of $286 million (in 1997 dollars) over nine years. To date, $9 million has been drawn down (in dollars current at the time of draw down).

The overseas shipment of the inventory of spent fuel arising over the lifetime operations of the HIFAR research reactor has been made possible through specific Government funding for this purpose. An amount of $86.4 million (in 1997 dollars) is being appropriated over time to implement this decision. To date, $23.542 million has been drawn down (in dollars current at the time of draw down).

Parliamentary appropriation, including equity injections, of $104.641 million was received in 1999-2000 (1998-1999 $74.479 million). This amount included a capital use charge of $24.572 million (1998-1999 nil), which is required to be repaid to the Government. The capital use charge is explained at Note 2(p) in the Notes to and forming part of the annual accounts. The amount of appropriation received was allocated as follows:

- $3.720 million for the replacement research reactor project representing an equity injection of $3 million, and a capital use charge of $0.720 million.
- $9.503 million for the disposition of HIFAR spent fuel elements, being $9.315 million specific purpose appropriation and a $0.188 million capital use charge.
- $91.418 million for core science and technology activities being $67.754 million as appropriation and $23.664 million as capital use charge (1998-1999: appropriation - $66.014 million; capital use charge $nil).

The funding received for core science and technology activities is a reduction in real terms from the appropriation received in 1998-1999 and earlier years. This is largely due to the cumulative impact of efficiency dividends on the administrative component of expenditure and the use by the Department of Finance and Administration of a parameter considerably less than the Consumer Price Index to adjust the base appropriation.

In the next financial year ANSTO, in cooperation with the Department of Finance and Administration, will participate in a Pricing Review, which could alter the Organisation's funding in future years.

Revenue ANSTO is a signatory to a Triennium Funding Agreement between the science agencies CSIRO, ANSTO and Australian Institute of Marine Science and the Government. Included in this Agreement is a required performance target to be met for generating external revenue from research and other services. In 1999-2000 ANSTO generated $32.2 million (1998-1999 $30.7 million) from external sources, which represented 29.5% of total income (excluding capital use charge). This amount is in line with the performance target set down in that Agreement.

The principle external revenue component is $15.976 million from the sale of radioistope products, an increase of $1.7 million over the prior year.

Expenditure ANSTO continued to focus its science and technology activities on the five core business areas described in this annual report. Expenditure was higher than in the previous financial year as a result of costs associated with an overseas shipment for the reprocessing of spent fuel. In addition, an increase in production costs associated with radiopharmaceutical operations occurred as a result of the unavailability of raw material from HIFAR during its routine maintenance program.

Overall, expenditure against the core business and support activities was broadly in line with budgeted expectations and accorded with the planned outcomes detailed in ANSTO's 1999-2000 Operational Plan.

The operating deficiency is partly the result of project expenditure scheduled and budgeted for 1998-99 actually being incurred in 1999-2000. Further contributing factors were the increase in costs associated with the radiopharmaceutical operations referred to above, the introduction of regulatory charges and the impact of the reduced appropriation.

Through its baseline funding, ANSTO maintains and manages its research infrastructure and core nuclear facilities, which include HIFAR, the National Medical Cyclotron and the National Tandem Accelerator. In 1999-2000, $3.5 million was spent on the maintenance and upgrade of these facilities.

Internal audit ANSTO's Internal Audit Section provided specialist advice on risk management practices and risk mitigation strategies across the organisation. It also presented its integrated risk assessment and audit methodology to external forums, including those sponsored by Comcover.

ANSTO provided Comcare with a summary of the organisation's first year of occupational health and safety self audit activities. The organisation was granted self audit status in June 1999.

Insurances

ANSTO is a participant in the Commonwealth's managed fund for insurable risk, organised by Comcover. Under these arrangements, ANSTO is covered against claims for financial loss, death or personal injuries, or damage to property arising out of activities or products of the organisation.

All areas of risk, including property, business continuity, professional indemnity, directors and officers, motor vehicles, personal injury, marine transit, medical malpractice, travel, and industrial special risk for a property used for commercial purposes, are covered. Premiums, deductibles and insurable limits are set on Comcover's normal terms and conditions. Medical expenses for staff posted overseas are covered under a separate insurance policy on normal commercial terms and conditions.

Workers compensation is covered by statute under the *Safety Rehabilitation and Compensation Act 1988*.

A Deed of Indemnity is in place between the Commonwealth of Australia and ANSTO to indemnify ANSTO, ANSTO directors and officers and contractors from any loss or liability arising from claims caused by ionising radiation.

Human resource management and development

During the year a new, 3-year human resources strategy was developed and presented to the Board. The strategy identified outcomes to be achieved in workforce planning, performance management, learning and development, and reward and recognition. The strategy focuses on supporting and enhancing an environment that values intellectual capital and in which people are encouraged to create, share, find and use knowledge.

A major initiative in the year was the introduction of the Learning Environment for New Strategies (LENS) Program. Phase 1 of this teamwork and cultural change training program was trialed with 150 staff, before being offered, progressively, across the organisation. The program will involve all staff in an active learning process over a 3-year period. Existing, ongoing training programs were reviewed and aligned with LENS to maximise their effectiveness.

The main management development program used during the year was a "Leadership in Innovation" program organised by the Business and Higher Education Round Table. Staff who have completed this program have become a valuable resource supporting the LENS program.

The competency project, which is developing a competency-based human resource framework for the organisation, continued. Management and core competencies were defined and catalogued and significant progress made on defining competencies required in the different disciplines represented at ANSTO. The competencies underpin the ongoing development of human resource practices and, although in draft form, have already been incorporated in the recruitment process and accepted as adding transparency and rigour.

Staff management policies continued to be reviewed. Areas covered included harassment and drug and alcohol policies, the vacation employment program, the year-in-industry scholarship program and overseas terms and conditions. Human resources staff continued to provide advice and support to management and staff.

Four trade apprentices were recruited during the year.

Training carried out during 1999-2000 financial year

Categories	Number of courses	Male participants	Female participants
LENS program	16	343	72
Quality assurance courses	41	122	35
Health and safety courses	125	895	228
Science and engineering courses and conferences (including HIFAR-specific training)	125	338	46
All other management and competency-based courses	119	334	130

Scholarships valued at $360,000 were paid for undergraduate, postgraduate and year-in-industry scholarships.

Work experience for young Australians

This year the work experience program placed more than 46 secondary school students. During the university summer vacation another 17 undergraduate students were provided with work experience at ANSTO.

Employee and industrial relations

Employee and industrial relations remained relatively stable despite a significant level of negotiation and consultation with staff and unions associated with the Award simplification process. Because of the formality of the process, a number of these interactions involved attendance at the Australian Industrial Relations Commission. As a result of the Award simplification process, the Commission issued a new Award effective on and from 20 July 2000.

ANSTO's consultative mechanisms, the Joint Consultative Committee and the ANSTO Peak Council, continued to serve as the major vehicles for dialogue between management and staff representatives on industrial relations issues.

ANSTO continued to foster its links with government, industry and the science community in order to monitor employment and management policies and practices in those sectors and to ensure that its remained relevant.

In April, ANSTO and union representatives began negotiating a new Enterprise Agreement to replace the third Agreement, which covered the period from August 1997 to February 2000. Negotiations are continuing with a view to completing a new Agreement at an early date.

Computing services

Year 2000 date change compliance work on critical systems for ANSTO was completed by the end of the previous financial year and a second external audit carried out. Contingency plans for the end of year roll-over were subsequently prepared, including a plan for the deployment of diesel generators, a test plan for HIFAR, a Safety Emergency Response plan, and plans to control personnel access to the site. In the event, it was not necessary to put any of these plans to use.

Computer Helpdesk services were enhanced by the installation of HEAT helpdesk management software, which logs and tracks assistance requests and provides a screen prompt, alerting computing staff to the existence of a high priority task.

Scientific computing facilities were augmented by the introduction of a network of linux-based computers, which are specially suited to heavy computational loads.

ANSTO's computing systems continued to be updated and simplified, with some packages being upgraded and others replaced.

The use of a public domain package, PVM (Parallel Virtual Machine), that manages the communication and synchronization of information between different computers, was investigated. The package would exploit the computational power of the current generation of ANSTO desktop PCs and absorb some of the ever-increasing workload carried by the central scientific computer. A commercially available software package was purchased to assist with scheduling and managing multiple simulations across many processors.

An automatic data transfer system for transferring data from the Australian Valuation Office assets revaluation section to the ANSTO Financial Information Management System was completed.

Secure business-to-business transfer of superannuation information to ComSuper, the body that administers the major Commonwealth employees' superannuation funds, was implemented. This provides additional automation of ComSuper processing, removing the need for payroll staff to perform a manual and error-prone transfer each fortnight, and allows better system control.

The National Medical Cyclotron's computer network was integrated with the Lucas Heights site network, making it easier for staff at the two sites to communicate via ANSTO's intranet system.

The SAGE financial system used by radiopharmaceuticals staff was upgraded so that it could operate in the Windows environment.

ANSTO's dosimetry application was tested extensively for Year 2000 date change compliance using external testing service providers and test-robot software. The test robot software was purchased specially for this task and will be used in future applications development.

Electronic data management

A web-based electronic form was developed for the collection of AINSE grant applications. This allows faster processing and reduces data entry requirements. ANSTO's electronic file archiving system, Dorostore, was upgraded to a new, Year 2000 date change compliant version that has a new cross-platform Java interface The Docushare software package was purchased to provide indexed web access and version control management for ANSTO's electronic documents.

Disk capacity was increased on a number of site servers, including the site exchange mail server. Corporate server directories were rationalised and access permissions tightened.

Systems documentation was developed for the installation of Windows operating systems (approximately fifty standard applications are used across site) and the set-up of databases on Microsoft Standard Query Language server databases. For disaster recovery purposes, procedures were developed for the recovery of individual databases on individual servers.

Uninterruptable power supply units were installed for the data collection computer systems at ANSTO's gamma pond, which is used for short-term storage of spent HIFAR fuel elements - and for the quality control monitoring system in the radiopharmaceuticals production area.

Computing staff successfully converted the TRIM records software program to a Windows application, making it easier to access and use. The TRIM program is used to record, track and locate ANSTO's paper files.

Internal telecommunications

The site Voicemail system software was upgraded to ensure it was Year 2000 compliant and stable.

Data and telecommunication connections across the site, including those in the Emergency Operations Centre and the Replacement Reactor Project offices, continued to be upgraded. This ongoing network upgrade program is providing ANSTO with fast, dedicated ethernet connections to each desktop personal computer

A new backup power system for the Lucas Heights site PABX telephone system was designed, installed and commissioned.

Outsourcing project

ANSTO joined CSIRO, the Bureau of Meteorology, the Australian Institute of Marine Science (AIMS), the Australian Geological Survey Organisation (AGSO), and the Antarctic Division, in Cluster 9, the scientific grouping, to begin scoping and preparing a tender for outsourcing its information technology infrastructure and services, as

required by the Commonwealth Government. The Director of Information Management represented ANSTO on the Cluster steering committee. (See also 'Federal information technology outsourcing initiative', p150).

Library services The ANSTO library continued to provide high quality service to ANSTO and CSIRO staff through a blend of electronic and print resources.

Sarah Shadlow (left) and Stacey Borg are working part-time in ANSTO's library for a year to complement their studies in the TAFE Diploma of Library and Information studies.

Desktop access by staff to key electronic information resources was further extended. ANSTO scientists were able to search more than 1200 titles, including 1100 Elsevier electronic journals, via the CSIRO Library Network, and over 70 databases via the ANSTO Library web site. The web-based ANSTO Library Journal List was the main access point, providing details and holdings for all print and electronic journal titles available to Lucas Heights staff. Links to electronic journals were provided as appropriate. Electronic files (on CD-ROM) of scientific and technical reports, conference proceedings, patents and dissertations reported in INIS since 1997 were also accessible.

Library staff continued to expand their role as trainers, facilitators and information experts, assisting other staff to access and manage information effectively. Group and individual training sessions were organised to highlight the features of newly acquired electronic resources and advise scientists how to fill their information needs effectively.

Security Physical protection of the Lucas Heights Science and Technology Centre, including responsibility for incident response, is the responsibility of the Australian Protective Service (APS), an operational unit of the Attorney-General's Department. This arrangement is provided to ANSTO under a user pays contract. The APS ensures that physical security of the site is constantly maintained in accordance with international criteria recommended by the International Atomic Energy Agency (IAEA) and that

access to the site by staff, contractors and visitors is controlled to minimise opportunity for unauthorised access.

Physical protection of all facilities and materials was satisfactorily maintained in accordance with national and international obligations. Physical protection technology and the Lucas Heights site security and safety alarm system were upgraded as part of a program of continuous improvement. A new security access system was installed at the National Medical Cyclotron and linked with the Lucas Heights security system. Protective security arrangements covering classified material and information, and security vetting of staff and contractors, were satisfactorily managed. There were no incidents involving a breach of the physical protection system during the year.

Quality assurance

ANSTO's management systems continued to be developed to meet national, international and organisational objectives in accordance with the requirements of the recognised quality standard AS/NZS ISO 9001.

One Division and one unit in another Division hold third party certification to AS/NZS ISO 9000, and one unit in another Division holds certification to ISO 9001. Three Divisions are working towards third party certification to AS/NZS ISO 9001 with the intention of upgrading to the AS/NZS ISO 9001:2000 standard when it is released. Demonstration of quality was achieved through training of staff, application of training through internal audit, and laboratory intercomparison. The ANSTO analytical chemistry laboratories maintained a 'Superior' rating during the latest round of laboratory intercomparisons administered by the USA National Oceanographic and Atmospheric Administration.

Commercial leasing of ANSTO property

Three tenants took up options to renew their leases during the year and two tenants sought additional rented space to accommodate their expanded business activities.

Business development

An update of ANSTO business guidelines was issued in January 2000. The guidelines cover the operation of internal projects and the conduct of business between ANSTO and external organisations. The procedures for valuing and costing projects were amended to include provisions covering applicable GST issues.

Patents

Solely or jointly with other organisations, ANSTO held 168 patents, designs, trademarks and applications at the close of the financial year.

Engineering services

The electrical reticulation system upgrade, begun several years ago, neared completion. ANSTO has spent over three million dollars on the staged upgrade, which involved replacing and/or upgrading all high voltage switch gear and most low voltage switch gear, making energy efficiency improvements and upgrading stand-by power systems.

ANSTO successfully negotiated with Energy Australia for that company to provide ANSTO with two new transformers and state-of-the-art high voltage switch gears that will cater for any additional power demands in the future, including those created by the replacement reactor. This will be fully funded by Energy Australia.

A major upgrade of facilities for ANSTO's Environment Division was completed. The work involved the complete refurbishment of 20 laboratories and related staff offices and the construction of a new conference room. These upgrades, together with building extensions completed previously, have made it possible to accommodate almost all the Environment Division staff in one complex, which will lead to operational efficiencies.

Engineering Division staff members Steve Gatt (left), Danny Dean and Steve Prescott.

ANSTO scientist Mr Quan Hua (right), with dendrochronologist Dr Michael Barbetti from the University of Sydney, display a Three-Leaf Pine trunk used in radiocarbon calibration measurements carried out on ANSTO's ANTARES accelerator.

Legend:	Core business areas (p88)
ISRNS	International strategic relevance of nuclear science and technology
CNFOD	Core nuclear facilities operation and development
NSES	Nuclear science for environment and sustainability
TMRS	Treatment and management of man-made and naturally occurring radioactive substances
SICI	Sustainability and international competitiveness of industry
ODS	Organisational development and support

Performance indicator information

The Triennium Funding Agreement for the period 1997-2000 between CSIRO, ANSTO and the Australian Institute of Marine Science and the then Ministers for Finance and for Industry, Science and Technology contains an agreed set of performance indicators for ANSTO. These indicators are used as part of the process of monitoring the performance of ANSTO's functions and achievements of its objectives.

Reporting against Performance Indicators 1 and 2 and 4 to 10 is provided below.

Reporting against Performance Indicator 3, the adoption by users of practices, instruments and processes developed by ANSTO, is covered in the general reporting under core businesses.

Performance Indicator 1 ANSTO contracts (valued at over $1000)

Number of contracts

Core Business Area*	1997-98	1998-99	1999-2000
ISRN	14	15	0
CFOD	10	24	87
NSTN	48	57	24
TMRS	27	29	32
CESI	241	191	530
ORDS	0	0	1
Total	340	316	674

* see p87 for legend of core business areas

Percentage completed

	1997-98	1998-99	1999-2000
ISRN	86	93	-
CFOD	100	100	100
NSTN	100	100	100
TMRS	81	79	88
CESI	80	85	98

Performance Indicator 2 ORDS - - 100

ANSTO allocation of resources (in $'000) to agreed priority areas (Operating + Capital Expenditure + Spent Fuel Project)

	1997-98	1998-99	1999-2000
ISRN	6,668	7,385	10,506
CFOD	33,270	33,037	33,449
NSTS	5,816	5,804	6,205
TMRS	14,660	16,256	21,173
CESI	6,465	17,092	15,517
ORDS	14,208	13,873	14,000
Radpharm Ops	8,178	8,310	12,206

Performance Indicator 4 Total 99,265 101,757 113,056

Science- and technology-based gross revenue ($'000)

	1997-98	1998-99	1999-2000
ISRN	2,933	2,711	259
CFOD	4,475	5,291	4,557
NSTS	822	569	587
TMRS	1,052	973	1,228
CESI	4,282	3,912	6,032
ORDS	1,029	1,816	177
Radiopharm Ops	13,310	14,313	15,729
Total	27,903	29,585	28,569

Performance Indicator 5 Publications by type

	1997-98	1998-99	1999-2000
Journal articles	129	105	140
Conference papers/abstracts	272	272	330
Commercial/technical reports	161	120	133
Books/chapters	6	3	4
Published monographs	0	9	0
Other	7	17	24
Total	575	526	631

Performance Indicators 6&10 Cooperation with industry, research organisations and the university sector

	1997-98	1998-99	1999-2000
Number of visiting scientists who undertook research at ANSTO	35	53	60
Total number of students using ANSTO facilities	237	189	188
Number of phD students fully or partially sponsored by ANSTO	60	64	92

Performance Indicator 7 Activities for and on behalf of Government
27.7 person-years

Performance Indicator 8 Maintenance and extension of international networks
15.4 person-years

Performance Indicator 9 Degree of usage of maintained facilities by external users in 1999-2000

Core nuclear facilities
HIFAR Research Reactor

University projects funded by the Australian Institute of Nuclear Science and Engineering (AINSE) utilised 409 instrument-days.

ANSTO research utilised 154 instrument days. ANSTO research involving collaboration with international research organisations, university groups and training of postgraduate students used a further 140 instrument-days.

ANTARES Tandem Accelerator
External users accounted for 32% of operational time.

3 MV Van de Graaff Accelerator
External users accounted for 48% of operational time.

ANSTO emergency response personnel and the NSW Ambulance Rescue Service carry out an emergency exercise at the Lucas Heights site. The 'rescue' was successful.

Safety and environmental protection arrangements at ANSTO facilities

OBJECTIVES

ANSTO is committed to ensuring a safe and healthy environment at its facilities for employees, visitors and contractors without impacting on the external community or environment.

- *Ensure protection of human health and safety and the environment as the organisation's highest priority.*
- *Promote a positive safety culture and environmental awareness.*
- *Provide and maintain safety systems and assessment procedures that are in accordance with national and international standards.*
- *Strive for continual improvement in safe work practices and prevention of pollution to ensure that risks to staff and the public associated with ANSTO's operations are kept as low as is reasonably achievable.*

OUTCOMES

- ANSTO safety systems were again demonstrated to comply with the requirements of the Occupational Health and Safety (Commonwealth Employment) Act 1991. A COMCARE audit for compliance with the new plant regulations indicated that all ANSTO plant requiring licensing had been registered. The investigation reported a very positive outcome.

- A revised safety assessment and approval process consistent with the *Australian Radiation Protection and Nuclear Safety (ARPANS) Act 1998* and associated Regulations 1999 was introduced and is working effectively.

- All staff working with radioactive materials had their radiation exposure monitored to ensure that radiation doses complied with internationally agreed limits for both Lucas Heights staff and the public. No member of staff was exposed to a dose greater than 10 millisieverts (mSv). The limit set by the National Standard for limiting occupational exposure is 20 mSv.

- Controls, monitoring and assessment ensured that off-site exposures from airborne emissions from ANSTO were less than 1% (ie less than 10 microsieverts) of the public dose limit of 1 mSv (or 1000 microsieverts) per year. Effluent discharged into the sewer system complied with all requirements from Sydney Water and the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA).

- The results of ANSTO's environmental monitoring program showed that the organisation was in full compliance with all relevant regulations and guidelines and that operations at the LHSTC had no adverse effect on the environment or the health of the community during the year.

- The effectiveness of the ANSTO emergency management plans was recognised by the NSW Emergency Services as significantly exceeding all recommended standards and guidelines. An extensive emergency exercise was successfully conducted. It involved all the emergency services and had observers from the local community and from eight regional countries.

- A ground water monitoring regime was established for the Lucas Heights Science and Technology Centre. This regime, undertaken as part of ANSTO's Environmental Management Action Plan, involved the drilling and development of monitoring bores and a range of geophysical investigations to allow estimation of the geological structure between the bores. ANSTO commissioned PPK Environment and Infrastructure Pty Ltd to perform the ground water study. The establishment of a ground water monitoring system was a condition of approval arising from the Environmental Impact Assessment for the replacement research reactor.

ACTIVITIES AND OUTPUTS

ARPANSA licensing and regulation

In August ANSTO applied to ARPANSA for licences for its nuclear installations and prescribed radiation facilities, as it is required to do under the Australian Radiation Protection and Nuclear Safety Act 1998 and the Australian Radiation Protection and Nuclear Safety Regulations 1999. ANSTO also provided a public version of this application as it related to nuclear installations, which ARPANSA published on its web site. This application is open for public comment. ARPANSA will review the application and the public comments before determining the conditions on the licences. ANSTO also modified its safety systems to bring them into accord with the new ARPANS Act and Regulations.

Health and safety policies

The safety audit system was upgraded and the appropriate officers, including Health and Safety Representatives, trained to ensure safety procedures and requirements were consistently assessed throughout the organisation. This training will be extended to line supervisors to assist them in ensuring best safety practice in their work place.

The first COMCARE audit conducted under ANSTO's newly approved self-audit status was undertaken by the organisation's Site Auditor. This consisted of an Occupational Health and Safety Management Systems audit of ANSTO using the COMCARE version of the Safety Map audit tool at the Initial Level. Additionally, ANSTO identified three areas that would benefit from a more detailed risk assessment. Two of the areas, contractor safety and electrical safety, were assessed and reported on to COMCARE. Both demonstrated improvements. Assessment of the third area, Radiopharmaceuticals Lucas Heights, is expected to be completed in the next financial year.

Occupational health and safety

Occupational health and safety specialists ran 146 safety courses covering 21 different safety topics for Lucas Heights Science and Technology Centre staff. The courses help ensure staff are kept up to date with current health and safety practices.

Contractor safety

ANSTO occupational health and safety officers provided a safety training session for contractors every fortnight or on demand. Videos produced by ANSTO are utilised to ensure consistency of the safety message. Specialised training, such as that required by contractors who were to upgrade a crane used in the reactor building, was provided on request.

Course	Number of courses run	Number of participants
Contractor safety induction	39	129
Radiation safety for contractors	14	55
Radiation safety (1 day)	5	5

Accidents and incidents

A revised ANSTO Event Response System was developed and put in place. This enhances the initial response of all staff to any incident and is designed to speed up the reporting process so that investigation of an incident can begin as soon as possible after the event.

There were four COMCARE reportable incidents/medical cases on site during the year. One involved a contractor working in the canteen that was splashed with hot oil during a cleaning operation. Cleaning procedures were reviewed and tightened after the incident. The second incident occurred during the removal of a hot cell window. A hydraulic pump was being used to remove the window when one of the hydraulic rams was forced upwards from the trolley on which it was located. No one was injured. A review of similar equipment on site was initiated and the procedures for use of this equipment were reviewed and upgraded. The third incident involved a pedestrian forklift that was being driven down a driveway when a rock became lodged in the support wheels and the equipment tipped over. No one was injured in the incident. A review of the equipment and its usage was initiated. The fourth reportable case involved a medical condition not related to an accident or exposure to radiation that resulted in more than thirty days being lost. A return to work program will be managed by the Site Medical Officer.

Environmental Management Action Plan

The Environmental Management Action Plan (EMAP) is a new project initiated to ensure that environmental management at ANSTO is consistent with emerging environmental practices and appropriate for future operations. This will require external accreditation for the International Standards Organisation (ISO) 14001 standard for environmental management systems. EMAP will be addressing a number of the key approval conditions arising from the Environmental Impact Assessment of the replacement research reactor. It will investigate all areas of potential environmental impact, including airborne and liquid discharges from the site, transport of materials through the environment, monitoring of radionuclide concentrations in the environment, and the effects on the public and the general environment. The project will also examine the underlying systems used to protect the environment with the objective of ensuring continual improvement in ANSTO's environmental performance.

Staff began investigating Australian best practice in environmental management and made technical visits to a number of organisations that are successfully addressing environmental issues similar to those faced by ANSTO. The organisation also contacted selected overseas nuclear establishments with good environmental credentials to examine international best practice relating to environmental management.

Current monitoring performed by ANSTO was reviewed and will be assessed in line with International Standards Organisation (ISO) 14001. New systems for monitoring discharges are under investigation with a move to real-time monitoring. Real-time monitoring provides operators with information on the emissions as they occur, which allows more operational control and may ultimately result in a decrease in emissions. Drilling of ground-water monitoring bores was completed. Additional geophysical studies were performed to determine the physical characteristics of the monitoring bores and to provide information on the geological structures between bores. Work is progressing on an environmental gamma monitoring system for ANSTO that will allow continuous measurement of both natural and operational contributions to external dose rate.

The National Association of Testing Authorities provided ISO 14001 training for 15 ANSTO staff. The training provided information on environmental management systems and helped increase staff awareness of the importance of the environment in all areas of ANSTO's operation.

A report entitled *Environmental and Effluent Monitoring at the Lucas Heights Science and Technology Centre, 1998* was approved by the ANSTO Health, Safety and Environment Committee and released to the public. This report provides full details of the organisation's environmental performance. It demonstrated that ANSTO was in full compliance with all relevant regulations and guidelines.

Airborne emissions

In the course of their normal operations, some facilities produce small quantities of gaseous emissions. Emissions are minimised by treatment and filtration prior to discharge and all are constantly monitored. The effect on the surrounding environment is too small to directly detect, so an atmospheric dispersal model is used to estimate the doses to the surrounding region and the public.

The results of discharge monitoring and dose assessments showed that radiation doses to staff and the public due to the discharges were less than 0.01 mSv (10 microsieverts), which is only 1% of the annual limit for members of the public recommended by the National Health and Medical Research Council. The doses were well below the average dose of 2 mSv per year received from natural background radiation. A dose of 0.01 mSv corresponds to the dose received as a result of a return commercial airline flight to Melbourne.

ARPANSA's independent monitoring of ANSTO's airborne discharges during the reporting period confirmed the results obtained by ANSTO.

Airborne discharges for the reporting period were strongly influenced by the major shutdown of the HIFAR reactor, which occurred from 7 February to 2 May. During the shutdown period there was no release of argon-41 and releases of other noble gases from the radioisotope production facilities were also reduced. However, due to the increase in maintenance activities, tritium releases from HIFAR increased, as they have during all previous major shutdowns. They were still within the authorised levels. The net effect of the shutdown period was a reduction in the already low doses to the general public.

Liquid effluent discharges

Effluent discharged from ANSTO into the Sydney Water sewer met all limits for radioactive discharges in accordance with the Trade Waste Agreement with Sydney Water. These limits ensure compliance at the Cronulla Sewage Treatment Plant with World Health Organisation drinking water standards for radioactivity. For non-radioactive materials, all discharges were in compliance with the Trade Waste Agreement. The Australian Radiation Protection and Nuclear Safety Agency continued to validate the measurements taken.

Safety assessment

ANSTO is committed to undertaking its activities in a manner that protects human health and the environment, promotes continual improvement in safe working practices and is in accordance with all applicable State and Commonwealth statutory obligations. To achieve these objectives, it is necessary to have both an approval system before experiments, processes and operations are conducted, and a monitoring system to ensure that the experiments, processes and operations continue to be conducted safely, and that their performance is consistent with environmental commitments. These functions are performed by ANSTO's Health, Safety and Environment Committee and Safety Assessment Committee.

ANSTO Health, Safety and Environment Committee

The ANSTO Health, Safety and Environment Committee (AHSEC), which was formed last year, met four times. The first meeting dealt with the draft Source and Facility Licence applications. At other meetings the committee reviewed reports from the managers of HIFAR, the Facilities Safety Unit, the Environmental Monitoring Committee, the Environmental Management Action Plan, and the Leader of Waste Operations and Technology Development, the minutes of the Safety Assessment Committee, the quarterly airborne emissions reports and the quarterly and annual reports from ARPANSA.

In March Mr Don Macnab, Acting Director of the Regulatory Branch of ARPANSA, briefed the AHSEC on ARPANSA's views of the safety responsibilities at ANSTO, including the functions of the AHSEC, and on the status of the licence applications and other issues.

The AHSEC monitored progress on a number of issues including follow up actions from the fuel handling incidents that occurred last year, actions carried out as a result of the HIFAR Safety Document update and the HIFAR Probabilistic Safety Assessment, the replacement reactor project, completion of HIFAR projects and environmental monitoring.

Facilities Safety Unit

The Facilities Safety Unit continued to support the operation of the AHSEC. It reviewed submissions for modifications to plant and to operations of facilities, assisted in the development of safety directives for the Lucas Heights site and participated in the re-accreditation of facility operations staff.

Safety Assessment Committee

All potentially hazardous activities not directly involving higher category facilities require approval by the Safety Assessment Committee. The Committee assessed and approved 170 submissions for new or modified processes during the year. All submissions were examined by assessors before being presented to the Committee. The Committee contains a wide representation from across site as well as an external member. It has a major focus on occupational health and safety and environmental issues, and waste management. Within the ANSTO system, it provides the approval route for all prescribed

radiation facilities and the management of sources at ANSTO, as well as interacting with the Facilities Safety Unit for reviews of nuclear installations.

Radiation protection

Radiation protection services, in the form of operational health physics support and personal dose monitoring, were provided to all ANSTO sites. Routine health physics monitoring of work areas ensures that radiological hazards are controlled and a high standard of safe working conditions maintained.

As part of the assurance of safety at work for all staff, the ANSTO Personal Dosimetry Service monitored the external radiation exposure of 762 persons working at the Lucas Heights Science and Technology Centre and at the National Medical Cyclotron, which is located adjacent to the Royal Prince Alfred Hospital, Sydney.

The highest effective dose for the year to any individual was 8.9 mSv, which is well below the annual dose limit of 20 mSv (averaged over 5 years) and lower than the highest effective dose last year. This reduction in the highest effective dose can be attributed to the completion of refurbishment and mechanisation of the Radiopharmaceuticals Operations dispatch area.

Table 1 shows the maximum, average and collective effective doses for the past four financial years.

Table 1: Effective dose

		1996-97	1997-98	1998-99	1999-2000
Maximum effective dose	mSv	15.0	12.6	11.3*	8.9
Average effective dose	mSv	1.0	1.0	1.0	0.8
Collective effective dose	Person mSv	730	811	772*	617

*This is a corrected value reported as slightly less in last year's report.

Table 2 shows the distribution of individual effective (whole body) doses for the past four financial years.

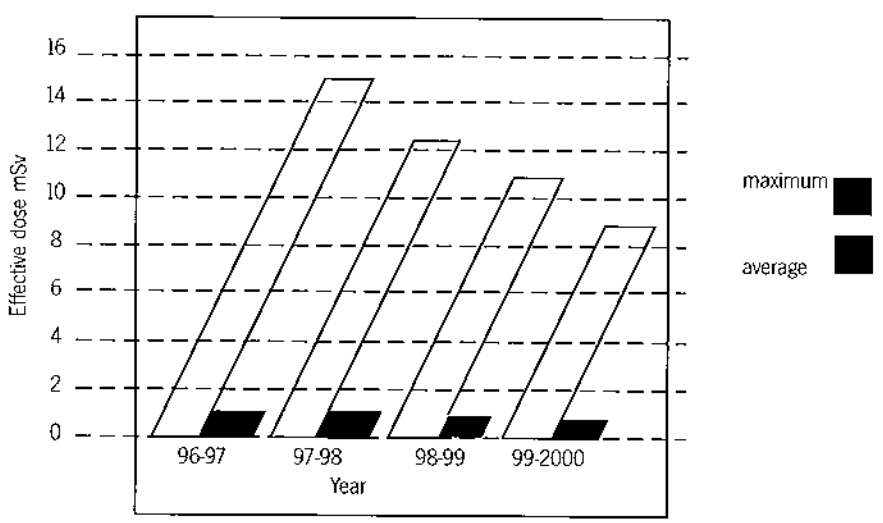
Table 2: Distribution of individual effective dose

Individual effective dose ranges (mSv)	1996-97	1997-98	1998-99	1999-2000
	Number of persons			
<2	657	670	665*	669
>2 to 5	66	80	81*	67
>5 to 10	28	29	25*	26
>10 to 15	3	3	1	0
>15 to 20	0	0	0	0
>20	0	0	0	0

*This is a corrected value reported as slightly less in last year's report.

Seventy nine per cent of workers monitored received less than 1 mSv and no worker received more than 9 mSv. The highest dose was received by a radioisotopes production worker in ANSTO's National Medical Cyclotron, and 16 of the 26 workers with doses between 5 and 10 mSv have been involved with radiopharmaceutical production at Lucas heights or the National Medical Cyclotron during the year. A comparison of the maximum and average effective doses for the past four years is shown in Figure 1.

Figure 1: Comparison of the maximum and average effective doses (mSv)



The ANSTO Personal Dosimetry Service also measures shallow doses of all monitored workers. The highest shallow dose for the year to any individual was 18.4 mSv, which is well below the national and international annual dose limit of 500 mSv.

Doses to extremities such as hands and fingers are also monitored for those workers handling radioisotopes and likely to receive a dose to their extremities significantly different from the dose to their body. The highest extremity dose to any individual for the year was 189 mSv, which is also below the annual dose limit of 500 mSv.

In addition to monitoring external exposures, ANSTO also routinely monitors internal exposures of staff working with unsealed sources. Methods include bioassay and whole body and thyroid counting. Any significant doses are added to those from external radiation and are included in effective doses for reporting purposes.

A 24-hour emergency response capability was provided at the Lucas Heights Science and Technology Centre. Additionally, emergency arrangements were maintained and exercised in conjunction with State agencies.

Emergency response

Emergency planning at the Lucas Heights Science and Technology Centre was conducted under the provisions of the *NSW State Emergency and Management Act*

1989. This Act requires that a range of plans, generally known as DISPLANS, is in place for potential emergencies. The purpose of these plans is to allow for emergencies to be controlled at the lowest appropriate level. The arrangements make provision for assistance to be provided should the incident escalate. This assistance is a staged process and provides for escalation of emergency control from local to district to State level. For the arrangement to be effective, all involved agencies are required to have in place appropriate internal instructions and/or standing operating procedures and to make resources available when required. Plans that have a direct bearing on activities at the Lucas Heights Science and Technology Centre are explained below.

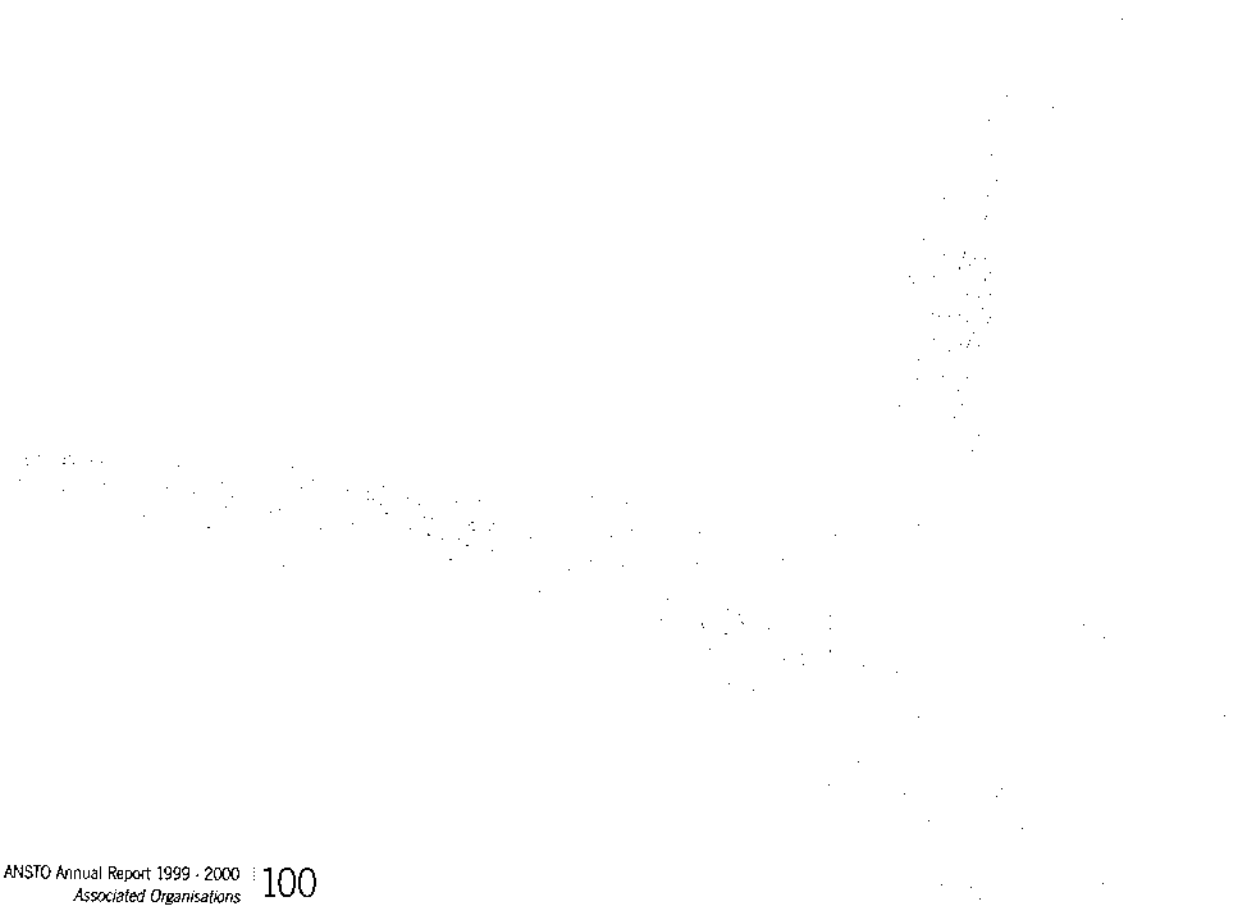
Accidents, incidents or emergencies with on-site consequences are covered by two plans. The Lucas Heights Science and Technology Centre Emergency Plan describes the on-site emergency arrangements that can be handled by ANSTO personnel. The ANSTO Emergency Plan (DISPLAN) provides for the on-site emergency arrangements that require assistance and control from the NSW combat agencies. ANSTO personnel provide full technical support to this plan.

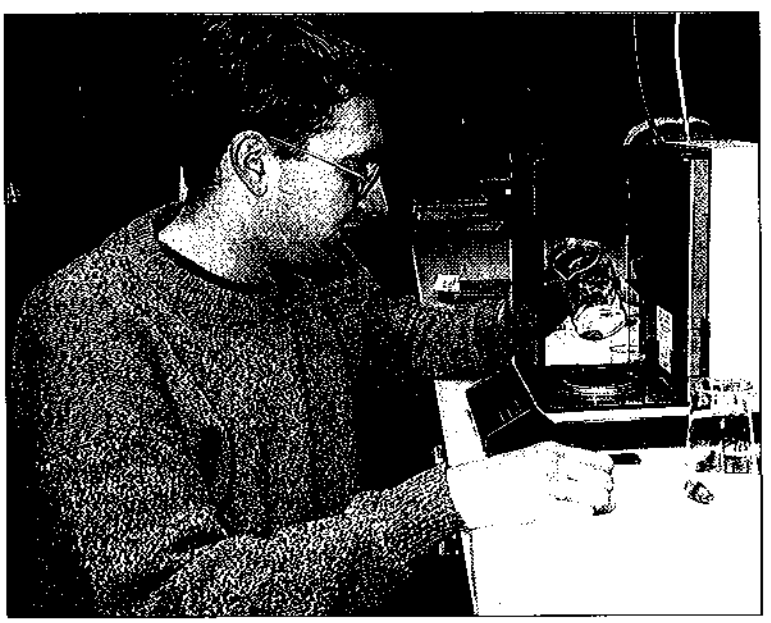
Accidents, incidents or emergencies with off-site consequences are covered by escalating arrangements consisting of the Sutherland Shire Local Disaster Plan (DISPLAN), the Georges River District Disaster Plan (DISPLAN) and the NSW State Disaster Plan (DISPLAN). The ANSTO Local Liaison Working Party (LLWP) is responsible for preparing the ANSTO Emergency Plan (DISPLAN). ANSTO's Safety Division and the LLWP prepare the Lucas Heights Science and Technology Centre Emergency Plan. Membership of the LLWP consists of representatives of ANSTO, NSW Emergency Services Organisations and local government. ARPANSA is an observer. The LLWP met four times during the year with a high level of participation by the NSW Emergency Services Organisations.

To support the effective implementation of emergency response procedures a new Emergency Operations Centre was established on the Lucas Heights site. This was the first move in a phased approach to locating all ANSTO's emergency response equipment in the one area.

An emergency response exercise, codenamed Exercise Dingo, was held to test the setting up and operation of the new Emergency Operation Centre and to exercise components of the ANSTO Emergency Plans. Members of the Emergency Services Organisations participated and ANSTO Mobile Monitoring Teams worked in conjunction with members of the Environment Protection Authority and the NSW Fire Brigades. A rescue exercise was also held with the Caringbah Ambulance Rescue to test the operation of ANSTO emergency Standing Operating Procedures and the interaction of ANSTO emergency personnel with an outside emergency agency.

The Environmental Radiological Atmospheric Impact Modelling System, ERAIMS, developed last year, was field-tested. The system can determine the real-time response to any potential accidental airborne release from operations at the Lucas Heights Science and Technology Centre.





Chris Evenhuis from the University of Tasmania at the 1999 AINSE Winter School.

Australian Institute of Nuclear Science and Engineering Incorporated

OBJECTIVES

To ensure users in member organisations of AINSE have access to major nuclear science and engineering and associated facilities for research purposes.

To facilitate graduate and undergraduate education and training experience utilising major nuclear science and technology facilities.

To encourage collaboration and cooperation between member organisations of AINSE in areas primarily related to nuclear science and engineering and their applications.

To sustain and support the development of major nuclear science and technology facilities in Australia for shared use by member organisations of AINSE.

The Australian Institute of Nuclear Science and Engineering Incorporated (AINSE) is a consortium of 35 Australian universities and the University of Auckland in partnership with ANSTO. It is a non-profit-making institute incorporated under the *NSW Associations Incorporation Act 1984* and was established by the Commonwealth Government in 1958 to conduct research into nuclear energy and provide training in the nuclear field.

AINSE's mission is to advance research, education and training in nuclear science and engineering and their applications within Australia by being, in particular, the key link between universities, ANSTO and major nuclear science and engineering and associated facilities.

AINSE's governing council consists of a representative of each member university, the Executive Director of ANSTO and the Directors of ANSTO's seven scientific and technical Divisions.

Core business

AINSE operates on a calendar-year basis and this report covers 1 January to 31 December 1999. During this period, income of $2,519,090 was made up of $1,181,700 from ANSTO, $614,000 from university subscriptions, $521,666 from external grants, $153,886 from interest on investments and $47,838 from other sources, mainly conference registrations.

Funds received by AINSE are used primarily to support university research. This is done mainly through grants to cover costs associated with operating and developing ANSTO's facilities. During the year 159 university projects utilising ANSTO's facilities were supported under the AINSE grant scheme. The total value of grants taken up was $957,601.

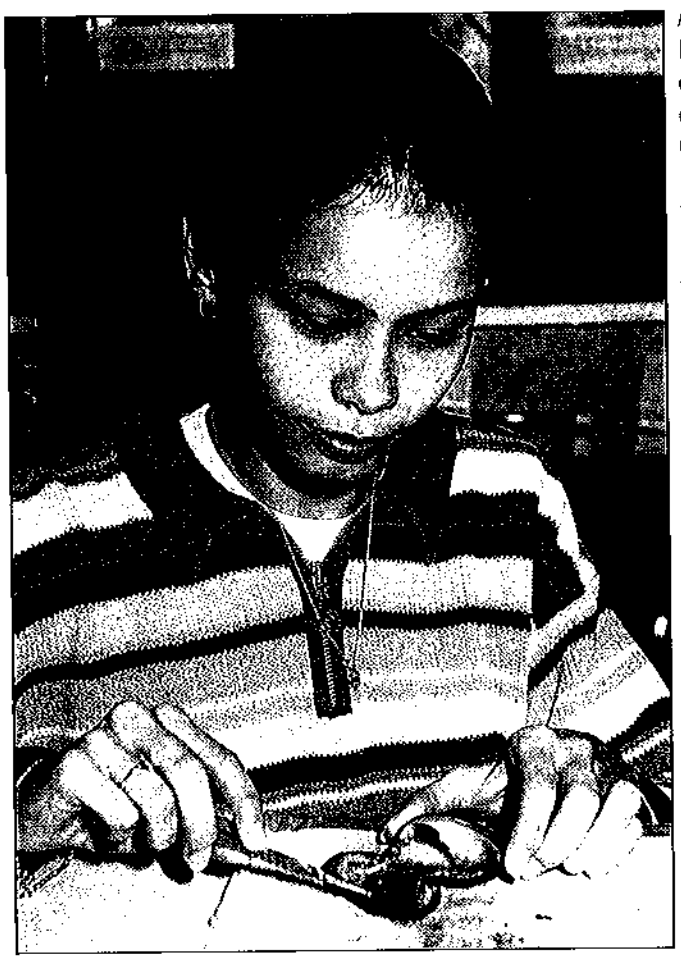
Costs for using facilities are met by AINSE on behalf of the universities from funds held in reserve for this purpose. By this means, AINSE is able to maintain a measure of control and flexibility that ensures maximum use is made of the national facilities at Lucas Heights. The projects supported have applications in a wide range of disciplines including, for example, cultural heritage, advanced technology, manufacturing, mining, agriculture, medicine and environmental protection. All are of vital importance to Australia's future.

In 1999, 20 postgraduate students received AINSE supplements and grants for access to ANSTO's facilities. ANSTO subsidises these awards by providing additional time on its facilities at no cost to AINSE. The students, in turn, provide valuable support for ANSTO's research. In addition, 73 students gained access to the facilities via grants held by their supervisors. The total value of postgraduate studentships was $252,666.

AINSE organised five conferences and workshops during the year. These are described below. AINSE also sponsored the Australian Nuclear Association conference, which

was held in Canberra. Contributors from member universities received travel and accommodation subsidies for these conferences totalling $46,043 in 1999.

Two conferences were held in February: "Oncology: Therapy, Diagnosis and Palliation", held at the University of Sydney, and "Plasma 99", held at the Australian National University.



Emily Tan from Monash University at the 1999 AINSE Winter School.

A Quaternary Dating Workshop, held at Lucas Heights in June, was the first event to be run by AINSE without an external conference organiser. Congratulations are due to AINSE staff members for their excellent work in taking over this task.

A Small Angle Neutron Scattering Symposium was held at Lucas Heights in September.

The largest conference during the year was the Nuclear Techniques of Analysis Conference, which was held in November. It was attended by a broad cross section of the community and financially supported by twelve enterprises.
AINSE supported the 3rd Australian Nuclear Association Conference, held in Canberra from 27 to 29 October, by providing travel subsidies to contributors from member universities.

The third AINSE Winter School, held from 3 to 7 July, was extended from four to five days so that a particular experiment in radiation biology could be carried out. Thirty-six third-year university students attended. A scholarship was offered to every member university to enable a nominated third-year student to participate. Feedback judged this program to be an outstanding success. The Winter School will be held again in 2000 incorporating the expanded experimental program. AINSE is very grateful to the staff at ANSTO who gave their time and expertise to this important program. It significantly contributes to the public profile of AINSE and ANSTO, and is especially effective as an opportunity for potential users to see ANSTO's facilities in operation.

Notification of 126 published papers incorporating results from AINSE projects were received in 1999.

Additional projects

AINSE acts as a peak body on behalf of its member organisations in applying for and administering major research infrastructure grants. In 1999 an Australian Research Council (ARC) grant under the Research Infrastructure, Equipment and Facilities (RIEF) program of $243,729 was awarded to provide infrastructure support for small angle, polarised neutron and reflectrometry instruments at ANSTO's neutron scattering facilities.

Membership of the UK facility ISIS, the world's most powerful pulsed neutron source, was funded through a grant from the Department of Industry, Science and Resources for $350,000, together with $25,000 each from ANSTO and AINSE. Membership enables Australian scientists to use the facility's specialised small angle neutron scattering techniques for a range of research activities that would not be possible within Australia. Twenty-one projects were granted access for a total of 58 days

During the year AINSE prepared two successful applications for RIEF funding for 2000. The first, for membership of ISIS, attracted $255,000 from ARC, $90,000 from member universities, $25,000 from ANSTO and $30,000 from AINSE. The second, a grant application for a new accelerator, attracted $1 million from ARC, $264,000 from universities, $600,000 from ANSTO and $300,000 from AINSE. The University of Wollongong is the lead institution for this project, contributing $100,000, and the University's Professor Allan Chivas will chair the Stakeholders' Committee.

Recognition of outstanding people

The AINSE Gold Medal was awarded to Professor Ian McDougall and presented at the Council meeting in Canberra in December. Professor McDougall delivered his medal address at the Council meeting in May 2000. The Student Gold Medal was awarded to Ismunander, who worked under Dr Erich Kisi at the University of Sydney.

At the December 1999 Council meeting Professor Trevor Ophel was awarded the AINSE Honorary Fellowship. Professor Ophel, who passed away in June 2000, had invested a great deal of time and effort in the affairs of AINSE over very many years.

Key officers

The President of AINSE for 1999 was Professor Ron MacDonald from the University of Newcastle. The Vice President was Associate Professor Ron Cooper from the University of Melbourne. The Scientific Secretary was Dr Dennis Mather.

Member organisations of AINSE as at 31 December 1999

ANSTO
University of Adelaide
University of Auckland, New Zealand
Australian National University
University of Ballarat
University of Canberra
Central Queensland University
Charles Sturt University
Curtin University of Technology
Deakin University
Edith Cowan University
Flinders University of South Australia
Griffith University
James Cook University of North Queensland
La Trobe University
Macquarie University
University of Melbourne
Monash University
Murdoch University
University of New England
University of New South Wales
University of Newcastle
Northern Territory University
University of Queensland
Queensland University of Technology
Royal Melbourne Institute of Technology
Southern Cross University
University of South Australia
University of Southern Queensland
Swinburne University of Technology
University of Sydney
University of Tasmania
University of Technology, Sydney
Victoria University of Technology
University of Western Australia
University of Western Sydney
University of Wollongong.

Further information on AINSE can be found on its website, at http://www.ainse.edu.au.

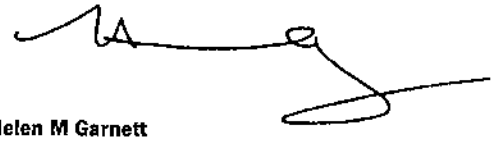
Australian Nuclear Science and Technology Organisation

STATEMENT BY DIRECTORS

In the opinion of the members of the Board of the Australian Nuclear Science and Technology Organisation, the attached financial statements for the year ended 30 June 2000 give a true and fair view of the matters required by Schedule 2 to the Finance Minister's Orders made under the Commonwealth Authorities and Companies Act 1997.
Signed in accordance with a resolution of the members of the Board.

S M Richards
Chairman

15/8/2000
Canberra



Helen M Garnett
Executive Director

15/8/2000
Canberra

INDEPENDENT AUDIT REPORT

To the Minister for Industry, Science and Resources

Scope

I have audited the financial statements of the Australian Nuclear Science and Technology Organisation for the year ended 30 June 2000. The financial statements comprise:

- Statement by Directors
- Balance Sheet
- Operating Statement
- Statement of Cash Flows
- Schedule of Commitments
- Schedule of Contingencies, and
- Notes to and forming part of the Financial Statements.

The members of the Board are responsible for the preparation and presentation of the financial statements and the information they contain. I have conducted an independent audit of the financial statements in order to express an opinion on them to you.

The audit has been conducted in accordance with Australian National Audit Office Auditing Standards, which incorporate the Australian Auditing Standards, to provide reasonable assurance as to whether the financial statements are free of material misstatement. Audit procedures included examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial statements, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial statements are presented fairly in accordance with Australian Accounting Standards, other mandatory professional reporting requirements and statutory requirements in Australia so as to present a view of the entity which is consistent with my understanding of its financial position, the results of its operations and its cash flows.

The audit opinion expressed in this report has been formed on the above basis.

PO Box A456 Sydney South NSW 1235
130 Elizabeth Street
SYDNEY NSW
Phone (02) 9367 7100 Fax (02) 9367 7102

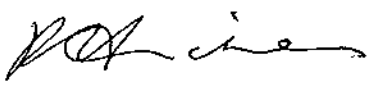
Audit Opinion

In my opinion,

(i) the financial statements have been prepared in accordance with Schedule 2 of the Finance Minister's Orders; and

(ii) the financial statements give a true and fair view, in accordance with applicable Accounting Standards, other mandatory professional reporting requirements and Schedule 2 of the Finance Minister's Orders, of the financial position of the Australian Nuclear Science and Technology Organisation as at 30 June 2000 and the results of its operations and its cash flows for the year then ended.

Australian National Audit Office



P Hinchey
Senior Director

Delegate of the Auditor-General

Sydney
15 August 2000

Australian Nuclear Science and Technology Organisation

OPERATING STATEMENT

for the year ended 30 June 2000

	Note	2000 $'000	1999 $'000
Operating revenues			
Revenues from government	2(p), 5A, (a)	**101,641**	74,479
Sales of goods and services	5B	**27,621**	27,074
Grants	5B	**948**	1,911
Interest on deposits	5B	**1,657**	1,054
Net gains from the sale of assets	5C	**452**	635
Net foreign exchange gains – non speculative	5C	**667**	3
Other	5D	**872**	48
Total operating revenues		**133,858**	105,204
Operating expenses			
Employees	6A	**48,930**	48,868
Suppliers	6B	**46,216**	34,738
Depreciation and amortisation	6C	**16,218**	15,069
Write down of assets	6D	**171**	1,317
Grants	6E	**1,521**	1,756
Total operating expenses		**113,056**	101,748
Operating surplus before extraordinary items		**20,802**	3,456
Gain on extraordinary items	13	**–**	321
Net surplus after extraordinary items	11	**20,802**	3,777
EQUITY INTEREST			
Accumulated surpluses at beginning of reporting period	11	**98,130**	95,240
Amounts transferred to reserves	11	**(6,600)**	(887)
Total available for appropriation		**112,332**	98,130
Capital use charge provided for or paid	11, (a)	**(24,572)**	–
Accumulated surpluses at end of reporting period	1	**87,760**	98,130

Following changes in the Government funding policy for 1999/2000 (refer Note 5A), the 1999 accumulated surpluses have been restated to separately identify equity injections included in Appropriations in previous years.
Opening accumulated surpluses have been adjusted as follows:

	1999 Reported Amounts	Restatements	1999 Restated Amounts
Accumulated surpluses at beginning of reporting period	97,240	(2,000) (1)	95,240
1999 Operating surplus	7,777	(4,000) (2)	3,777
Amounts transferred to reserves	(887)		(887)
Total available for appropriation	104,130	(6,000)	98,130
Capital use charge provided for or paid	–	–	
Accumulated surpluses at end of 1998 reporting period	104,130	(6,000)	98,130

(1) Equity injections transferred to capital in respect of years prior to 1999
(2) Equity injections transferred to capital in respect of 1999 year (excluded from Revenues from government)

(a) Revenues this year include $24.572 million (1999 $nil) which is repaid to government (Note 2(p) refers).

Note 4 to the financial statements provides an operational view by core business activity.

The accompanying notes form an integral part of these financial statements.

Australian Nuclear Science and Technology Organisation

BALANCE SHEET

as at 30 June 2000

	Note	2000 $'000	1999 $'000
ASSETS			
Financial assets			
Cash	8A	**6,049**	9,202
Receivables	8B	**7,715**	8,765
Investments	8C	**10,100**	14,090
Total financial assets		**23,864**	32,057
Non-financial assets			
Land and buildings	9A	**152,424**	111,729
Infrastructure, plant and equipment	9B	**115,120**	84,681
Inventories	9C	**7,020**	7,849
Intangibles	9D	**309**	467
Other	9E	**574**	118
Total non-financial assets		**275,447**	204,844
Total assets		**299,311**	236,901
LIABILITIES			
Provisions and payables			
Capital use charge	10A	**339**	–
Employees	10B	**18,597**	17,726
Suppliers	10C	**2,262**	8,100
Other payables	10D	**773**	3,327
Other provisions	10E	**2,250**	2,978
Total provisions and payables		**24,221**	32,131
Total liabilities		**24,221**	32,131
EQUITY	11		
Capital		**9,000**	6,000
Reserves		**178,330**	100,640
Accumulated surpluses		**87,760**	98,130
Total equity		**275,090**	204,770
Total liabilities and equity		**299,311**	236,901
Current liabilities		**12,495**	19,277
Non-current liabilities		**11,726**	12,854
Current assets		**26,225**	33,971
Non-current assets		**273,086**	202,930

The accompanying notes form an integral part of these financial statements.

Australian Nuclear Science and Technology Organisation

STATEMENT OF CASH FLOWS

for the year ended 30 June 2000

	Note	2000 $'000 Inflows (Outflows)	1999 $'000 Inflows (Outflows)
OPERATING ACTIVITIES			
Cash received			
Sales of goods and services		**28,577**	25,641
Interest received		**1,904**	962
Parliamentary appropriations		**101,641**	74,479
Total cash received		**132,122**	101,082
Cash used			
Employees		**(53,755)**	(47,743)
Suppliers		**(50,637)**	(35,037)
Total cash used		**(104,392)**	(82,780)
Net cash from operating activities	12	**27,730**	18,302
INVESTING ACTIVITIES			
Cash received			
Proceeds from sales of property, plant and equipment		**432**	16
Total cash received		**432**	16
Cash used			
Purchase of property, plant and equipment		**(14,072)**	(13,311)
Total cash used		**(14,072)**	(13,311)
Net cash used in investing activities		**(13,640)**	(13,295)
FINANCING ACTIVITIES			
Cash received			
Equity appropriation		**3,000**	4,000
Total cash received		**3,000**	4,000
Cash used			
Capital use charge paid		**(24,233)**	--
Total capital used		**(24,233)**	--
Net cash used in financing activities		**(21,233)**	4,000
Net increase/(decrease) in cash held		**(7,143)**	9,007
Cash at 1 July		**23,292**	14,285
Cash at 30 June		**16,149**	23,292
Cash at bank and on hand	8A	**6,049**	9,202
Fixed term investment	8C	**10,100**	14,090
Total cash		**16,149**	23,292

The accompanying notes form an integral part of these financial statements.

Australian Nuclear Science and Technology Organisation

SCHEDULE OF COMMITMENTS

as at 30 June 2000

	Note	2000 $'000	1999 $'000
BY TYPE			
CAPITAL COMMITMENTS			
Property, plant and equipment		**5,617**	3,497
Waste treatment and disposal project	10E(b)	**5,000**	3,988
Fuel elements purchase	11	**5,000**	–
Total capital commitments		**15,617**	7,485
OTHER COMMITMENTS			
Disposal of spent fuel (a)		**62,858**	75,226
Total other commitments		**62,858**	75,226
Total commitments payable		**78,475**	82,711
Commitments receivable			
Disposal of spent fuel (a)		**62,858**	72,361
Major international design and construction contract (b)		**16,687**	14,657
Total commitments receivable		**79,545**	87,018
Net commitments payable/(receivable)		**(1,070)**	(4,307)
BY MATURITY			
Commitments payable			
One year or less		**13,179**	9,743
From one to two years		**1,575**	607
From two to five years		**863**	–
		15,617	10,350
Commitments receivable			
One year or less		**(6,110)**	(6,869)
From one to two years		**(4,680)**	(856)
From two to five years		**(5,897)**	(6,932)
		(16,687)	(14,657)
Net commitments		**(1,070)**	(4,307)

(a) In 1997-98 the Government determined to provide $86.4 million (1997 dollars) to remove spent fuel rods from the Lucas Heights Science and Technology Centre and meet the costs of reprocessing offshore.
An amount of $23.542 million has been received as at 30 June 2000. The remaining $62.858 million will be drawn down by year 2020 in accordance with a schedule agreed with Government. The amount of $62.858 million is not included in the commitment by maturity figures as the commitment payable is fully offset by the commitment receivable.

(b) This commitment relates to the value of a major international design and construction contract to design, manufacture, install and commission a radioisotope production facility in Thailand. This income stream will be matched in due course against yet to be incurred expenditure required to complete the contract.

(c) All 1999/2000 commitments are GST inclusive where relevant.

The accompanying notes form an integral part of these financial statements.

Australian Nuclear Science and Technology Organisation

SCHEDULE OF CONTINGENCIES

as at 30 June 2000

	Note	2000 $'000	1999 $'000
CONTINGENT LOSSES			
		–	–
Total contingent losses		–	–
CONTINGENT GAINS			
		–	–
Total contingent gains		–	–
Net contingencies		–	–

Note: The Organisation is involved in a range of legal proceedings for which adequate provision has been made.

Australian Nuclear Science and Technology Organisation

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

for the year ended 30 June 2000

Note Description

1 Economic dependency
2 Summary of significant accounting policies
3 Segment and outcomes reporting
4 Reporting by core business activity
5 Revenue
6 Operating expenses
7 Radiopharmaceutical operations
8 Financial assets
9 Non-financial assets
10 Provisions and payables
11 Equity
12 Cash flow reconciliation
13 Extraordinary items
14 Remuneration of members of the Board
15 Remuneration of executives
16 Insurance
17 Remuneration of auditors
18 Board membership
19 Related party disclosures
20 Trust money
21 Financial instruments
22 Subsequent events

Australian Nuclear Science and Technology Organisation

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

for the year ended 30 June 2000

1 Economic dependency

ANSTO is dependent on appropriations from the Parliament of the Commonwealth Government to carry out its activities.

2 Summary of significant accounting policies

(a) Basis of accounting

The financial statements are required by clause 1(b) of Schedule 1 to the Commonwealth Authorities and Companies Act 1997 and are presented as a general purpose financial report.

They have been prepared:

i. having regard to the provisions of the Australian Nuclear Science and Technology Organisation (ANSTO) Act 1987 and the ANSTO Amendment Act 1992

ii. in accordance with:

- Requirements for the Preparation of Financial Statements of Commonwealth Agencies and Authorities made by the Minister for Finance and Administration in August 1999 (Schedule 2 to the Commonwealth Authorities and Companies (CAC) Orders)
- Australian Accounting Standards
- Other authoritative pronouncements of the Australian Accounting Standards Boards; and the consensus views of the Urgent Issues Group.

The statements have been prepared having regard to:

- Statements of accounting concepts
- The Explanatory Notes to Schedule 2 issued by the Department of Finance and Administration.

The financial statements have been prepared on an accrual basis and are in accordance with the historical cost convention, except for certain assets which, as noted, are at valuation. Except where stated, no allowance is made for the effect of changing prices on the results or the financial position.

(b) Changes in accounting policies

Changes in accounting policies have been identified in this note under their appropriate headings – refer (k).

(c) Reporting by outcomes

A comparison of budget and actual figures by outcome specified in the Appropriation Acts relevant to ANSTO is presented in Note 3 for this financial year.

(d) Revenue recognition

Parliamentary appropriations

From 1 July 1999, the Commonwealth Budget has been prepared under an accruals framework. Under this framework, Parliament appropriates money to ANSTO as revenue appropriations and as equity injections (refer Note 11).

Revenue appropriations

Revenues from government are revenues of the core activities of ANSTO and are recognised as revenue to the extent that they have been received or are entitled to be received at year end (refer Note 11).

Non-revenue appropriations

Appropriations for capital items are recognised directly into equity, to the extent that the appropriation has been received or is entitled to be received by the end of the year (refer Note 11).

Operating revenue from independent sources

Operating revenue from independent sources comprises revenue earned from the provision of products, or services, to entities outside ANSTO. Revenue is recognised when the goods are provided, or when the fee in respect of the services provided is receivable.

Revenue received in advance

Revenue received in advance is initially brought to account as "other payables" and subsequently recognised as revenue when earned.

Contract revenue

Revenue from the rendering of a service is recognised by reference to the stage of completion of each contract. The stage of completion is determined by reference to the proportion that the completed physical contract work bears to the estimated total physical contract work.

Interest revenue

Interest revenue is recognised as the interest is received or is entitled to be received by the end of the year.

Revenue from the disposal of non-current assets

Revenue is recognised when control of the asset has passed to the buyer.

Core operations

All material revenues described in this note are revenues relating to the core operating activities of ANSTO.

Details of revenue amounts are given in Note 5.

(e) Employee entitlements

The provisions for employee entitlements encompass annual leave and long service leave that ANSTO has a present obligation to pay resulting from employee services provided up to balance date.

General leave

The Organisation's Enterprise Agreement provides under the heading General Leave for an employee entitlement which combines sick leave, carer's leave and leave for other prescribed purposes. No provision has been made for general leave as all such leave is non-vesting and the average general leave taken by employees is less than the annual entitlement.

Annual leave

The provision for annual leave reflects the value of total annual leave entitlements of all employees at balance date and is recognised at its nominal value.

Long service leave

The provision for long service leave is recognised and measured at the present value of estimated future cash outflows to be made by ANSTO in respect of employee entitlements at balance date.

(f) Superannuation

The Australian Nuclear Science and Technology Organisation contributes to the Commonwealth Superannuation (CSS) and the Public Sector (PSS) superannuation schemes which provide retirement, death and disability benefits to employees. Contributions to the schemes are at rates calculated to cover existing and emerging obligations. Current contribution rates are 20.1% of salary (CSS) and 11.2% of salary (PSS). An additional 3% is contributed for employer productivity benefits. The vast majority of staff are covered by one of these two schemes. For those staff who do not contribute to either of these two schemes, ANSTO contributes 7% of salary to the Australian Government Employees Superannuation Trust fund. Additional employer contributions are made to nominated complying funds on behalf of several term employees at a rate of 8%, where the employee chooses not to make a personal contribution or 11%, where the employee chooses also to contribute. Contributions during the year are detailed in Note 6A. No liability is shown for superannuation in the Balance Sheet as the employer contributions fully extinguish the accruing liability which is assumed by the Commonwealth.

(g) Leases

Operating leases are expensed on a basis which is representative of the pattern of benefits derived from the leased assets.

(h) Cash

For the purposes of the Statement of Cash Flows, cash includes short term deposits held in a bank, cash on hand and cash equivalents.

(i) Financial instruments

Accounting policies for financial instruments are stated at Note 21.

(j) Bad and doubtful debts

A provision is made for any doubtful debts based on a review of all outstanding accounts at year end. Bad debts are written off during the period in which they are identified.

(k) Property, infrastructure, plant and equipment

Acquisition

Items of property, plant and equipment are recorded at cost and depreciated as outlined below. Items of plant and equipment with a cost of less than $3,000 are expensed in the year of acquisition.

The cost of assets constructed by the entity includes the cost of materials, direct labour and an appropriate proportion of fixed and variable overheads.

Revaluations

Basis of valuation

Schedule 2 to the Commonwealth Authorities and Corporations Act 1997 requires that buildings, infrastructure, plant and equipment be revalued progressively in accordance with the deprival method of valuation in successive three year cycles. Land is valued annually on the basis of its highest and best use, unless disposal is restricted by legislation, zoning or government policy.

The requirements of Schedule 2 are being implemented as follows:

- Freehold land was revalued as at 30 June 2000
- Buildings on freehold land were revalued at 30 June 2000
- Plant and equipment were revalued at 30 June 1999
- Infrastructure was revalued at 30 June 2000
- The major national facility, HIFAR reactor excluding instrumentation was revalued as at 30 June 2000 to deprival value based on current equivalent historical cost.
- Other national and major facilities were revalued at 30 June 1999.

The current revaluation cycle commenced in 1999. Because of the integrated nature of the site and its facilities each of the following class of assets: buildings, infrastructure, plant and equipment including national and other major facilities, will be revalued as a class over the three year revaluation cycle.

Assets acquired after the commencement of revaluation are reported at cost as at 30 June 2000.

Assets where the revalued amount was below $3,000 continued to be disclosed at cost less accumulated depreciation.

Application of the deprival method of valuation values land at current market buying price and buildings, infrastructure, plant and equipment including national and major facilities are recognised at depreciated replacement value.

Any assets classified as "not to be replaced" or which are surplus to requirements are valued at net realisable value at balance date.

All valuations are conducted by independent qualified valuers.

Changes in Accounting policies

The frequency and valuation basis for freehold land are changes of accounting policy required by a change in the Finance Minister's Orders in 1999-2000. The changes in policy are:

- Freehold land is now valued annually. In the preceding period, land was valued at three yearly intervals
- The valuation basis for land is now the highest and best use for the land. In the preceding period land was valued on a current use basis.

Depreciation and amortisation

Items of property, plant and equipment, including buildings, but excluding freehold land, are depreciated over their estimated useful lives to ANSTO using the straight line method.

Depreciation and amortisation rates applying to each class of depreciable asset are based on the following useful lives:

	2000	1999
Buildings on freehold land	**30 years**	30 years
Plant and equipment	**2 to 30 years**	2 to 30 years
Infrastructure	**20 years**	20 years
National and major facilities	**5 to 30 years**	9 to 30 years

The depreciation rates (useful lives) of ANSTO's property, plant and equipment have been reviewed during the year and found to be appropriate. The aggregate amount of depreciation allocated for each class of asset during the reporting period is disclosed in Note 6C.

Recoverable amount test

The carrying amounts of assets are reviewed to determine whether the values are in excess of the recoverable amount. If an excess exists as at the reporting date, the asset is written down to its recoverable amount. In assessing recoverable amounts, the relevant cashflows, including the expected cashflows from future appropriations by the Parliament, have been discounted to their present value.

(l) Inventories

Uranium and Cobalt-60 inventories of enriched, natural and depleted uranium are valued on the basis of net realisable value.

Stocks of reactor fuel, heavy water and stores are valued at average purchase price.

Work in progress is valued at cost, which includes both direct costs and an appropriate allocation of overhead expenses.

(m) Intangibles

Software

Items of software are recorded at cost and depreciated as outlined below. Items with a cost of less than $3,000 are expensed in the year of acquisition. In previous years software was included in plant and equipment and was revalued with other plant and equipment. Software transferred out of plant and equipment in 2000 has been reported under a separate heading "software" with no change in value or expected useful life

There is no material internal software development.

Licences

Licences were revalued in 1999.

Amortisation

Intangibles are amortised over their estimated useful lives to ANSTO using the straight line method.

Depreciation rates applying to intangibles are as follows:

	2000	1999
Purchased software	**2 – 7 years**	2 – 7 years
Licences	**3 years**	3 years

The depreciation rates (useful lives) of ANSTO's software and licences have been reviewed during the year and found to be appropriate.

The aggregate amount of depreciation allocated for each class of asset during the reporting period is disclosed in Note 9D.

Recoverable amount test

The carrying amount of each intangible asset is reviewed to determine whether it is in excess of the asset's recoverable amount. If an excess exists as at the reporting date, the asset is written down to its recoverable amount. In assessing recoverable amounts, the relevant cashflows, including the expected cashflows from future appropriations by the Parliament, have been discounted to their present value.

(n) Patents

Due to the uncertain commercial value of patents, and because benefits extending beyond one accounting period cannot be assured, the costs associated with the development and registration of patents are expensed in the year in which they are incurred, unless recoverability is assured beyond any reasonable doubt. At 30 June 2000 there were 168 patents (144 at 30 June 1999) registered to ANSTO and no associated costs are recognised as an asset (nil at 30 June 1999).

(o) Foreign currency

Transactions denominated in a foreign currency are converted at a rate of exchange prevailing at the date of the transaction. At balance date, amounts receivable and payable in foreign currency are translated at the exchange rate prevailing at that date and any exchange differences are brought to account in the Operating Statement.

(p) Capital use charge

A capital use charge of 12% is imposed by the Commonwealth on the budgeted estimate of net assets of ANSTO for the 1999/2000 financial year. Any adjustment based on the calculation of actual net assets, excluding asset revaluations during the financial year, is recognised as an asset or liability as appropriate in the balance sheet (refer Note 5A).

(q) Taxation

ANSTO is exempt from all forms of taxation in Australia except fringe benefits tax, bank account debit tax and the goods and services tax. The Organisation is not subject to exemption from any foreign taxation laws relative to its overseas operations.

(r) Assets received free of charge

The acquisition of property, plant and equipment free of charge, or for a nominal amount, is recognised at fair value.

(s) Comparatives

Where necessary, comparative information has been reclassified to achieve consistency in disclosure with current financial year amounts and other disclosures.

(t) Rounding

Amounts are rounded to the nearest one thousand dollars except in relation to:

- remuneration of members of the Board
- remuneration of executives
- remuneration of auditors

3 Segment and outcomes reporting

Reporting by segments

ANSTO operates in a single industry within Australia, namely in the nuclear scientific research industry.

Reporting by outcomes:

ANSTO has three outcomes:

Outcome 1: Replacement research reactor
Outcome 2: Disposal of spent fuel
Outcome 3: Core business: Science and technology

Reporting by Outcomes for 1999-2000

$000s	Outcome 1		Outcome 2		Outcome 3		Total	
	Budget	Actual	Budget	Actual	Budget	Actual	Budget	Actual
Net cost of entity outputs	720	720	9,503	11,852	91,418	92,839	101,641	105,411
Net cost to budget outcome	720	720	9,503	11,852	91,418	92,839	105,411	105,411
Total assets employed at 30/6/00 (1)	9,000	9,092	–	–	231,120	290,219	240,120	299,311
Net assets employed at 30/6/00 (1)	9,000	9,092	–	–	204,079	265,998	213,079	275,090

Reporting by Outcomes by funding source for 1999-2000

Outcomes	Outputs					Total Appropriations	Total Expenses
	Expenses against Revenue From Government (appropriations)			Expense against Revenue from other Sources	Total expenses against Outputs		
	Special Acts	Annual other	Total				
Outcome 1							
Actual		720	720	–	720	720	720
Budget		720	720	–	720	720	720
Outcome 2							
Actual (2)		11,852	11,852	–	11,852	9,503	11,852
Budget		9,503	9,503	–	9,503	9,503	9,503
Outcome 3							
Actual (3)		92,839	92,839	32,217	125,056	91,418	125,056
Budget		91,418	91,418	29,849	121,267	91,418	121,267
Total							
Actual		105,411	105,411	32,217	137,628	101,641	137,628
				Appropriation Act 4 Capital			
				Actual		3,000	
				Budget		3,000	
				Total Appropriations			
				Actual		104,641	

(1) The value of total assets and net assets employed shown as Actual in outcome 3 includes the unbudgeted impact of the revaluation of land, buildings, electrical facilities and the HIFAR reactor.

(2) Expenditure exceeded appropriation due to the carry over of $2.865 million, being unspent special purpose appropriation funding received in the 1998/9 financial year for the disposition of spent fuel.

(3) Revenue from other sources exceeded budget by $2.367 million. This surplus was applied to expenditure incurred under outcome 3.

4 Reporting by Core Business Activity

NET COST OF SERVICES

Operating expenses	2000 $'000	1999 $'000
International strategic relevance of nuclear science and technology	**10,506**	7,385
Core nuclear facilities operation and development	**33,449**	33,037
Nuclear science for environment and sustainability	**6,205**	5,804
Treatment and management of manmade and naturally occurring radioactive substances	**21,173**	16,256
Sustainability and international competitiveness of industry	**15,517**	17,092
Organisational development and support	**14,000**	13,873
Radiopharmaceutical operations (Note 7)	**12,206**	8,301
Total operating expenses (Note 6)	**113,056**	101,748
Operating revenues from independent sources		
International strategic relevance of nuclear science and technology	**260**	2,298
Core nuclear facilities operation and development	**4,660**	5,154
Nuclear science for environment and sustainability	**587**	489
Treatment and management of manmade and naturally occurring radioactive substances	**1,315**	932
Sustainability and international competitiveness of industry	**6,029**	5,163
Organisational development and support	**3,598**	2,376
Radiopharmaceutical operations (Note 7)	**15,768**	14,313
Total operating revenues from independent sources (Note 5)	**32,217**	30,725
Net cost of services	**80,839**	71,023
REVENUE FROM GOVERNMENT		
Parliamentary appropriations received (Note 5A)	**101,641**	74,479
Surplus of revenues from government over net cost of services	**20,802**	3,456
Gain on extraordinary items	**—**	321
Operating surplus	**20,802**	3,777
Capital use charge	**(24,572)**	—
Operating (deficit)/surplus net of capital use charge	**(3,770)**	3,777

5 Revenue

	2000 $'000	1999 $'000
5A. Revenues from Government		
Appropriation Act No.1 Operating	**100,598**	57,687
Appropriation Act No.3 Operating	**1,043**	–
	101,641	57,687
Appropriation Act No.2 Capital	–	16,792
	101,641	74,479

Following a change in Government funding policy, appropriation in 1999/2000 through Appropriation Act No.1 now includes funding for depreciation used for fixed asset acquisitions, previously appropriated through Appropriation Act No.2. In addition, funds provided through Appropriation Act No.1 also include funding to meet the cost of a capital use charge ($24,572; 1999 $nil) payable to Government; Note 2(p) refers.

1999 Restatement
The previous year appropriation Act No.2 amount has been changed to remove a component of equity funding ($4.0 million which is reported at Note 11). This adjustment brings the 1999 presentation in line with current government reporting requirements.

5B. Operating Revenue from Independent Sources
Sales of goods and services:

	2000 $'000	1999 $'000		
Radioisotope sales	**15,976**	14,281		
Services and contract research	**3,382**	3,696		
Major international design and construction contract	**–**	1,674		
Silicon irradiation	**1,988**	2,355		
CSIRO site support	**903**	903		
Training courses	**111**	190		
Land management	**3,560**	1,936		
Synchrotron project	**758**	733		
AINSE interactions	**943**	1,306		
Total sales of goods and services			**27,621**	27,07
Grants			**948**	1,911
Interest on cash and investments			**1,657**	1,054
5C. Profit on disposal of plant and equipment			**452**	635
Net foreign exchange gains - non speculative			**667**	3
5D. Other revenue:				
ACARRE contributions	**–**	45		
Prior year adjustments	**92**	–		
Nuclear material stock revaluation	**–**	3		
Resources received free of charge	**780**	–		
Total other revenue			**872**	48
Total operating revenue from independent sources			**32,217**	30,72
Total operating revenues			**133,858**	105,204

6 Operating expenses

Research and other business activities are managed principally within six core business areas; a seventh Unit, Radiopharmaceutical Operations, operates as an independent commercial business (Note 7).

The breakdown of operating expenses is:

	2000 $'000	1999 $'000	2000 $'000	1999 $'000
6A. Employee expenses:				
Salaries	**36,824**	37,846		
Superannuation	**6,697**	6,423		
Annual leave	**4,246**	3,277		
Long service leave	**714**	1,210		
Separation and redundancy	**449**	112		
Total employee expenses			**48,930**	48,868
6B. Supplier expenses:				
General expenses	**12,940**	10,366		
Stores	**5,448**	6,090		
Maintenance and external services	**7,010**	7,522		
Power and water	**1,693**	1,397		
Reactor supplies	**984**	1,067		
Disposition of spent fuel rods	**11,344**	5,177		
Variable production costs	**6,693**	2,977		
Operating lease rentals	**104**	142		
Total supplier expenses			**46,216**	34,738
6C. Depreciation and amortisation:				
Depreciation of property, plant and equipment	**16,042**	14,889		
Amortisation of intangible assets - licence	**103**	111		
Amortisation of intangible assets - software note 9D	**73**	69		
Total depreciation and amortisation			**16,218**	15,069

The aggregate amounts of depreciation expensed during the reporting period for each depreciable class of property, plant and equipment are as follows:

Buildings on freehold land	**3,963**	3,815
Plant and equipment	**7,814**	6,725
Infrastructure	**2,201**	2,114
National and major facilities	**2,064**	2,235
Total allocated	**16,042**	14,889

6D. Movements in provisions, unrealised losses and writedowns of assets				
Financial assets:				
Doubtful debts	**140**	50		
Share of partnership loss	**—**	59		
Unrealised foreign exchange loss (see also Note 21)	**2**	860		
Non financial assets:				
Loss on disposal of plant and equipment	**7**	336		
Nuclear materials stock revaluation	**22**	12		
Total other expenses			**171**	1,317
6E. Grants			**1,521**	1,756
Total operating expenses			113,056	101,748

	2000 $'000	1999 $'000

7 Radiopharmaceutical operations

Trading as Australian Radioisotopes (ARI)

ARI operating results, as an independent commercial unit within ANSTO, are as follows:

Revenue		
External sales and other revenue	**15,768**	14,313
Internal sales	**247**	151
Total revenue	**16,015**	14,464
Expenses		
Salaries	**4,174**	3,571
Superannuation	**535**	508
Annual leave	**86**	46
Long service leave	**77**	89
Doubtful debts	**—**	48
Other operating expenses	**7,177**	3,827
Depreciation of property, plant and equipment	**157**	212
	12,206	8,301
Internal support	**5,116**	5,203
Total expenses	**17,322**	13,504
Operating (deficit)/surplus	**(1,307)**	960

	2000 $'000	1999 $'000	2000 $'000	1999 $'000

8 Financial assets

8A. Cash

Cash at bank and on hand			**6,049**	9,202

8B. Receivables

Goods and services (trade debtors)			**7,746**	8,544
Less provision for doubtful debts			**315**	176
			7,431	8,368
Advance held by Dept of Industry Science and Resources			**60**	60
Interest accrued			**45**	297
Unrealised foreign exchange gain			**61**	–
Other			**118**	40
			7,715	8,765

Age analysis of trade debtors

Current	**2,874**	2,293
Overdue:		
Less than 30 days	**1,230**	1,195
30 to 60 days; and	**379**	441
60 to 90 days	**172**	198
More than 90 days*	**3,091**	4,417
	7,746	8,544

* An amount of $2.288 million is the subject of legal proceedings before the New South Wales Supreme Court and is subject to a cross claim. Without prejudice to further Court action and by consent of both parties, the matter is now subject to a process of mediation.

8C. Investments

Fixed term investment	**10,100**	14,090

Investment in Subsidiary

ANSTO Inc. was incorporated in Delaware, USA on 27 October 1999. At 30 June 2000, US$100 of capital has been invested in this subsidiary which is yet to commence trading.

	2000 $'000	1999 $'000
9 Non-financial assets		
9A. Land and buildings		
Land - at independent valuation - 30 June 2000	**52,202**	–
Land - at independent valuation - 30 June 1997	**–**	33,223
Buildings - at cost	**511**	8,293
Less accumulated depreciation	**158**	645
	353	7,648
Buildings - at independent valuation - 30 June 2000	**99,869**	–
Buildings - at independent valuation - 30 June 1997	**–**	77,775
Less accumulated depreciation	**–**	6,917
	99,869	70,858
Total buildings	**100,222**	78,506
Total land and buildings	**152,424**	111,729
9B. Infrastructure, plant, equipment and major facilities		
9B(i). Plant and equipment		
Plant and equipment - at cost	**18,311**	11,772
Less accumulated depreciation	**13,256**	10,843
	5,055	929
Additions - at cost	**7,918**	7,667
Less accumulated depreciation	**535**	718
	7,383	6,949
Plant and equipment - at independent valuation - 30 June 1999	**22,846**	22,421
Less accumulated depreciation	**5,066**	–
	17,780	22,421
Plant and equipment under construction	**3,832**	1,974
Total plant and equipment	**34,050**	32,273
9B(ii). Infrastructure		
Electrical /site services		
Electrical /site services facilities - at cost	**–**	2,166
Less accumulated depreciation	**–**	403
	–	1,763
Electrical /site services facilities - at independent valuation		
- 30 June 2000	**19,043**	–
- 30 June 1997	**–**	16,765
Less accumulated depreciation	**–**	3,726
	19,043	13,039
Total infrastructure	**19,043**	14,802

	2000 $'000	1999 $'000
9 Non-financial assets (continued)		
9B(iii). Major national and major research facilities		
Major national research facilities - at cost	1,008	13,547
Less accumulated depreciation	497	12,296
	511	1,251
Major national research facilities - at independent valuation		
- 30 June 2000*	35,391	–
- 30 June 1999	8,329	8,329
- 30 June 1997*	–	12,999
less accumulated depreciation	539	764
	43,181	20,564
* includes $15,599 (1999:$12,999) buildings on leasehold land.		
Major research facilities - at independent valuation - 30 June 1999	7,667	6,000
Less accumulated depreciation	279	–
	7,388	6,000
Research facility under construction - at cost	187	1,068
Research facility under construction - at independent valuation - 30 June 1999	1,668	3,333
Replacement Research Reactor capitalised cost	9,092	5,390
Total major national and major research facilities	**62,027**	37,606
Total infrastructure, plant, equipment and major facilities	**115,120**	84,681
Total land, buildings, infrastructure, plant, equipment and major facilities	**267,544**	196,410

9 Non-financial assets (continued)

Movement summary 1999-2000 for all assets irrespective of valuation basis

	Land	Building	Total Land Land and Building	Infrastructure, plant, equipment national and major facilities	Total
	$'000	$'000	$'000	$'000	$'000
Net book value as at 1 July 1999	**33,223**	**91,139**	**124,362**	**72,206**	**196,568**
Reclassification of national facilities		**(12,633)**	**(12,633)**	**12,633**	**–**
Reclassification of software to intangibles				**(158)**	**(158)**
Total after reclassifications	33,223	78,506	111,729	84,681	196,410
Gross value as at 1 July 1999	33,223	99,488	132,711	100,171	232,882
Reclassification of National Facilities		(13,420)	(13,420)	13,420	–
Transfer of software to intangible assets				(158)	(158)
Additions - new assets					
Additions - replacements		2,501	2,501	14,087	16,588
Revaluations	18,979	23,187	42,166	28,926	71,092
Disposals				(1,269)	(1,269)
Writeback of accumulated depreciation		(11,376)	(11,376)	(19,885)	(31,261)
Gross value as at 30 June 2000	**52,202**	**100,380**	**152,582**	**135,292**	**287,874**
Accumulated depreciation/ amortisation 1 July 1999		8,349	8,349	27,965	36,314
Reclassification of National Facilities		(788)	(788)	788	–
Transfer of software to intangible assets		–	–	–	–
Depreciation/amortisation for assets held 1 July 99		3,843	3,843	11,226	15,069
Depreciation/amortisation charge for additions		130	130	839	969
Writeback of accumulated depreciation		(11,376)	(11,376)	(19,885)	(31,261)
Adjustments for disposals				(761)	(761)
Accumulated depreciation/ amortisation 30 June 2000		**158**	**158**	**20,172**	**20,330**
Net book value as at 30 June 2000	**52,202**	**100,222**	**152,424**	**115,120**	**267,544**

9 Non-financial assets (continued)

Summary of balance of assets at valuation basis as at 30 June, 2000

(a) The 2000 independent valuation of land, buildings, electrical and site services facilities was performed by Mr John Starr (registered valuer No. 2388) of the Australian Valuation Office. Note 2(k).

(b) The revaluation of land, building, electrical and site services facilities includes the building component of the National Medical Cyclotron facility. The entire Cyclotron facility has been reclassified as part of major national facilities.

Movement summary 1999-2000 for all assets at valuation

Item	Land	Building	Total Land Land and Building	Infrastructure, plant, equipment, National and major facilities	Total
	$'000	$'000	$'000	$'000	$'000
As at 30 June 1999					
Gross value	33,223	90,774	123,997	57,006	**181,003**
Reclassification of national facilities		(12,999)	(12,999)	12,999	
Reclassification of software to intangibles				(158)	**(158)**
Reclassified gross value	33,223	77,775	110,998	69,847	**180,845**
Accumulated depreciation/amortisation		6,917	6,917	4,490	**11,407**
Reclassification of national facilities					
Reclassification of software to intangibles					
Reclassified depreciation		**6,917**	**6,917**	**4,490**	**11,407**
Net value	**33,223**	**70,858**	**104,081**	**65,357**	**169,438**
As at 30 June 2000					
Gross value	52,202	99,869	152,071	94,944	**247,015**
Accumulated depreciation/amortisation				5,884	**5,884**
Net value	**52,202**	**99,869**	**152,071**	**89,060**	**241,131**

	2000 $'000	1999 $'000
9C. Inventories		
Raw materials and stores-not held for resale		
Stores - at cost	970	774
Cobalt-60 sources - at net realisable value	508	551
Reactor fuel and heavy water - at average purchase price	4,847	5,815
Nuclear materials - at net realisable value	607	592
Nuclear materials - at cost	–	20
	6,932	7,752
Work in progress - held for sale		
Work in progress - at cost	88	97
	7,020	7,849

	2000 $'000	1999 $'000
9 Non-financial assets (continued)		
9D. Intangibles		
Licences - at valuation - 30 June 1999	309	309
Less accumulated amortisation	103	–
	206	309
Software at cost	38	–
Less accumulated amortisation	12	–
	26	–
Software at valuation - 30 June 1999	140	158
Less accumulated amortisation	63	–
	77	158
Total Intangibles	309	467

Movement summary 1999-2000 for intangibles irrespective of valuation basis

Intangibles	Licences $'000	Software $'000	Total $'000
Net book value as at 1 July, 1999	**309**		**309**
Transfer from Plant & equipment		**158**	**158**
Net book value as at 1 July, 1999 after transfers	**309**	**158**	**467**
Gross value as at 1 July, 1999	309	158	467
Additions - new assets			
Additions - replacement assets		20	20
Revaluation			
Gross value as at 30 June, 2000	**309**	**178**	**487**
Accumulated amortisation 1 July, 1999			
Other movements - transfer from Plant & Equipment			
Amortisation for assets held 1 July, 1999	103	63	166
Amortisation charge for additions		12	12
Adjustments for other movements			
Accumulated amortisation 30 June, 2000	**103**	**75**	**178**
Net book value as at 30 June, 2000	**206**	**103**	**309**

	2000 $'000	1999 $'000
9E. Other		
Prepayments	**574**	118
	574	118
Total non financial assets	**275,447**	204,844

	2000 $'000	1999 $'000
10 Provisions and payables		
10A. Capital use charge payable (refer Note 2(p))		
	339	–
10B. Liabilities to employees		
Accrued salaries and wages	1,383	1,014
Annual leave	6,571	5,472
Long service leave	10,643	11,240
	18,597	17,726
10C. Suppliers		
Trade creditors	2,262	8,100
	2,262	8,100
10D. Other payables		
Unrealised foreign exchange losses	–	607
Revenue received in advance	773	2,720
	773	3,327
10E. Other provisions		
HIFAR spent fuel rods - (a)	1,000	1,553
Waste treatment & disposal - (b)	–	965
Common law and other claims	1,250	460
	2,250	2,978

(a) Provision for HIFAR spent fuel rods

In 1995 ANSTO created a provision of $6.6 million, for the overseas transport and reprocessing of HIFAR spent fuel rods. No expenses have been incurred against the provision during 1999-2000 and following review the provision has been reduced.

This provision is separate from and precedes the Government's 1997 determination to fund disposition of the balance of spent fuel rods.

(b) Provision for waste treatment and disposal

In the 1995 financial year, an initial provision of $3 million was created for the management of a quantity of residual waste from past operations. This provision was increased to $5 million in 1996. The total estimated project cost is $11.1 million, comprising $4.9 million operating expenses, covered by the provision, and $6.2 million capital expenditure.

In 1999-2000 $0.965 million (1998-99 $1.504 million) has been charged against the provision. Further expenditure of $0.240 million (1998-99 $0.254) million was capitalised. In 2001/02 a further $5 million of funding will be provided by the Government.

This provision was reviewed in 2000 and found to be adequate due to the restoration of $5 million funding by the government which is to be received during the 2000/01 financial year.

	2000 $'000	1999 $'000
11 Equity		
Reserves, including movements		
Asset revaluation reserve		
Balance 1 July	**99,240**	87,538
Net revaluation increases	**71,090**	11,702
Balance 30 June	**170,330**	99,240
Fuel elements reserve		
Balance 1 July	**–**	513
Transferred from accumulated surpluses - (d)	**5,000**	–
Transferred to accumulated surpluses	**–**	(513)
Balance 30 June	**5,000**	–
Instrumentation reserve		
Balance 1 July	**1,400**	–
Transferred from accumulated surpluses - (a)	**1,600**	1,400
Balance 30 June	**3,000**	1,400
Total reserves	**178,330**	100,640
Accumulated surpluses		
Accumulated surpluses 1 July - (c)	**98,130**	95,240
Transfers to instrumentation reserve	**(1,600)**	(1,400)
Transfer (to)/from fuel elements reserve	**(5,000)**	513
Operating surplus - (b),(c)	**20,802**	3,777
Capital usage charges	**(24,572)**	–
Accumulated surpluses 30 June	**87,760**	98,130
Capital		
Capital 1 July - (c)	**6,000**	2,000
Equity Injections	**3,000**	4,000
Balance 30 June	**9,000**	6,000
Total equity	**275,090**	204,770

(a) Instrumentation reserve

In addition to the 1997 Government decision to fund the construction of a replacement research reactor at Lucas Heights, ANSTO has identified a planned future capital investment for the development of instrumentation associated with the replacement research reactor.

(b) Operating surplus

The operating surplus for 1998-99 includes an amount of $2.865 million being unspent special purpose appropriation funding for the disposition of spent fuel rods. The schedule of Commitments also refers.

(c) Restatement of opening balance

Equity injections received from the Government of $4 million in respect of 1999 and $2 million in respect of previous years have been reclassified from operating surplus to Capital in line with current reporting requirements.

(d) Fuel elements reserve

A transfer has been made to this reserve to identify separately the amount required for the purchase of fuel elements.

	2000 $'000	1999 $'000
12 Cash flow reconciliation		
Reconcillation of operating surplus to net operating cash flows		
Operating surplus before extraordinary items	**20,802**	3,456
Extraordinary items (refer to Note 13)	**–**	321
Operating surplus after extraordinary items	**20,802**	3,777
Decrease/(increase) in prepayments	**(456)**	1,479
Decrease in inventories	**829**	980
(Decrease) in provision for waste treatment and disposal	**(965)**	(1,504)
Increase/(decrease) in creditors	**(5,838)**	5,140
Increase in employee entitlements	**870**	899
Increase in provision for common law and other claims	**790**	110
(Decrease) in HIFAR spent fuel provision	**(553)**	–
(Increase)/decrease in accrued interest	**252**	(95)
(Increase) in assets under construction	**(1,655)**	(4,385)
Decrease/(increase) in receivables	**1,077**	(3,650)
Foreign exchange loss/(gain)	**(666)**	856
Nuclear materials (devaluation)/revaluation	**22**	(9)
(Increase) in plant and equipment	**(774)**	–
Depreciation/amortisation	**16,218**	15,069
Gain on disposal of assets	**(452)**	(635)
Loss on disposal of assets	**7**	336
Increase in capital use charge	**339**	–
(Decrease) in revenue in advance	**(1,947)**	(139)
(Increase)/decrease in other receivables	**(78)**	73
(Decrease) in prior year adjustment	**(92)**	–
Net cash provided by operating activities	**27,730**	18,302

12A Cashflows presented on a net basis

Cashflows arising from profits and losses on foreign exchange activities are presented on a net basis in the statement of Cashflows and the cashflow reconciliation.

13 Extraordinary items

There were no extraordinary items for the year ended 30 June 2000. The previous year extraordinary gain ($321,000) resulted from disposal of a business previously operated in partnership with Orica Australia Proprietary Limited.

14 Remuneration of members of the Board

Members' remuneration is determined by the Remuneration Tribunal and payment is made in accordance with Section 12 of the ANSTO Act 1987.

Included in operating expenses (Note 6) are:

	2000 $'000	1999 $'000
Aggregate amounts of superannuation payments in connection with the retirement of members of the Board	**29,050**	27,819
Other remuneration received, or due and receivable by the members of the Board	**325,946**	274,809
	354,996	302,628

The number of members included in these figures is shown below in each relevant remuneration band:

Remuneration between	Number	Number
$Nil and $9,999	**1**	1
$10,000 and $19,999	**2**	2
$20,000 and $29,999	**1**	1
$30,000 and $39,999	**1**	1
$40,000 and $49,999	**1**	–
$190,000 and $199,999	**–**	1
$220,000 and $229,999	**1**	–
	7	6

15 Remuneration of executives

Executive remuneration is determined by an Enterprise Agreement 1997, which is underpinned by the ANSTO Award. Included in operating expenses (Note 6) is total remuneration received or due and receivable, by executives (excluding the Executive Director who is included in Note 14) who earn $100,000 or more in connection with the management of ANSTO.

	2000 $	1999 $
	1,952,422	1,517,062

The number of executives included in these figures is shown below in each relevant remuneration band:

Remuneration between	Number	Number
$100,000 and $109,999	**2**	3
$110,000 and $119,999	**1**	1
$120,000 and $129,999	**–**	2
$130,000 and $139,999	**4**	4
$140,000 and $149,999	**3**	1
$150,000 and $159,999	**2**	–
$160,000 and $169,999	**1**	1
$200,000 and $209,999	**1***	–
	14	12

* includes retirement lump sum component

16 Insurance

Insurance risks, including professional indemnity, general liability, industrial special risk for a property used substantially for commercial purposes, directors and officers, and travel, remain insured with Comcover.

Workers compensation is covered by statute under the Safety Rehabilitation and Compensation Act 1988.

A Deed of Indemnity between the Government and ANSTO, under which the government has formally agreed to indemnify ANSTO and ANSTO Officers from any loss or liability arising from claims caused by ionising radiation, remains in place.

	2000	1999
	$	$
17 Remuneration of auditors		
Remuneration to the Auditor-General for auditing the financial statements for the reporting period	**89,280**	92,000

No other services were provided by the Auditor-General during the reporting period.

18 Board membership

The members of the Board during the financial year and to the date of the report on the statements were:

Member	Appointed	Term Concluded	Term Concludes
H M Garnett	11 May 1995 11 May 2000	10 May 2000	10 May 2005
M H Codd AC	5 July 1996 21 July 1999	30 June 1999	31 December 2001
S M Richards	5 July 1996		30 June 2001
F A Khafagi	14 May 1997 1 January 2000	31 December 1999	30 June 2002
J M Craker	2 June 1998		31 December 2002
C Hillyard	21 July 1999		21 July 2004
J Spasojevic	21 July 1999		21 July 2004

For the 1999-2000 financial year the aggregate remuneration paid to members of the Board is disclosed in Note 14.

The aggregate of superannuation payments paid to the Commonwealth Superannuation Scheme (CSS) and Public Sector Superannuation Scheme (PSS), in connection with the retirement of members of the Board was $29,059 (1998-99 $27,819).

19 Related party disclosures

Several members of the ANSTO Board were also members of Boards of entities with whom ANSTO had commercial transactions. None of these members were in a position to exercise significant influence on the relevant Boards. All such transactions were in accordance with commercial practice and on normal terms and conditions.

	2000 $'000	1999 $'000

20 Trust money

Monies received by ANSTO for specific purposes are placed in special bank accounts and are expended for these specified purposes only. These monies are not recognised in the financial statements.

Total		
Balance 1 July	**2,435**	1,780
Add: receipts	**2,182**	1,927
interest received	**88**	68
Deduct: payments	**2,063**	1,340
Balance 30 June	**2,642**	2,435

Represented by the following:

ANSTO RPAH joint account

Being moneys paid by a debtor in accordance with a Deed of Agreement pending the outcome of litigation.

Balance 1 July	**–**	–
Add: receipts	**252**	–
interest received	**3**	–
Deduct: payments	**–**	–
Balance 30 June	**255**	–

Trust account

ANSTO receives monies from trade creditors as security deposits for contracts to be performed. These monies are held in a Trust Account and refunded to the respective trade creditors on satisfactory completion of the contract.

Balance 1 July	**20**	9
Add: receipts	**2**	11
interest received	**–**	–
Deduct: payments	**17**	–
Balance 30 June	**5**	20

MNRF synchrotron

The Australian Synchrotron Research Program Incorporated was established under the Major National Research (MNRF) Program.

Balance 1 July	**2,395**	1,752
Add: receipts	**1,928**	1,916
interest received	**85**	67
Deduct: payments	**2,043**	1,340
Balance 30 June	**2,365**	2,395

	2000 $'000	1999 $'000
20 Trust money (continued)		
NEDO grant		
ANSTO is the research coordinator in the Interface Properties of Ceramics and their Impact on Materials Functions project under the NEDO International Joint Research Program. The NEDO Grant Trust account was established in		
Balance 1 July	**3**	3
Add: receipts	**–**	–
interest received	**–**	–
Deduct: payments	**3**	–
Balance 30 June	**–**	3
Welfare fund		
A Welfare Fund Trust Account is maintained to receive and manage donations to the fund and expenditure on specific welfare items for ANSTO employees.		
Balance 1 July	**17**	16
Add: receipts	**–**	–
interest received	**–**	1
Deduct: payments	**–**	–
Balance 30 June	**17**	17

21 Financial Instruments

(a) terms, conditions and accounting policies

Financial Instruments	Notes	Accounting Policies and Methods (including recognition criteria and measurement basis)	Nature of underlying instrument (including significant terms & conditions affecting the amount, timing and certainty of cash flow)
Financial assets		Financial assets are recognised when control over future economic benefits is established and the amount of the benefit can be reliably measured.	
Cash at bank	8A	Cash is recognised at cost. Interest is accrued as it is earned.	All Australian dollar cash balances are with the Commonwealth Bank of Australia and Westpac banking Corporation. At 30 June current rates were 4.5%pa, calculated daily.
Fixed term investment	8C	The deposit is recognised at cost. Interest is accrued as it is earned.	The deposit is with the Commonwealth Bank of Australia and earns an effective rate of interest of 6.19% payable monthly.
Foreign exchange holdings	8A, 8B, 10D,	Transactions denominated in a foreign currency are converted at a rate of exchange prevailing at the date of each transaction. Balances at year end are converted at end of year exchange rates.	The deposits are with the Commonwealth Bank of Australia and the Bank of America, and earn an effective rate of interest of 2.58%.
Receivables for goods & services	8B	Receivables are recognised at the nominal amounts due less any provision for bad and doubtful debts. Provisions are made when collection of the debt is judged to be less rather than more likely.	Credit terms are net 30 days (1998-99: 30 days).
Loans	8B	The loan is a non-interest bearing advance to a Commonwealth agency to initially meet on ANSTO's behalf costs incurred overseas, and is recognised at its nominal value.	Monthly reconciliation of expenses incurred and claimed by the Commonwealth agency provides the basis for reimbursement of the advance to the operating limit.
Other debtors	8B	As for receivables for goods and services.	As for receivables for goods and services.
Financial Liabilities		Financial liabilities are recognised when a present obligation to another party is entered into and the amount of the liability can be reliably measured.	
Trade creditors	10B	Creditors and accruals are recognised at their nominal amounts, being the amounts at which the liabilities will be settled. Liabilities are recognised to the extent that the goods or services have been received (and irrespective of having been invoiced).	Settlement is usually made net 30 days.
Revenue received in advance	10D	Revenue received in advance is initially brought to account as 'other payables' and subsequently recognised as revenue when earned.	Revenue earned is brought to account on a monthly basis.
Other provisions	10E	Liabilities have been recognised for transport and reprocessing of spent fuel elements and pending common law claims.	Provision for spent fuel disposition will be drawn as and when required. Other provisions for common law claims are dependent upon completion and outcome of legal proceedings.

21 Financial Instruments (cont.)

(b) Interest Rate Risk

Financial Instruments	Notes	Floating Interest Rate		Fixed Interest Rate				Non-Interest Bearing		Total		Weighted Average Effective Interest Rate	
				1 year or less		> 2 years							
		2000 $'000	1999 $'000	2000 $'000	1999 $'000	2000 $'000	1999 $'000	2000 $'000	1999 $'000	2000 $'000	1999 $'000	2000 $'000	1999 $'000
Financial assets (recognised)													
Cash at bank	8A	**5,578**	2,451	**–**	–	**–**	–	**–**	–	**5,578**	2,451	**4.50%**	3.79%
Cash on hand	8A	**–**	–	**–**	–	**–**	–	**20**	17	**20**	17	**n/a**	n/a
Fixed term investment	8C	**–**	–	**10,100**	14,090	**–**	–	**–**	–	**10,100**	14,090	**6.00%**	4.81%
Foreign exchange holdings	8A	**451**	6,734	**–**	–	**–**	–	**–**	–	**451**	6,734	**2.80%**	2.58%
Receivables for goods and services	8B	**–**	–	**–**	–	**–**	–	**7,431**	8,368	**7,431**	8,368	**n/a**	n/a
Loans	8B	**–**	–	**–**	–	**–**	–	**60**	60	**60**	60	**n/a**	n/a
Interest accrued	8B							**45**	297	**45**	297	**n/a**	n/a
Unrealised foreign exchange gains	8B							**61**	–	**61**	–	**n/a**	n/a
Other debtors	8B		–	**–**	–	**–**	–	**118**	40	**118**	40	**n/a**	n/a
Total financial assets (recognised)		**6,029**	9,185	**10,100**	14,090	**–**	–	**7,735**	8,782	**23,864**	32,057		
Total assets										**299,311**	236,901		
Total financial liabilities (recognised)													
Trade creditors	10C	**–**	–	**–**	–	**–**	–	**2,262**	8,100	**2,262**	8,100	**n/a**	n/a
Unrealised foreign exchange losses	10D							**–**	607	**–**	607	**n/a**	n/a
Revenue received in advance	10D	**–**	–	**–**	–	**–**	–	**773**	2,720	**773**	2,720	**n/a**	n/a
Other provisions	10E	**–**	–	**–**	–	**–**	–	**2,250**	2,978	**2,250**	2,978	**n/a**	n/a
Total financial liabilities (recognised)		**–**	–	**–**	–	**–**	–	**5,285**	14,405	**5,285**	14,405		
Total liabilities										**24,221**	32,131		

21 Financial Instruments (cont.)

(c) Net Fair Values of Financial Assets and Liabilities

	Note	2000 Total carrying amount $'000	2000 Aggregate net fair value $'000	1999 Total carrying amount $'000	1999 Aggregate net fair value $'000
Financial assets (recognised)					
Cash at bank	8A	5,578	5,578	2,451	2,451
Cash on hand	8A	20	20	17	17
Fixed term investments	8C	10,100	10,100	14,090	14,090
Foreign exchange holdings	8A	451	451	6,734	6,734
Receivables for goods and services	8B	7,746	7,746	8,368	8,368
Interest accrued	8B	45	45	297	297
Unrealised foreign exchange gains	8B	61	61	–	–
Loans	8B	60	60	60	60
Other debtors	8B	118	118	40	40
Total financial assets		**24,179**	**24,179**	32,057	32,057
Financial liabilities (recognised)					
Trade creditors	10C	2,262	2,262	8,100	8,100
Unrealised foreign exchange loss	10D	–	–	607	607
Revenue received in advance	10D	773	773	2,720	2,720
Other provisions	10E	2,250	2,250	2,978	2,978
		5,285	**5,285**	14,405	14,405

21 Financial Instruments (cont.)

(c) Net fair values of financial assets and liabilities (cont.)

Financial assets

The net fair values of cash, deposits on call and non-interest-bearing monetary financial assets are in accord with their carrying amounts.

Loans receivable are carried at cost, which is above their net fair value, because it is intended to hold them to maturity.

Financial liabilities

The net fair values for trade creditors and revenue received in advance, all of which are short-term in nature, are in accord with their carrying amounts.

(d) Credit risk exposures

ANSTO's maximum exposures to credit risk at reporting date in relation to each class of recognised financial assets is the carrying amount of those assets as indicated in the Statement of Assets and Liabilities.

ANSTO has no significant exposure to any concentrations of credit risk other than those disclosed in Note 8.

22 Subsequent events

Following the requisite approval received from the Minister for Industry, Science and Resources, a contract was executed on 13 July 2000 between ANSTO and INVAP SE for the design, construction and commissioning of a replacement research reactor at Lucas Heights. The cost of the reactor, including ANSTO's contingency and project development costs, is A$278.5 million, excluding GST (November 1999 dollars). This subsequent event has no material impact on the reported financial position at 30 June 2000.

APPENDIX 1
EQUAL EMPLOYMENT OPPORTUNITY

OBJECTIVES

- To ensure that Equal Employment Opportunity (EEO) principles and practices are actively incorporated into all people management activities.
- To ensure that the structures and processes to implement EEO adjust to changing employment needs.
- To confirm and communicate the vision that ANSTO's employment activities reflect ANSTO's values

STATISTICS

Staff employed at corporate executive level as at 30 June 2000

Band 3 Corporate Executive	2 males	
Band 2 Corporate Executive	9 males	1 female
Band 1 Corporate Executive	1 male	2 females

Staff numbers as at 30 June 2000

	Full Time		Part Time	
	Male	Female	Male	Female
Executive Director		1		
Corporate Executives	12	3		
Professional Officers	171	47		7
Research Scientists	91	20	3	
Technical Officers	245	20		5
Administrative Services Officers	35	62	1	14
Craftspersons	64	6	1	1
Totals	618	159	5	27
Total Staff = 809				

Summary of EEO statistics as at 30 June 2000

Total staff = 809	Number employed	Percentage of total staff	Average salary
Female	186	23%	$44,587
Male	623	77%	$53,886

Staff in specific employment categories (based on specific data voluntarily provided by 330 staff)

People with disabilities	21	$49,795
Aboriginal and Torres Strait Islanders	2	$45,552
Non-English-speaking background	136	$49,497

The review of all people management policies and procedures continued to ensure all policies met best practice requirements and recognised the value of diversity.

Staff and their families continued to be provided with access to the services of counsellors from Citipsych.

APPENDIX 2
FREEDOM OF INFORMATION

In compliance with Section 8 of the Freedom of Information (FOI) Act (1982), the following is the annual statement on consultative arrangements, categories of documents maintained, and facilities and procedures for access to documents relating to ANSTO. Details of the functions of the organisation, membership of the Board and decision-making powers of the Board and the executive are provided elsewhere in the Annual Report.

Arrangements for external participation

Liaison groups

Technical advisory committees for each of ANSTO's major strategic research and development projects assist in assessing and evaluating research and development activities. Members are drawn from industry, commerce, government, academia and ANSTO staff.

The Local Liaison Working Party (LLWP), established in 1967, comprises representatives from the NSW Police, NSW Ambulance, NSW Fire Brigades, NSW State Emergency Services, NSW Environment Protection Authority, NSW Department of Health, Australian Protective Services, Sutherland Shire Local Emergency Management Committee, St George - Sutherland District Emergency Management, the Sutherland Shire Council and ANSTO, as well as an observer from ARPANSA. The LLWP reviews procedures applicable to a potential accident at the Lucas Heights Science and Technology Centre that could have implications for the public.

A Central Safety Coordinating Committee assists in developing, reviewing and implementing ANSTO's occupational health and safety policies. Membership includes representatives of unions and staff associations, the NSW Labor Council and ANSTO.

ANSTO/State Government arrangements

ANSTO, located in New South Wales, liaises with a range of NSW departments and authorities responsible for safety, environmental planning and related matters.

Associated organisation

The Australian Institute of Nuclear Science and Engineering Incorporated, an association of ANSTO and 36 universities, arranges access by staff and students of Australasian universities and institutes of technology to the major facilities at ANSTO.

Other arrangements

Less formal arrangements exist for discussions, the exchange of views and/or collaboration with organisations outside the Commonwealth administration including local government authorities, universities, standards bodies, professional societies, unions and staff associations, industrial groups and international nuclear agencies.

Categories of documents held

Computer software packages, computer print-outs, technical books and reports, and International Nuclear Information System documents are available for purchase. Single copies of Annual Reports, Lucas Heights News, Strategic Plans, Operational Plans, ANSTO emergency plans, general information literature and videos (under loan arrangements) are available on request.

Documents relating to decision-making processes include Cabinet documents about matters in which ANSTO has an interest, ministerial correspondence and directions,

ANSTO Board agenda, memoranda and decisions, deeds, legal contracts and formal agreements, minutes and submissions, and accounting handbooks and manuals on employment, delegations, security and finance.

General correspondence includes ministerial briefs, speeches, conference papers for national and international meetings, parliamentary questions and answers, cables, telexes and facsimiles, and general records files. Technical documents held include scientific and technical reports and laboratory notes comprising patents and inventions; computer tapes and print-outs; plant and equipment operating manuals; maintenance, quality assurance and safety manuals; reactor operating authorisations, records and log books; radioisotope quality control procedures manuals; radioisotope catalogues and price lists; engineering service general records; nuclear material movement vouchers and accounting records; photographs; and radiographs. Health and safety documents include staff medical records, safety-related survey records, film badge and radiological records, accident reports, and emergency response procedures.

Administration documents held include personnel records such as staff promotion files; organisation and establishment reports; compensation files; word processor disk systems for administrative instructions and information storage; staff lists and classifications; accounting records; pay-roll, flexitime and overtime records; tender and contract documents; building plans, specifications and instructions; directives; orders; memoranda; bulletins; notices; and information. Other documents held include drawing office records such as plans, microfilm, drawings, maps, and photographs.

Facilities for access

FOI reading facilities can be provided in the Reception and Information Centre at the entrance to the Lucas Heights Science and Technology Centre. Other arrangements for access may be made by contacting The FOI Coordinator, ANSTO, Private Mail Bag 1, Menai, NSW 2234, Australia (e-mail smi@ansto.gov.au).

Information about ANSTO is available on the Internet through the organisation's homepage at http://www.ansto.gov.au/.

The Director, Corporate Services, and the Director, Government and Public Affairs, have been appointed as authorised officers under Section 23 of the FOI Act.

APPENDIX 3
CORPORATE GOVERNANCE

Economic dependency

ANSTO is economically dependent on the Commonwealth Government, requiring appropriation of money by Parliament to carry out the majority of its activities.

Compliance

ANSTO is subject to the provisions of the following key Commonwealth Acts and Awards:

- *Australian Nuclear Science and Technology Organisation Act 1987*
- *Auditor-General Act 1997*
- *Commonwealth Authorities and Companies Act 1997*
- *Workplace Relations Act 1996*
- *Public Service Act 1922*
- *Long Service Leave (Commonwealth Employees) Act 1976*
- *Superannuation Act 1976*
- *Superannuation Act 1990*
- *Superannuation (Productivity Benefit) Act 1988*
- *Superannuation Guarantee (Administration) Act 1992*
- *Maternity Leave (Commonwealth Employees) Act 1987*
- *Nuclear Non-proliferation (Safeguards) Act 1987*
- *Australian Radiation Protection and Nuclear Safety Act 1998*
- *Occupational Health and Safety (Commonwealth Employment) Act 1991*
- Australian Nuclear Science and Technology Organisation (General) Award 1990
- Australian Government Statutory Authorities Redeployment and Retirement (Redundancy) Award 1988.

ANSTO has put in place policies and procedures to deliver compliance with the above Acts and Awards.

The provisions of the Australian Government Statutory Authorities Redeployment and Retirement (Redundancy) Award 1988 are only operative to the extent that they deal with an allowable matter in terms of Section 89A of the Workplace Relations Act 1996.

The functions of the Board

A Board established under Section 8 of the Australian Nuclear Science and Technology Organisation Act 1987 (referred to hereafter as the ANSTO Act) governs ANSTO.
The general functions of the Board, as set out in Section 9 of the Act, are to:

- ensure the proper and efficient performance of the functions of the organisation and
- determine the policy of the organisation with respect to any matter having regard to the current policies of the Commonwealth Government.

In particular it has responsibility for:

- approval of organisational strategy and the annual business plan and budget
- monitoring financial performance
- monitoring managerial performance and
- ensuring that the significant risks facing the organisation have been identified and that appropriate control, monitoring and reporting mechanisms are in place.

The Board has established an Audit Committee. All matters considered are submitted to the Board for information and, where appropriate, ratification. Details of the Audit Committee are provided below. The Board is also supported in its role by other committees or mechanisms relating to safety and environmental management and to technical assessment. These are also described below.

Board membership

The Board comprised six non-executive members, drawn from the broader community, and an Executive Director. The Executive Director, who is appointed by the Board, cannot be the

Chairman. The non-executive members are appointed by the Governor-General for specified periods.

Section 19 of the ANSTO Act provides that the Executive Director shall manage the affairs of the organisation, subject to the directions of, and in accordance with, policies determined by the Board. Senior management attend Board meetings as required to report on matters relevant to their individual areas of responsibility.

Each member brings complementary skills and experience to the Board. Its members during the 1999-2000 financial year had experience in areas that included public service, industry, mining, scientific research, medicine, and the commercialisation of research.

The Board meets regularly in accordance with a formally approved timetable and agenda. Board members receive regular papers from management on financial and business performance and specific papers on a range of issues relevant to the organisation.

Seven Board meetings were held during the financial year. Details of the number of Board meetings attended by each member are provided below.

	Meetings	
Member	Held	Attended
S M Richards (Chairman)	7	6
M H Codd AC	7	7
F A Khafagi	7	6
J M Craker	7	7
C Hillyard	7	5
J Spasojevic	7	6
H M Garnett (Executive Director)	7	7

Remuneration and allowances

Non-executive members of the Board and the Executive Director's remuneration and allowances are determined by the Remuneration Tribunal.

Remuneration of Board members is disclosed in the Financial Statements.

Disclosure of interests

Section 21 of the Commonwealth Authorities and Companies Act provides for the disclosure of material personal interests in a matter that is being considered by the Board and prohibits participation, deliberation and decision making by any member on such matters.

Independent professional advice

The Board has established procedures by which members may seek independent professional advice.

Report of operations

Section 9, Schedule 1 of the Commonwealth Authorities and Companies Act requires that this annual report include a report of operations. The format and content of the 1999-2000 Annual Report addresses this requirement in general. In particular the Board reports that:

- ANSTO's mission has not changed from that reported for the previous financial year and continues to be managed through six core business areas
- each core business area is reported against in terms of its outputs and contribution to outcomes
- actual performance is reported against approved performance indicators
- an audited note setting out performance by core business area is included in the Financial Statements attached to this report

- there were no significant events requiring disclosure in terms of Section 15 of the Commonwealth Authorities and Companies Act
- there have been no significant changes in ANSTO's state of affairs or principal activities during the year
- a significant event occurred subsequent to the end of the 1999/2000 financial year. This related to the execution of a contract on 13 July between ANSTO and INVAP SE for the design, construction and commissioning of a replacement research reactor at Lucas Heights. This matter is reported at Note 22 to the Financial Statements attached to this report.

In the opinion of management and the Board, at the time of making this report, adequate cash resources are, and will continue to be, available to cover the entity's requirement for working capital, to pay existing debts, and to meet obligations during the next financial year.

Safety The Board places primary importance on the safe performance of all ANSTO activities. The monitoring of safety in general, and compliance with relevant legislation in particular, is designated as a responsibility of the whole Board. ANSTO's Health, Safety and Environment Policy sets out clearly the organisation's commitment to verifiable implementation of best practices in safety and environmental protection.

The Board continued to attach priority to the recommendations on safety made by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Under the ARPANS Regulations 1999 ANSTO has submitted licence applications for all ANSTO facilities and radioactive sources.

ANSTO revised its safety management committees following the passage of the ARPANS Act and Regulations in 1999. The new structure created a committee (the ANSTO Health, Safety and Environment Committee) to oversee health, safety and environmental management. The new committee replaced the Reactors Safety Committee and has a wider remit: to review, and advise the Executive Director on, the effectiveness and compliance of ANSTO's health, safety and environmental performance.

The Board receives regular reports on health and safety issues. ANSTO was granted occupational health and safety self audit status by Comcare in 1999. The first year's audit programme was successfully completed, with the results reported to the Board Audit Committee, the Board and Comcare.

Audit Committee The Audit Committee, a formal sub-committee of the Board, comprised Mr M. H. Codd (Chairman), Mr J. M. Craker and a member external to ANSTO, Mr J. Bergman. The Executive Director, the Director, Corporate Services, and the Chief Internal Auditor attend all meetings or relevant parts of all meetings by invitation. Others, including representatives of the Australian National Audit Office (ANAO), attend meetings, as appropriate, at the invitation of the Committee.

This Committee was established by the Board to oversee the organisation's risk management policies, practices and controls in relation to its business, including financial and commercial activities, legislative and regulatory conformance, and asset protection.

The Committee also reviews summaries of the internal and external audit work scheduless and reports. Additionally, in accordance with the provisions of the Commonwealth Authorities and

Companies Act, the Committee is responsible for assisting Board members to fulfil their specific responsibilities under that Act.

Four Audit Committee meetings were held during the financial year. Details of the number of Committee meetings held and attended during the period in which each member held office during the financial year are provided in the table below.

Member	Meetings	
	Held	Attended
M H Codd AC (Chairman)	4	4
J M Craker	4	4
J Bergman (External Member)	4	4

The Committee generally meets quarterly. It is the only sub-committee of the Board.

Technical Advisory Committee

The Technical Advisory Committee, which was formally established in accordance with a Board decision, comprises four members, all of whom are external to ANSTO. Members are chosen on the basis of internationally recognised scientific expertise and experience. The members of the committee are Professor Joan Dawes (Australia), Dr Jean Lefevre (France), Dr James O Stiegler (United States) and Dr J W Zillman (Australia).

This Committee was established by the Board to:

- advise on the scope of ANSTO's scientific research program
- advise on ANSTO's ability to achieve the scientific goals of its mission, and
- review the progress of ANSTO's research against defined milestones and objectives.

The Committee was formally constituted in October 1996 and is required to meet at least once per year. It met once during the reporting period and presented a formal report to the Board.

Risk management

The Board recognises that developing and implementing ANSTO's strategies requires careful assessment and balancing of both risk and opportunity.

The Board is charged with the responsibility of ensuring that appropriate policies are in place to cover identified risks, and management is required to develop appropriate procedures to manage these risks.

The Board has endorsed a risk management framework introduced by management in 1997. As part of this framework, ANSTO's Internal Audit function undertakes a systematic program of risk assessments designed to identify, evaluate and prioritise high and significant risks, utilising a methodology consistent with the Australian Risk Management Standard AS/NZS - 4360/1999. The Audit Committee and the ANAO receive summaries of all risk assessment reports.

ANSTO has a risk management policy setting out that it is the responsibility of the operational management of ANSTO to develop and implement risk mitigation strategies. The overall risk framework is actively applied in ANSTO's operations and to new initiatives in particular. Project risk management was a significant area of focus in the replacement research reactor, business information system and information technology outsourcing projects.

In appropriate circumstances, insurance is used as a method to transfer the financial impact of risk.

The Board, supported by the Audit Committee, oversights the development and operation of business continuity planning and other emerging risk issues. It reviewed a revised organisational risk profile in March 2000.

Ethical standards The organisation's ethics policy is set out in a document entitled "Ethics and Conduct - A Code for ANSTO Staff". The policy provides a reference point for ethical behaviour and applies to members of the Board, management and all staff. The Code sets out the standards for ethical behaviour and conduct and provides guidance by defining the expected values and standards of workplace behaviour and performance.

Fraud control A revised fraud risk assessment of the organisation, commissioned in accordance with the Government's fraud control policy, was conducted in June 2000. There was no requirement to materially revise the existing fraud control policy and plan.

External audit Under the Commonwealth Authorities and Companies Act, the Commonwealth Auditor General, through the ANAO, is the external auditor for ANSTO.
The Audit Committee reviews the ANAO audit plan and reports and meets with ANAO representatives prior to recommending to the Board that the annual Financial Statements be accepted and the Statement by Directors signed.

Internal audit The ANSTO Internal Audit function has a dual reporting line to the Audit Committee and the Executive Director. Its responsibility is to provide an independent, risk-based review function as set out in a formal charter endorsed and periodically reviewed by the Audit Committee. The Audit Committee reviews the annual Internal Audit plan and receives regular reports on progress against that plan.

Internal control The Board is responsible for ensuring that appropriate policies and internal controls are in place and operating.

Compliance and review are monitored through the Audit Committee and the Internal Audit function.

Year 2000 compliance ANSTO ran a Year 2000 compliance project from July 1997. Through this project, mission critical systems were identified and made compliant in terms of the Year 2000 computer date problem. The project was successfully completed and there were no date-related issues at the critical times. The project had the beneficial side effect of leading to the updating of equipment such as alpha and gamma spectrometers to current hardware and software.

Federal information technology outsourcing initiative The Commonwealth Government decided in 1997 that information technology infrastructure and services across all budget-funded Government Agencies would be outsourced subject to the outcome of a competitive tendering process.

In March 2000, a science cluster comprising the Australian Antarctic Division, the Australian Geological Survey Organisation, the Australian Institute of Marine Science, ANSTO and CSIRO began the process for the organisations concerned. Since then the group has drafted a classification framework for the computer inventory. The computers in scientific agencies range from corporate servers and desktops to computers integrated into scientific instrumentation and control systems. Towards the end of the reporting period effort was focussed on preparing an inventory for the tender drafting process and refining the scope of the outsourcing process.

The next stage will involve drafting the request for tender. The process of negotiating a satisfactory tender through to acceptance is expected to take about a year.

Goods and Services Tax

ANSTO established a project in October 1999 to ensure that ANSTO was in a position to implement the changes required under the New Taxation System, including the introduction of the Goods and Services Tax.

Formal signoff was provided to the Minister in May 2000 that all ANSTO systems would be compliant from 1 July 2000.

Service Charter

ANSTO's Service Charter sets out a statement of what ANSTO does and the standards of product and service that customers, stakeholders and the community can expect from the organisation. The Service Charter was released in June 1999 and adheres closely to the Customer Service Charter Principles developed by the Department of Finance and Administration. Customer feedback is fundamental to improving customer service and is an integral part of all service charters. During the year, ANSTO recorded 358 complaints, pertaining mainly to the supply of radiopharmaceuticals. Most of the non-technical complaints were resolved within twenty-four hours.

APPENDIX 4
FUNCTIONS AND POWERS OF THE ORGANISATION UNDER THE ANSTO ACT

This appendix describes the functions and general powers of the Organisation under the *Australian Nuclear Science and Technology Organisation Act 1987* (the ANSTO Act).

Functions of the Organisation under the ANSTO Act

"Organisation" means the Australian Nuclear Science and Technology Organisation.
Section 5 of the ANSTO Act provides that:
(1) The functions of the Organisation are:

(a) to undertake research and development in relation to:
  (i) nuclear science and nuclear technology;
  (ii) the production and use of radioisotopes, and the use of isotopic techniques and nuclear radiation, for medicine, science, industry, commerce and agriculture; and
  (iii) such other matters as the Minister directs;

(b) to encourage and facilitate the application and utilisation of the results of such research and development;

(ba) to condition, manage and store radioactive materials and radioactive waste, arising from:
  (i) the Organisation's activities (including the production of radioactive materials for other persons); or
  (ii) the activities of companies in which the Organisation holds a controlling interest (including the production of radioactive materials for other persons); or
  (iii) the use by other persons of radioactive materials produced by the Organisation or such companies; or
  (iv) the activities of other persons who are specified in the regulations;

(c) to provide and sell goods (whether produced by the Organisation or purchased or otherwise acquired by the Organisation) and services:
  (i) in connection with the production and use of radioisotopes, and the use of isotopic techniques and nuclear radiation, for medicine, science, industry, commerce and agriculture; or
  (ia) in connection with the conditioning, management and storage of radioactive materials or radioactive waste; or
  (ii) otherwise in connection with matters related to its activities;

(d) to act as a means of liaison between Australia and other countries in matters related to its activities;

(e) to provide advice on aspects of nuclear science and nuclear technology and other matters related to its activities;

(ea) to make available to other persons, on a commercial basis, the knowledge, expertise, equipment and facilities of the Organisation by:
  (i) providing training and management expertise; or
  (ii) selling or leasing equipment; or
  (iii) leasing land and facilities; or
  (iv) taking any other action that the Organisation thinks appropriate;

(f) to co-operate with appropriate authorities of the Commonwealth, the States and Territories, and with other organisations and institutions in Australia or elsewhere, in matters related to its activities;

(g) to publish scientific and technical reports, periodicals and papers on matters related to its activities;

(h) to collect and sell or distribute, as appropriate, information and advice on matters related to its activities;

(j) to arrange for training, and the establishment and award of scientific research studentships and fellowships, in matters related to its activities;

(k) to make grants in aid of research into matters related to its activities; and

(m) to make arrangements with universities and other educational research institutions, professional bodies and other persons for the conduct of research or of other activities in matters related to its activities.

(1A) A regulation made for the purposes of subparagraph (1)(ba)(iv) must not have the effect of authorising the premises on which the Lucas Heights Research Laboratories [the Lucas Heights Science and Technology Centre] are situated to become a national nuclear waste repository.

(IB) In subsection (IA): "national nuclear waste repository" means a site chosen by the Commonwealth, after the commencement of this subsection, for the storage of nuclear waste with a view to it never being moved to another site.

(2) The Organisation shall not undertake research or development into the design or production of nuclear weapons or other nuclear explosive devices.

Section 6 of the ANSTO Act provides that:

General powers of the Organisation under the ANSTO Act

(1) Subject to this Act, the Organisation has power to do all things necessary or convenient to be done for or in connection with the performance of its functions and, in particular, has power:

(a) to enter into contracts;
(b) to acquire, hold and dispose of real or personal property;
(c) to occupy, use and control any land or building owned or held under lease by the Commonwealth and made available for the purposes of the Organisation;
(d) to erect buildings and structures and carry out works;
(e) to form, or participate in the formation of, a company or partnership;
(f) to appoint agents and attorneys, and to act as an agent for other persons;
(g) to engage persons to perform services for the Organisation;
(h) to design, produce, construct and operate equipment and facilities; and
(i) to do anything incidental to any of its powers.

(2) The powers of the Organisation may be exercised within or outside Australia.

APPENDIX 5

STATUS REPORT on the implementation of the conditions arising from the ENVIRONMENTAL IMPACT ASSESSMENT OF THE REPLACEMENT RESEARCH REACTOR

Introduction The Minister for the Environment and Heritage indicated in a Media Release on 30 March 1999 that he had decided there were no environmental reasons, including reasons based on safety, health, hazard or risk grounds, to prevent construction of the replacement research reactor at Lucas Heights, subject to a number of recommendations. On 3 May 1999, the Minister for Industry, Science and Resources announced that he had accepted those recommendations, and noted that their implementation would ensure that the replacement reactor at Lucas Heights was built and operated in accordance with best international practice.

In its report dated 12 August 1999, the Parliamentary Public Works Committee endorsed the decision to construct the replacement reactor, commended the recommendations made by the Minister for the Environment and Heritage and recommended:

"In future, in its Annual Report to Parliament ANSTO should report on compliance and implementation of all recommendations in the Environment Assessment Report, including the commitments listed in Appendix A of the report."

This appendix constitutes ANSTO's first report pursuant to that recommendation.

Since the completion of the environmental assessment process, there has been major progress on the replacement reactor project. The House of Representatives agreed to the necessary expediency motion on 26 August 1999 to carry out the work, based on the report of the Parliamentary Standing Committee on Public Works. The request for tender was subsequently provided to the four pre-qualified tenderers, with tenders closing in January 2000. After an exhaustive evaluation of the offers from the four tenderers, INVAP S.E. was named the preferred tenderer in June 2000.

Of the 29 conditions, none were required to be completed prior to signature of the contract for the replacement reactor. Six conditions (conditions 2, 3, 5, 6, 11 and 26) must be completed prior to the commencement of construction. Some approval conditions (conditions 1, 4, 10, 24, 27 and 29) require a long-term commitment by ANSTO or the Government and these will continue beyond the completion and commissioning of the reactor.

The 29 conditions The 29 approval conditions are given below, and the current status of implementation of each condition is discussed.

1. *The construction and operation of the proposed reactor at the Lucas Heights Science and Technology Centre (LHSTC) must be in accordance with the undertakings and commitments provided by the Australian Nuclear Science and Technology Organisation (ANSTO) in the Final Environmental Impact Statement (Replacement Nuclear Research Reactor, 1997/98, Volumes 1, 2 and 3), and as summarised in Chapter 18 of Volume 3. If there is conflict between the ANSTO undertakings and the recommendations below, the recommendations will take precedence.*

Compliance with all undertakings and commitments given by ANSTO within the EIS was a mandatory component of the tender process. INVAP demonstrated that it would comply with those EIS undertakings and commitments through all phases of the replacement reactor project.

2. *ANSTO must prepare a construction environmental management plan (EMP), to the satisfaction of the Minister for the Environment and Heritage, prior to construction commencing. The EMP will address all commitments and undertakings made by the proponent for environmental management during construction, and as summarised in Chapter 18 (Volume 3) of the Final Environmental Impact Statement. The following associated recommendations must also be addressed:*

- *an Erosion and Sedimentation Control Plan must be prepared as part of the EMP. Measures proposed to be implemented must be referred to the NSW Environment Protection Authority (EPA) and the NSW Department of Land and Water Conservation for comment prior to their adoption in the EMP. The Plan shall conform with the principles and objectives of the following NSW EPA handbooks:*
  - *Managing Urban Stormwater: Treatment Techniques 1997;*
  - *Managing Urban Stormwater: Soils and Construction 1998; and*
  - *Managing Urban Stormwater: Source Control (draft release 1998);*

- *a Remedial Action Plan must be developed, as part of the EMP, in accordance with NSW EPA guidelines for the treatment of hydrocarbon-impacted soil. Any requirements for off-site disposal of contaminated soils must be to the satisfaction of the NSW EPA;*

- *an Air Quality Management Plan must be prepared, as part of the EMP, in consultation with the NSW EPA and the NSW Department of Land and Water Conservation. A primary objective of the Plan will be to ensure that particulate levels at the nearest residence are below 50 µg m-3 (PM10) during construction works;*

- *appropriate works must be installed to protect the identified Aboriginal shelter site (PAD 1) from construction water run-off and sediment. Provision will be made in the EMP for liaison between the proposed ANSTO EMP Environmental Officer and the NSW National Parks and Wildlife Service concerning environmental management in the vicinity of the site, if required;*

- *a Noise Management Control Plan must be prepared, as part of the EMP, with the objective of ensuring that noise impacts to the public are minimised. The Plan must be prepared to meet NSW EPA requirements;*

- *the EMP must include a comprehensive monitoring program to ensure that run-off and discharges from the construction site meet nutrient, sediment and other surface water quality criteria for protection of the environment. At least 12 months baseline data must be collected prior to construction works commencing.*

The program will include measures to be implemented should acceptability criteria be exceeded; and

- *a program of groundwater monitoring must commence at least twelve months prior to construction commencing. This program will be detailed in the EMP. Prior to construction commencing, an independent report reviewing the results of the program and requirements for further monitoring during construction and operation of the reactor must be prepared (see also Recommendation 11, below). This report must be submitted to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the Department of the Environment and Heritage for agreement.*

Some steps, such as the necessary baseline studies and a ground water monitoring program, which are required to commence at least twelve months prior to construction, are already in progress.

ANSTO has been monitoring surface water run-off from the site for radiological contamination for over 10 years. Monitoring for the purposes of establishing the 12-month surface water baseline will commence in late 2000.

Following a tender process, ANSTO appointed PPK Environment & Infrastructure in January 2000 as an external consultant to design a ground water monitoring program for the Lucas Heights Science and Technology Centre. A total of 15 bores were drilled around the site and geological, hydrogeological and geophysical studies were conducted to obtain a detailed knowledge of local groundwater conditions. Included in the work undertaken by PPK were recommendations, based on best practice, for the sampling of groundwater as part of the monitoring program. An initial presentation on the groundwater program, covering the scope of the work and results obtained to date, was provided to ARPANSA. Sampling of the bores has commenced. This will provide the necessary baseline information prior to construction commencing.

3. ANSTO must consult with the NSW Roads and Traffic Authority to determine if upgrading of the intersection between New Illawarra Road and the LHSTC entrance is needed, in particular, extension of the southbound deceleration lane. Any works required will be completed prior to construction commencing and at ANSTO's expense.

ANSTO, in collaboration with the NSW Roads and Traffic Authority, completed a review of traffic densities at the intersection; the final report of the review is expected to be completed in late 2000. Based on the outcomes of this review, a decision will be made on the necessity for upgrading the intersection and, if this is considered necessary, on the type of junction required.

4. Monitoring of water quality must continue into the operational phase until sufficient data has been collected to indicate that the site, and stormwater run-off, has stabilised.

This condition flows on from Condition 2. The water quality monitoring program will

continue into the operational phase until sufficient data has been collected to indicate that the site, and stormwater run-off, has stabilised.

5. A Stormwater Control Plan must be developed during the design stage to ensure that the site system is constructed to current best practice and in accordance with NSW EPA guidelines. The plan will also consider options for containment of one-off larger volume spills, such as fire fighting foams. The plan must be prepared to the satisfaction of the Department of the Environment and Heritage.

The final engineering and architectural design work will include a Stormwater Control Plan, which will be submitted to the Department of the Environment and Heritage for approval.

6. ANSTO must review the Lucas Heights Buffer Zone Plan of Management (1986), in consultation with relevant stakeholders, to ensure measures required for the protection of the environment during the construction and operation of the proposed replacement reactor are implemented, and to ensure that the biological and conservation values of the buffer zone are maintained. The revised plan must be prepared to the satisfaction of the Department of the Environment and Heritage.

ANSTO has commenced a review of the Lucas Heights Buffer Zone Plan of Management (1986) as part of its Environmental Management Action Plan (EMAP). ANSTO is using EMAP to develop an environmental management system for the Lucas Heights Science and Technology Centre which is consistent with ISO 14001, incorporates national and international best practice, and complies both with ARPANSA's requirements and with ANSTO's commitments in the EIS for the project. The review will cover all land use in the buffer zone and the impacts of the LHSTC within this zone. The revised management plan will be submitted to the Department of the Environment and Heritage for approval prior to the commencement of construction.

7. Radioactive gaseous emissions discharged via stacks from buildings associated with radiopharmaceutical production (primarily Buildings 23 and 54) must not increase above existing levels regardless of any future production increases. This requirement should be recognised by ARPANSA as part of its licensing of emissions from radiopharmaceutical facilities at the LHSTC. The objective of this approach is to ensure implementation of existing and emergent technologies to further contain or reduce such emissions.

As part of an ARPANSA process for setting notification levels for airborne discharges, ANSTO has submitted details of the emissions from radiopharmaceutical production to ARPANSA for review. This provides a benchmark for measuring compliance with this condition.

Work has also commenced on the identification of possible methods to reduce emissions. For instance, by using improved monitoring technology, it has been

possible to analyse noble gas emissions from radioisotope processing activities in the radiopharmaceuticals production area in real time, with a view to identifying process steps where there might be the opportunity to reduce emissions. Modification of operational procedures and plant hardware has commenced, and initial indications are that reductions in emissions will be realised. If proven, this modified process will help ensure that gaseous emissions do not increase despite higher production of radiopharmaceuticals. This use of environmental monitoring to improve environmental performance is to be a key component of the implementation of ANSTO's EMAP.

8. ANSTO, in consultation with ARPANSA, should re-examine the issue of coordination and timing of processes which give rise to gaseous emissions from stacks with a view to minimising the impacts of radioactive gaseous discharges, to the extent practicable.

ANSTO has an ongoing program to characterise the airborne emissions from the LHSTC. It is also investigating new monitoring techniques that will be geared to provide real time information to operators. An example of this is the work currently being trialed in the radiopharmaceuticals production area, as detailed in the response to condition 7, which has the potential to reduce emissions. ANSTO has had preliminary discussions with ARPANSA, and is planning detailed consultation on the issue prior to submission of the next report.

9. A review of the method of molybdenum-99 production process must be undertaken by ANSTO, in consultation with ARPANSA, to investigate means whereby the isotope can be produced and isolated with decreased releases of subsidiary radioactive waste products. This should be completed to the satisfaction of ARPANSA.

ANSTO has commenced a major project that is reviewing all aspects of molybdenum-99 production, including new target technology, modification of the target handling system and new processing techniques. The project is scheduled for completion in 2002. The current process is also under examination, with initial work indicating that some process modifications might be able to further reduce noble gas emissions. Consultations with ARPANSA will take place once initial scientific studies are completed.

10. A high priority must be given to the review and licensing of radioactive waste discharges to sewer by ANSTO. As part of this, ANSTO should be required to undertake further assessment and analysis to ensure that all possible exposure pathways and future events at the Cronulla Sewage Treatment Plant are taken into account. Monitoring and assessment of individual discharges within the LHSTC is also desirable, to enable understanding of the various sources and their relative contributions. This assessment must be prepared to the satisfaction of ARPANSA and prior to reactor operations commencing.

A new trade wastewater agreement was concluded with Sydney Water in June 1999. ARPANSA was involved in these negotiations and agreed to the appropriateness of the

discharge levels for radionuclides. The trade wastewater agreement requires that, by the time discharges from Lucas Heights reach the sewage treatment plant at Cronulla, the levels of radioactivity comply with the World Health Organisation's derived concentration limits for drinking water. The trade wastewater agreement will be reviewed periodically to ensure that it takes into account any changes in operation both within the LHSTC and within the sewage handling system. As part of its EMAP, ANSTO is in the process of characterising its liquid discharges in terms of internal sources and their contribution to the discharge to sewer. This assessment will be prepared to the satisfaction of ARPANSA, and prior to reactor operations commencing. Further, ANSTO plans to construct a new liquid waste treatment plant by the end of 2003, which will result in further reductions in discharges of radioactivity to the sewer. Design and operation of the plant must meet ARPANSA's requirements.

11. As part of the groundwater monitoring program (see Recommendation 2 above), ANSTO must establish bores at appropriate locations in the LHSTC and the buffer zone to ensure coverage of contaminants from the site overall and aquifer flows downstream of the proposed reactor. The locations and monitoring regimes must be agreed with ARPANSA.

See response to Condition 2.

12. ANSTO must consult with ARPANSA with a view to establishing a radiological site characterisation, or 'footprint' for the reactor site and LHSTC/buffer zone in general. The objective of this characterisation is to provide a fundamental basis for ongoing radiological monitoring programs and the detection of radiological trends over time. The current radiological monitoring should be reviewed on the basis of the site characterisation. The characterisation and monitoring review must be completed prior to commissioning of the proposed reactor.

A preliminary review of current environmental monitoring was undertaken during the development of ANSTO's EMAP as the basis for an initial site characterisation. This covered all ANSTO discharges, including airborne releases and liquid discharges. Investigation of new techniques to measure the environmental gamma radiation in the local area commenced. These techniques, using ultra sensitive radiation detectors, have the potential to separate the small contribution arising from ANSTO's operations from the much larger contribution from natural background radiation. This work will be submitted to ARPANSA.

ANSTO has systematically monitored the Lucas Heights site and its surroundings since the mid-1960s. Cumulatively, this data provides a valuable source of information for the development of a radiological site characterisation. The monitoring program is set out in detail in the annual ANSTO Environmental Monitoring Reports. This Report covers not only the ANSTO site and the buffer zone, but also the National Medical Cyclotron and off-shore near the sewage outfall at Potter Point.
The monitoring program includes airborne discharges, storm water, soil and sediments as well as effluents discharged to the sewer. The program is designed to maximise

the probability of detecting any radionuclides resulting from ANSTO's activities. The sampling points for routine monitoring have been carefully targeted with this in mind. Supplementary work is being planned to further extend the coverage of the radiological sampling program.

13. The Preliminary Safety Analysis Report (PSAR), to be prepared at the detailed design stage, must be subject to independent peer review to the satisfaction of ARPANSA.

This work will be undertaken during the detailed design phase of the project. The PSAR will comply with relevant International Atomic Energy Agency Guidelines. The contractor will provide the PSAR in a manner that facilitates a peer review. Arrangements for the peer review will be made by ARPANSA.

14. The assumptions used in deriving the Reference Accident effectively constitute design parameters for the proposed reactor and must be incorporated in the final design to the satisfaction of ARPANSA. In the event of changes, such that the Reference Accident examined may no longer be valid, agreement to any major design changes must be sought from the Minister for the Environment and Heritage prior to design finalisation.

The site licence issued by ARPANSA requires that the design meet the assumptions used in deriving the Reference Accident, and that prior agreement be sought from the Minister for the Environment and Heritage and the CEO ARPANSA to any major design changes such that the Reference Accident described in the Licence application may no longer be valid. At this stage, it is not envisaged that there will be any changes in the assumptions used in deriving the Reference Accident such that the Reference Accident might be invalidated.

15. The PSAR must demonstrate that the design of reactor components (eg reactor pool, beam tube penetrations) effectively excludes the failure of these components for earthquakes of lower frequency than the design basis earthquake, to rule out a fast loss of coolant accident as a credible incident. This will need to be demonstrated to the satisfaction of ARPANSA.

This matter is being addressed in the PSAR. The status of the PSAR has been discussed in the response to Condition 13.

16. The consequences resulting from loss of off-site electricity for water supply and fire fighting purposes must be examined as part of the PSAR. If risks are significant, on-site power provisions for water pumps should be provided to the satisfaction of ARPANSA.

This matter is being addressed in the PSAR. The status of the PSAR has been discussed in the response to Condition 13.

17. The safety implications of an inter-linked store for spent fuel elements must be assessed in detail in the PSAR, to the satisfaction of ARPANSA.

This matter is being addressed in the PSAR. The status of the PSAR has been discussed in the response to Condition 13.

18. The final design of the reactor should include a fixed and possibly automatic fire suppression system within the containment building, to the satisfaction of ARPANSA. The PSAR should also examine the need for a drencher system for the cooling towers.

An analysis and design of the fire suppression system will be undertaken in the current detailed design phase and addressed in the PSAR. The status of the PSAR has been discussed in the response to Condition 13.

19. The risk of a common mode failure involving both HIFAR and the replacement reactor during the commissioning period, and resourcing requirements to ensure adequate infrastructure and staffing safety, must be addressed as part of the PSAR to the satisfaction of ARPANSA. The results of the PSAR analysis should also be reflected in emergency plans.

This matter is being addressed in the PSAR. The status of the PSAR has been discussed in the response to Condition 13.

20. In the event of dual operation occurring for a longer period than six months, ANSTO must obtain separate approval and authorisation from ARPANSA. This authorisation should specify safety, infrastructure and occupational requirements to ensure that doses are minimised during any extended commissioning period.

Should a period of dual operation longer than six months be required, it will be subject to authorisation by ARPANSA. However, it is unlikely that a requirement for any such extension would be apparent before 2005.

21. The Safety Analysis Report for the reactor must include provision for ongoing monitoring and audit of the frequency and severity of external events to ensure that assessed risks to the replacement reactor remain valid and acceptable, taking into account new developments in the vicinity of the reactor over time.

External events will be analysed in the PSAR and the Final Safety Analysis Report and at regular intervals during operation. These results will be subject to review by ARPANSA.

22. Existing emergency plans and arrangements must be updated and subject to independent review at the detailed design stage and prior to the proposed reactor becoming operational. This must be completed to the satisfaction of ARPANSA. The independent review of the plans should include opportunities for input by relevant State emergency agencies and the general public.

Periodic review of emergency management plans will continue throughout the life of the replacement reactor. The contract for the replacement reactor has made review and acceptance by the Local Liaison Working Party (which incorporates representatives of all State emergency service organisations and the local Council), and approval by ARPANSA, of emergency plans a contractual condition. An independent review of emergency planning arrangements will also be undertaken during 2001.

During this year, a review of emergency planning in relation to ANSTO was conducted by a consultant, Mr Brian Carr, at the request of the NSW Minister for Emergency Services. ANSTO provided full cooperation to this review, the results of which are expected to be released in the second half of 2000.

23. The emergency management plan must also include a specific plan aimed at facilitating community understanding of credible hazards and risks from the reactor, mitigation measures, emergency arrangements and implications for the community. The plan should consider the best combination of media to achieve the above objectives. The plan must be prepared to the satisfaction of the Minister for the Environment and Heritage, in consultation with the Minister

ANSTO regularly distributes information to the local community on credible hazards and emergency planning arrangements. In addition, these plans are available in local libraries.

ANSTO is also discussing with the emergency service organisations the most appropriate means of enhancing community understanding of these plans.

24. ANSTO must develop a specific program for ongoing community consultation and dissemination of information during the design, construction and commissioning phases of the reactor, to the satisfaction of the Minister for the Environment and Heritage.

ANSTO began preparing a program that will embrace community consultation and the dissemination of information during all phases of the reactor project. The program will be submitted to the Minister for the Environment and Heritage in the second part of 2000.

25. A high priority must be given by ANSTO to finalising a 'Community Right to Know Charter' between ANSTO and the community. This charter, as a minimum, must establish principles for information exchange, the obligations of parties in providing and using information, timely mechanisms for dispute resolution, and a process for periodic review and update. The use of a recognised mediator to facilitate completion of the charter should be considered. If a charter has not been agreed within 12 months of the date of these recommendations, the outstanding issues of dispute should be referred to the Minister for the Environment and Heritage for resolution, in

consultation with the Minister for Industry, Science and Resources and the Minister for Health.

ANSTO engaged a respected and experienced mediator, Mr John Woodward, to seek a mutually satisfactory resolution of the Community Right to Know Charter between ANSTO and the local community. Mr Woodward devoted considerable time and effort to the task of achieving an agreed resolution on the Community Right to Know Charter. Despite Mr Woodward's best efforts, final agreement on a Charter did not prove possible. As Mr Woodward reported to Senator Hill in May, the stumbling block to agreement was the extent of information to be provided under a Charter. Senator Hill has written to ANSTO and the Sutherland Shire Council inviting comment on Mr Woodward's report.

26. Reactor construction should not be authorised until arrangements for the management of spent fuel rods from the replacement reactor have been demonstrated to the satisfaction of ARPANSA and the Minister for the Environment and Heritage.

This matter will be taken up with ARPANSA and the Minister in advance of reactor construction commencing.

27. The Minister for Industry, Science and Resources and the Minister for Health should give timely consideration to strategies for the long term management and eventual permanent disposal of Australia's long-term intermediate-level nuclear wastes, and associated issues.

This is not a matter for which ANSTO is responsible.

28. ANSTO must continue, as a high priority, to review and upgrade its environmental management systems (EMS) to achieve ISO 14000 standards. The EMS should be certified by a suitably accredited independent body and be in place prior to the replacement reactor being commissioned.

As indicated in the response to Condition 6, all facets of ANSTO's environmental management are being reviewed within ANSTO's EMAP and will be upgraded as necessary to be compliant with ISO 14001. Initial staff training in ISO 14001, provided by the National Association of Testing Authorities (NATA), was conducted at ANSTO in October 1999. Training was provided to members of ANSTO's EMAP team, key environmental monitoring staff, operational staff and divisional directors. Representatives of ARPANSA attended the first session of the training to obtain an overview of ANSTO's approach to the implementation of ISO 14001. The environmental management system will undergo accreditation using the services of a certified external organisation. ANSTO anticipates that full ISO 14001 accreditation will be achieved at least a year prior to the commissioning of the replacement reactor. The implementation of ISO 14001 will provide a framework for ongoing review and re-assessment of ANSTO's environmental management systems.

29. ANSTO must report to the Minister for the Environment and Heritage on measures taken, or to be taken, to implement the above recommendations, including the undertakings and commitments referred to at Recommendation 1. This is to be done by way of an initial written report to the Minister prior to construction commencing and thereafter at six monthly intervals until all recommendations have been addressed to the satisfaction of the Minister for the Environment and Heritage. These reports must be made publicly available by ANSTO, following their acceptance by the Minister.

The first report to the Minister for Environment and Heritage will be submitted in August 2000.

APPENDIX 6
INDEX OF COMPLIANCE WITH REPORTING GUIDELINES

Enabling legislation	iv
Responsible Minister/s	iv
Location of major activities and facilities	iv
Powers, functions and objectives of the organisation	154
Service Charter	153
Membership and staff	145
Financial statements	107
Activities and reports	7

GLOSSARY

AAD	Australian Antarctic Division
AGSO	Australian Geological Survey Organisation
AHSEC	ANSTO Health, Safety and Environment Committee
AIMS	Australian Institute of Marine Science
AINSE	Australian Institute of Nuclear Science and Engineering
AMS	Accelerator Mass Spectrometry
ANAO	Australian National Audit Office
ANBF	Australian National Beamline Facility
ANTARES	Australian National Tandem for Applied Research
ARC	Australian Research Council
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASNO	Australian Safeguards and Non-proliferation Office
ASRP	Australian Synchrotron Research Program
BATAN	Indonesian National Atomic Energy Agency
BIOMASS	Biosphere Modelling and Assessment
BNL	Brookhaven Research Laboratory
COGEMA	Compagnie Generale des Matieries Nucleaires
CRC	Cooperative Research Centre
CRP	Coordinated Research Programs
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DCC	Digital Coincidence Counting
EMAP	Environmental Management Action Plan
EMP	Environmental Management Plan
EPA	Environment Protection Authority
FDG	Fluorine-18 Fluorodeoxyglucose
FNCA	Forum for Nuclear Cooperation in Asia
GATRI	Gamma Technology Research Irradiator
GST	Goods and Services Tax
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
IBA	Ion Beam Analysis
INIS	International Nuclear Information System
ISO	International Standards Organisation
LDV	Laser Doppler Velocimetry
LENS	Learning Environment for New Strategies program
LHSTC	Lucas Heights Science and Technology Centre
LLNL	Lawrence Livermore National Laboratory
LONGPOL	Long Wavelength Polarized Diffractometer Instrument
MSD	Major shutdown (routine 4- or 5-yearly shutdown of HIFAR for maintenance)
mSv	millisieverts
NEA	Nuclear Energy Agency
NMC	National Medical Cyclotron
NPL	National Physical Laboratory
NPW	Nuclear-powered Warships
OAEP	Thai Office of Atomic Energy for Peace

OECD	Organisation for Economic Cooperation and Development
Otoliths	in fish, calcareous concretions in a fluid filled ear-like sac that provides a sense of balance
PI^3	Plasma Immersion Ion Implantation
PNNL	Pacific Northwest National Laboratory
PSA	Probabilistic Safety Assessment and Remaining Life Study
RCA	Regional Cooperative Agreement
RIEF	Research Infrastructure, Equipment and Facilities
RNCA	Regional Nuclear Cooperation in Asia
SAC	Safety Assessment Committee
SAGNA	Standing Advisory Group for Nuclear Applications
SAGTAC	Standing Advisory Group on Technical Assistance and Cooperation
SIMS	Secondary Ion Mass Spectrometry
UNDP	United Nations Development Program
USDEO	United States Department of Energy
VSP(N)	Visiting Ships Panel (Nuclear)
WATAC	IAEA International Radioactive Waste Technology Advisory Committee
WMPC	Waste Management and Pollution Control
XAFS	X-ray Absorption Fine-structure Spectroscopy
Y2K	Year 2000 date change

A
Al2O3-rich waste, 54
accelerator mass spectrometry (AMS), 8, 10, 34-36, 42, 46
accidents and incidents, 9, 93
accounting, 76
ACE-Asia(Asian Regional Aerosol Characterisation Experiment), 45
Acts and Awards, compliance, 148
Advanced Photon Source, 37, 38-39
AEA Technology Group, 73
agriculture, 65
air quality sampling, 48
airborne emissions, 92, 95
algal blooms, 43
aluminium smelters, 67
aluminium 26, 35
americium-beryllium, 71
annual report, 149, 156
ANSTO
  "25 years at ANSTO", 21
  Accounting and Control Procedures for Safeguarding Nuclear Materials manual, 18
  activities for and on behalf of government, 89
  Board, vi, 148-150
  Canberra liaison officer, 17
  capital expenditure, 1
  communications, 19-21
  community liaison program, 19
  compliance statement, iv, 148
  counsellors (Nuclear), 16, 17, inside back cover
  distributor for US Dept of Energy, 73
  employees, long service, 21
  Environment Division, 85
  environmental monitoring program, 5, 92
  external representation, 17-18
  financial services, 76
  functions and powers, 154-155
  health and safety, 93
  home page, 8, 19
  IAEA, RCA activities, 13-17
  IAEA participation, 8, 10-12
  information role, 9
  internet website, 8, 19
  intranet, 19
  legislation enabling, iv
  location, iv
  media activities, 20
  minister responsible, iv
  ministerial and VIP visits, 21
  mission, iv, 149
  nuclear safeguards, 18-19
  organisation chart, v
  parliamentary appropriation, 1
  payroll services, 76
  public access to information, 8
  public tours, 21
  Radiation Technology Quality Manual, 66
  Reception Centre display, 20-21
  safety, 91-99, 150
  Service Charter, 153
  Waste Management Action Plan, 56-57, 58-59
  Waste Operation and Technology Development Quality Assurance system, 59
ANSTO update, 20
Antarctic Division, 82
Antarctica, 46, 47-48
apatite, 30
apprentices, 80
AQUARISK, 63
Argonne National Laboratory, 52, 53, 54, 71
arsenic, 4, 62, 64
atmospheric fine particle aerosol research, 45, 48
atmospheric pollution, 48
Atomic Layer Chemical Vapour Deposition, 68
audit
  ASNO audits, 18
  Committee, 150, 151
  external, 152
  HIFAR audit, 25
  internal, 78, 152
  replacement reactor process, 33-34
AusAID, 14, 44
Australasian Chemical Engineering Conference, 56
Australian Academy of Sciences, 67
Australian Antarctic Division, 46, 48
Australian Geological Survey Organisation, 82
Australian Industrial Relations Commission, 80
Australian Institute of Marine Science, 44, 82
Australian Institute of Nuclear Science and Engineering (AINSE), 24, 48, 76, 101-105
  additional projects, 104
  core business, 102-104
  funds, 102
  grants, 102
  home page, 19
  key officers, 104
  member organisations, 105
  mission, 102
  objectives, 101-102
  recognition of outstanding people, 104
Australian Mineral Industry Research Association, 64
Australian National Audit Office, 34
Australian National Beamline Facility (ANBF), 38-39, 44, 54
Australian National Tandem Accelerator for Applied Research (ANTARES), 35-37
Australian National University, 37
Australian and New Zealand Environment and Conservation Council (ANZECC), 63
Australian Nuclear Association, 102, 103
Australian Nuclear Science and Technology Organisation Act 1987 Act, 154-155
Australian Protection Service (APS), 83, 146
Australian Quarantine and Inspection Service, 66
Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), 17, 26, 92, 95, 149
Australian Radiation Protection and Nuclear Safety (ARPANS) Act 1998, 92, 93
Australian Radiation Protection and Nuclear Safety Regulations 1999, 93
Australian Research Council (ARC), 48, 104
Australian Safeguards and Non-proliferation Office (ASNO), 10, 17, 18
Australian Science Festival, 20
Australian Small Angle Neutron Scattering Facility (AUSANS), 31
Australian Standard, AS1978, 62
Australian Synchrotron Research Program (ASRP), 37-38, 44, 76
  fellowship scheme, 38
awards, 80

B
Bangladesh, 72
Battelle, 53
Beam Facilities Consultative Group (BFCG), 31
beryllium-10, 35, 47
bilateral cooperation, 9, 16-17
biogeochemical processes, 43
Biomolecular Research Institute, 39
Board
  audit committee, 150
  Corporate governance, 148-153
  disclosure of interests, 149
  ethical standards, 152
  external audit, 152
  Federal information technology outsourcing initiative, 152-153
  Fraud control, 152
  functions, 148
  Goods and Services Tax, 153
  independent professional advice, 149
  internal audit, 152
  internal control, 152
  meetings, 149
  members, iv, 148-149
  remuneration and allowances, 149
  report of operations, 149
  risk management, 151
  safety monitoring, 150
  Technical Advisory Committee, 151
  Year 2000 compliance, 152
budget, 77-78
Bureau of Meteorology, 43, 82
Burns & Roe, 53
business development, 4, 84
C
caesium, 10, 12, 43, 69
calibration, 69
cancer treatment drugs, 71, 73
carbo-platin, 71
carbon dating, 24
carbon-14, 43, 47
Caringbah Ambulance Rescue, 99
Carr, Brian, 164
CFAScan, 73
cellulose, 30
ceramic wasteforms, 52, 57, 68
Chairman's report, 1-2
Chemistry and Material Sciences CARS (ChemMatCARS), 38
Chernobyl, 10
China, 9, 17
chloride, 55
chlorine-36, 35, 36
chromium, 58
cis-platin, 71
Citipsych, 145
Clark Corporate Consulting P/L, 34
Clarkson University, 48
climate change, 16, 45, 46
  application of nuclear techniques, 43, 46-48
  chronologies, 45
Cluster 9, 82
coastal and marine environment, 8
cobalt-60, 43, 66
Cogema, 2, 24, 28, 52, 53
COGEMA-ANSTO LLC, 52
cold-crucible technology, 53
Comalco, 67
COMCARE, 78, 94
Comcover, 78
common mode failure, 163
Commonwealth/State Consultative Committee on the Management of Radioactive Waste, 59
communications, 19-21
community consultation, 9
Community Right to Know Charter, 19, 164
competency project, 79
complaints, 153
compliance, 148
  index of compliance with reporting guidelines, 167
  statement of compliance, iv
computers
  financial systems, 76
  services, 81-82
  software and modelling, 26, 44
Consortium for Advanced Radiation Sources (BioCARS), 38
consultancy contracts, 70, 88
contractor safety, 93
cooperation with industry, research organisations and universities, 89
Cooperative Research Centre (CRC)
  Hydrometallurgy, 55
  Pipeline hydrostatic testing, 62
  Polymers, 66
  Waste Management and Pollution Control, 4, 62, 64
  Welding Structures, 66
core nuclear facilities operation and development, 23-39
  activities and outputs, 24-39
  objectives, 23
  outcomes, 24
core science and technology funding, 77
Corporate Governance, 148-153
cosmogenic isotopes, 35, 42, 48
counsellors, 145
CRC *see* Cooperative Research Centre (CRC)
criticality assessments, 28
crocodiles, 42
Cronulla Sewerage Treatment Plant, 44, 160
CSIRO, 37, 43, 44, 47, 55, 71
  Atmospheric Research, 46
  CRC for polymers, 66
  Division of Molecular Science, 55-56
  "Fastflo" computational engine, 63
customer database, 73
customer feedback, 153
D
data management, 82
data and voicemail, 76
decommissioning of research reactors, 34
decontamination centre, 59
Deed of Indemnity, 79
Denmark, 29
Department of Industry, Science and Resources, 59
Digital Coincidence Counting (DCC), 69-70
digital signal processing modules, 29
dopamine transporters, 73
dosimetry, 14, 65, 69, 82, 97, 98
E
earth sciences, 35
Earth Systems P/L, 64

economic dependency, 148
electricity
  fossil fuel, 48
  methane gas powered, 65
  nuclear powered, 9
  supply, 82, 162
electrochemical probes, 68
electronic data management, 82
emergency
  24-hour response capability, 98
  management plans (DISPLAN), 92, 99
  research reactor emergency response, 14, 163
employees, 21, 80-81, 145
Energy Australia, 71, 85
engineering
  hollow fuel element rigs, 26
  services, 84-85
enterprise agreements, 81
environment, 15
  contaminants, 16
  environmental impact assessment of replacement reactor, 156-166
  mine waste management, 63-64
  monitoring program, 5, 160, 161
Environment Australia, 42
Environment and Effluent Monitoring at the Lucas Heights Science and Technology Centre 1998, 95
Environmental Management Action Plan (EMAP), 5, 94-95
epidemiological study, ionising radiation, 18
Equal Employment Opportunity (EEO), 145
  objectives, 145
  statistics, 145
ethical standards, 152
European Conference on Neutron Scattering, 29
Evans Deakin Industries Ltd, 3, 33
Event Response System, 93
Executive Director's Report, 3-5
Exercise Dingo, 99
expenditure, 1, 78
export sales, 72

F

Facilities Safety Unit, 96
facility usage by external users, 89
FDG Drug Master File, 35
federal information technology outsourcing initiative, 82-83, 152-153
finance and supply activities, 76-77
financial statements, 107-144
fire suppression system, 163
fish otoliths, 24
fluorine-18 fluorodeoxyglucose, 35
Forum for Nuclear Cooperation in Asia, 15-16
fossil fuels, 4, 42, 48
France, 9, 17
  Atomic Energy Commission, 52, 53, 68
  Bureau International des Poids et Mesures, Paris, 69-70
fraud control, 152
Freedom of Information (FOI), 19, 146-147
  ANSTO/State Government arrangements, 146
  associated organisations, 146
  categories of documents held, 146-147
  external participation, 146
  facilities for access, 147
functional materials interfaces, 68

G

gallium-67, 35, 72
Gamma Technology Research Indicator (GATRI), 65
gas redox and replacement systems, 64-65
gaseous emissions stacks, 159
GATRI cobalt-60, 66
General Atomics, 66
Gentech, 4, 62, 63, 72
Georges River District Disaster Plan, 99
Germany, University of Bremen, 67
glaciation studies, 42, 47-48
global atmospheric methane budget, 4, 42
global baseline pollution, 46
global climate change *see* climate change
glossary, 168-169
gold extraction, 55, 56
gold-198, 44
Good Manufacturing practices, 73
Goods and Services Tax, 76, 153
greenhouse gas, 4
Greenpeace, 21
ground water monitoring, 92, 94, 161

H

Health, Safety and Environment Committee, 96
health and safety policies, 93
HIFAR research reactor
  audits, 25
  computer software, 26
  cooling water circuit, 58
  funding, 77
  hollow fuel element rigs, 26
  income, 24
  licensing, 25
  maintenance and support, 25-28
  mineral ore irradiation service, 24
  neutron scattering developments, 29
  operation and general utilisation, 24-25
  probabilistic safety assessment, 28
  quality assurance, 25
  reactor analysis, 28-29
  shutdown, 25-28
  spent fuel, 1, 2, 24, 28
  tenders, 3
  utilisation, 29-31
high energy heavy ion microprobe, 37
High Resolution Power Diffractometer (HRPD), 29
hollow fibre modules, 56
hollow fuel element rigs, 26
Home Show, 20
Hong Kong, 4, 42, 44
Human Activity and Climate Variability project, 45
human resources, 5, 79-80
hydrometallurgy, 56
hydroxyapatite, 30

I

ice cores, 46-47
Immunomedics Inc, 73
India, 9, 14
Indonesia, 12, 15, 17
  Institute of Science (LIP), 44
  PT Kaltim Prima Coal (KPC), 62
industrial gas and vapour plumes, 62
industrial radiography safety, 14
industrial relations, 80-81

industry, 65-69
competitiveness and sustainability, 61-73
activities and outputs, 63-73
objectives, 61
outcomes, 62-63
information provision, 8, 9
information technology, outsourcing, 82-83, 152-153
INIS *see* International Nuclear Information System (INIS)
insulin receptor, 39
insurance, 79
intellectual property, 4
intense cold neutron beams, 24
International Agency for Research on Cancer (IARC), 18
International Atomic Energy Agency (IAEA)
activities, 10-13
ANSTO participation, 8
Biosphere Modelling and Assessment (BIOMASS) workshop, 10
Code of Conduct on the Safety of Radiation Sources and the Security of Radioactive Material, 11
fellowship holders coordination and training, 12
International Dose Assurance Service, 65
International Radioactive Waste Technology Advisory Committee (WATAC), 11
International Symposium on Research Reactor Utilisation, Safety and Management, 11
Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste, 56-57
Joint Convention on the Safety of Spent Synroc-based wasteforms, 52
Marine Environment Laboratory, Monaco, 44
Program Performance Appraisal System, 11
Regional Cooperative Agreement (RCA)
activities, 11, 13-15
AusAID funding, 14
objectives, 13
projects, 8
reliability data, 12
Safeguards
93+2 Program, 18
department, 8
inspectors, 18
Safety Culture in Research Reactors workshop, 8, 11
Safety Guide, 11
Standing Advisory Group for Nuclear Applications (SAGNA), 11
Standing Advisory Group on Technical Assistance and Co-operation (SAGTAC), 11
International Conference on Accelerated Mass Spectrometry, 36
International Conference on Nuclear Cooperation in Asia (ICNCA), 15
International Conference on the Safety of Radioactive Waste Management, 11
International Global Atmospheric Chemistry Project (IGAC), 45
International Network for Acid Prevention (INAP) Ltd., 2, 62
international networks, 89
International Nuclear Information System (INIS), 12, 13
international strategic relevance of nuclear science and technology, 7-22
activities and outputs, 9-21
objectives, 7
outcomes, 8-9
International Union of Crystallography, 29
internet website
ANSTO, 8, 19, 147
firewall, 19
library, 8
INVAP SE, 3, 20, 33
iodine-123, 35
iodine-129, 10
iodine-131, 72
ion beam analysis, 36-37
ion exchangers, 69
ionising radiation epidemiological study, 18
ISIS, 104
ISO 9000, 84
ISO 9001, 72, 84
ISO 9002, 59, 73
ISO 14001, 94, 159, 165
isotope processing facility, Thailand, 66
J
Japan, 15, 16, 17
Australian National Beamline Facility (ANBF), 38
criticality accident, 9
Geological Survey Organisation, 44
Photon Factory, 37, 38
uranium-plutonium fuel from UK, 9
John Holland Construction and Engineering P/L, 3, 33
K
Kakadu, 42
knowledge application, 4
knowledge development, 4
Korea, 15, 16
bilateral nuclear consultation, 9
Korean Institute of Nuclear Safety, 17
Korean Peninsula Energy Development Organisation, 9
L
laboratory quality assurance, 49
Land-surface Parameterisation Schemes (PILPS), 46
landfill design and operation project, 65
landscape geomorphology, 48
Laser Doppler Velocimetry System (LDV), 28
Law Dome, Antarctica, 47
Lawrence Livermore National Laboratory, 52
lead-210, 43, 44
Learning Environment for New Strategies (LENS) Program, 5, 79
leasing, ANSTO property, 84
legislation, ANSTO, iv
LeukoScan, 73
library services, 8, 13, 83
licensing, ARPANSA, 93, 162
liquid effluent discharges, ANSTO, 58, 95
liquid waste, 4, 52, 57, 58
Local Liaison Working Party, 99, 146, 164
location, iv
long wavelength polarized diffractometer (LONGPOL) instrument, 29
Lucas Heights Buffer Zone Plan of Management, 159
Lucas Heights News, 21
Lucas Heights Science and Technology Centre (LHSTC), iv
Lynas Corporation, 54
M
McNab, Don, 95
magnetic resins, 55
Malaysia, 12
Maralinga, 70
marine coastal environment, 14, 43
marine radioactivity database, 14
materials assessment, 66-67
mathematical modelling, 42
medical and industrial isotope production, 24
medical ultrasound scanning, 30
metaiodobenzylguanidine (mIBG), 35

methane budget, 4, 42
methane gas generated electricity, 65
MIEX®, 55
mineral products, 24, 54-55
mining waste management, 17, 62, 63-64
Minister, iv
Minister, letter to, i
mission, iv
MOATA research reactor, 34
molybdenum-99, 26, 57, 63, 69, 71, 160
Monash University, 37, 42
  Pulp and Paper Institute, 30
Mongolia, 14, 15
Monte-Carlo simulations, 29
Montgomery Watson, Hong Kong, 44
Mouchel (Asia), 44
N
nanofiltration, 56
nanostructures, 68-69
National Association of Testing Authorities (NATA), 95, 165
National Health and Medical Research Council (NHMRC), 66
National Heritage Trust, 64
National Medical Cyclotron, 34-35, 78, 81, 84, 97, 161
  iodine-123 production, 72
  location, iv
National Radioactive Waste Repository, 12, 42, 43, 59
National Safeguards Systems, 19
National Tandem Accelerator, 78
national waste repository *see* National Radioactive Waste Repository
naturally occurring radioactive material (NORM), 15, 54
neodymium oxide, 55
neutron absorbers, 53
neutron beam instruments, 29
neutron diffractometer, 29
neutron scattering, 25, 29, 30-31, 68
Neutron Scattering and Synchrotron Radiation Group, 29-30
New South Wales Ambulance, 146
New South Wales Councils, 48
New South Wales Department of the Environment and Heritage, 159
New South Wales Department of Health, 146
New South Wales Environment Protection Authority, 70, 71, 99, 146
New South Wales Fire Brigade, 99, 146
New South Wales Minister for the Environment and Heritage, 159
New South Wales Police, 146
New South Wales Roads and Traffic Authority, 158
New South Wales State Disaster Plan, 99
New South Wales State Emergency and Management Act 1989, 98
New South Wales State Emergency Services, 146
New South Wales State Labor Council, 146
New Zealand, 15
  glaciation studies, 47
  Ministry of Fisheries, 24
  National Institute of Water and Atmospheric Research, 46
  NHMRC *see* National Health and Medical Research Council (NHMRC)
noble gas emissions, 57
non-proliferation, 52
Northern Territory, 42, 48
  radionuclide uptake in soil, 11-12, 43-44
Northern Territory University, 43
nuclear ceramics technology, 68
nuclear imaging, 63
nuclear medicine technologists, 14
Nuclear Non-Proliferation Treaty, 13
nuclear powered warships
  Early Warning System, 18
  visits, 18
nuclear proliferation, 8
nuclear safeguards, 10, 18-19
nuclear safety *see* safety
Nuclear Safety Bureau, 25
nuclear science for environment and sustainability, 41-49
  activities and outputs, 43-49
  objective, 41
  outcomes, 42-43
nuclear technologies, safe application, 14
nuclear weapons tests, ice core record, 47
O
occupational health and safety, 92, 93
  consultancies, 93
OECD, Nuclear Energy Agency, 16
organisation chart, v
Organisation for Economic Cooperation and Development *see* OECD
organisational development and support, 4, 75-85
  activities and outputs, 76-86
  objective, 75
  outcomes, 76
Orica P/L., 55
outcomes, 4
outsourcing project, 82
oxidation projects, 64
oxide coatings, 68
oxygen-18, 48
P
Pacific Northwest National Laboratory (PNNL), 52
Pakistan, 9, 14
paper, 30
Papua New Guinea, 44
Parkinson's disease, 71
parliamentary appropriation, 1, 77, 148
Patents, 4, 68, 84
perfluorocarbons, 62
performance indicators, 73, 87-88
perovskite, 30
personal dosimetry service, 98
Philippines, 12, 14, 15
Proton Factory, Japan, 37, 38, 44
piezoelectric materials, 30
pipelines, 62
plant tissue, 65
plasma immersion ion implantation technology, 67
plutonium, 10
plutonium immobilisation, 52
plutonium-238, 54
pollution
  Global baseline pollution, 46
  see also waste management
polonium-210, 44
polymer research, 66
Potter Point, 161
Power Reactor Status Summary, 9
PPK Environment & Infrastructure Pty Ltd, 92, 158
Preliminary Safety Analysis Report (PSAR), 162
Probabilistic Safety Assessment and Remaining Life Study of HIFAR, 28
public access to information, 8
Public Relations Institute of Australia, 9
publications, 89

pyrochlore-rich ceramic, 53
Q
Quadramet®, 4, 72
quality assurance, 84
  laboratories, 49, 84
  waste operations, 59
  waste repositories, 12
Quaternary Dating Workshop, 103
Queensland fruit fly, 65
R
RadCon code, 10
radiation accidents, 9
radiation exposure, deaths, 9-10
radiation monitoring, 92
radiation protection, 97-98
  consultancies, 70
  dose, 97, 98
  guidelines, 15
  IAEA, RCA project, 8, 14
  instrument calibration, 70
  training, 70
radiation standards, safety services, 69
radiation technology in industry, 65-66
radioactive waste, 56, 160-161
  airborne emissions, 159
  national repository site, 42, 43, 59
  quality assurance, 12
radioactivity, removal from mineral products, 54-55
radiocarbon analysis, 35
radiocarbon bomb pulse, 47
radioisotopes, 14, 71-73
  production and marketing, 72-73
  research and development, 71-72
  revenue, 72
radiometric sediment dating, 43
Radionuclide Environmental Pathways Project, 43-44
radionuclides
  accidental release to atmosphere, 10
  chemical thermodynamic constants, 16
  separation processes, 56
  solubility, 53
  uptake Douglas-Daly research station NT, 12
radiopharmaceuticals, 71-73
  customer database, 73
  doses supplied, 62
  liquid waste, 52
  operations dispatch, 97
  processing waste, 4
  production costs, 78
  production and marketing, 72-73
  research and development, 71-72
  revenue, 72, 73
radiotracers, 42, 44
radium-beryllium, 70
radon concentration in soils, 43
radon flux, Tasmania, 46
Ranger uranium mine, 48
rare-earths, 4, 52, 53, 54
Reference Accident, 162
Regional Nuclear Cooperation in Asia (RNCA), 15-16
Replacement Research Reactor Project, 1-3, 29, 31-34
  audit, 34
  community consultation, 9
  environmental impact assessment report, 32, 156-166
  funding, 77
  government facilitation group, 32
  pre-contract negotiations, 33
  public works committee report, 32
  safety analysis Report, 163
  schedule and budget, 34
  scientific community liaison, 32
  site facility licence, 32
  Tender Evaluation Management Group, 33, 34
  tenders, 3, 20, 31-34
research reactors, 11
resource allocation, 88
revenue, 1, 73, 78, 88
risk assessment, 70, 151-152
river sediments, 42, 44
RIVERWORKS program, 64
Robinson, Robert, 29
Royal Brisbane Hospital, 72
Royal Easter Show, 20
Royal Prince Alfred Hospital, 35, 97
Rum Jungle NT, 56
Russia, 17, 52
S
safety services, 69-71
  safety arrangements at ANSTO, 91-99
    activities and outputs, 93-99
    objectives, 91
    outcomes, 92
  audit, 70
  Code of Conduct, 11
  culture, 8, 10, 15-16
  industrial radiography, 14
  nuclear facilities, co-operative research, 10
  radiation standards, 69
  shutdown, 27
  training and consultancies, 93
Safety Assessment Committee (SAC), 96-97
Safety Rehabilitation and Compensation Act 1988, 79
St George-Sutherland District Emergency Management, 146
samarium-153, 72
SCADA (Supervisory Control and Data Acquisition) system, 58
Science Capability Review, 5
science and technology-based gross revenue, 88
SciFest, 20
secondary ion mass spectrometry, 48-49
Secondary Standard Dosimetry Laboratory, 69
security, 83-84
sediment particles, 42, 44
Service Charter, 153
sewage, 4, 44, 160-161
sheep worm larvae, 65
shutdown of reactor, 25-28
silicon, 24, 26
SIRTex Medical P/L, 73
Slovak Republic, 9
Small Angle Neutron Scattering (SANS) facility, 69
Small Angle Neutron Scattering symposium, 103
sodium iodide-131, 73
soil moisture changes, 46
sol-gel science, 4, 68
solid waste, 58
Sorption Forum, 16

Southern Hemisphere glaciation studies, 47-48
Southern Metropolitan Sewerage System, 44
Spanish conquistador, 24
spent fuel, storage and transport, 24, 28, 57, 163
SSAC (State System of Accounting and Control), 19
stacks *see* gaseous emissions stacks
staff, 21, 80
  Equal Employment Opportunity (EEO), 145
  involved in shutdown, 27
  organisation chart, v
  statistics, 145
standards, 25, 62, 84
  see also ISO
Stanford synchrotron facilities, 54
State University of New York, 48
Stormwater Control Plan, 159
strontium, 12, 30, 69
sulfidic mine waste, 4, 48, 62, 63
sulphur-34, 48
superannuation, 81
surface engineering, 67-68
Sutherland Shire Council, 146
Sutherland Shire Local Disaster Plan, 99
Sutherland Shire Local Emergency Management Committee, 146
Sweden, 9
SWIM^{SXS}, 4, 62
Switzerland, 29
Sydney Cancer Centre, 4, 68
Sydney Water, 58, 92, 95
Synchrotron Radiation Instrumentation Collaborative Access Team (SRI-CAT), 38
synchrotron X-ray techniques, 38
synroc-based wasteforms, 30, 52-54
T
Tasmania
  Cape Grim radon flux studies, 46
  glaciation studies, 47
  mine workings, 65
technetium, 63, 71
Technical Advisory Committee, 151
telecommunications, 82
Thailand, 4, 14, 15, 42
  accident, 9
  Isotope processing facility, 66
  Office of Atomic Energy for Peace (OAEP), 12, 13, 66
  Ongharak nuclear research centre, 12
  Prince of Songkhla University, 13
  Thai Harbour Authority, 13
  Unisearch Water Research Laboratory, 13
thallium-201, 35, 72
Therapeutic Goods Administration (TGA), 35, 63, 65, 66, 73
thermal-hydraulic research and development, 28-29
thorium, 4, 52, 53, 55
titanate ceramic, 4, 52, 53, 54
titanium, 30
Total Logistics Management P/L, 34
Trade Waste Agreement, 58, 95, 161
training, 80
treatment and management of man-made and naturally occurring radioactive substances, 51-59
  activities and outputs, 52-59
  objectives, 51
  outcomes, 52
Triennium Funding Agreement, 87
tritium, 44
Tropical River-Ocean Processes in Coastal Settings (TROPICS) Project, 44
U
underwater irradiation facilities, 65
unions, 81, 146
Unisearch Water Research Laboratory, 13, 14
United Kingdom, 9, 17
  National Physical Laboratory, 69
United States, 17
  Brookhaven National Laboratory, 29
  Department of Energy, 17, 30, 52, 73
    Office of Fissile Materials Disposition, 53
  Food and Drug Administration, 73
  National Institute of Standards and Technology (Boulder), 68
  National Oceanographic and Atmospheric Administration, 49, 84
  National Science Foundation (US-NSF), 44
  nuclear power, 9
  Oak Ridge National Laboratories, 30
University of Auckland NZ, 48
University of Canberra, 37
University of Melbourne, 37, 48
University of New England, 48
University of New South Wales, 30, 37, 38
  epidemiological study on ionising radiation, 18
  safety culture surveys, 10
  Water Research Laboratory, 44
University of Newcastle, 28, 29, 30, 48
University of Pennsylvania, 36
University of Queensland, 37
University of Sydney, 4, 30, 37, 68
University of Tasmania, 14, 43, 48
University of Technology, Sydney, 28, 43
University of Western Australia, 37
University of Wollongong, 43
uranium, 10, 48
  Beverley mine, 55
  mining, cleaner technology, 55-56
  ore processing, 54
V
Vacuum Society of Australia, 36
Van De Graf accelerator, 21, 36
Vietnamese Atomic Energy Commission, 17
visits, ANSTO site, 21
voicemail, 82
W
waste management
  Action Plan, 56-59
  arsenic waste, 64
  immobilisation, 53
  International Conference, 11
  inventory and database, 56-57
  landfill, 65
  liquid waste, 2, 57-58
  minimisation, 57
  mining, 2, 54-55, 64
  molybdenum-99 production, 2
  quality assurance, 12
  radioactive waste, 12
  solid waste, 58, 65
  spent fuel storage, 57
  sulfidic waste, 63
  Symposium on the Scientific Basis, 17
  treatment and packaging, 58

waste water, 58
waste repository *see* National Radioactive Waste Repository
Waste Service NSW, 65
water
arsenic removal, 64
waste, 58
welding, CRC, 66
Western Australia, 64
Mt Weld, 54
Westinghouse Savannah River Company, 52
Woodward, John, 19, 165
work experience, 80
World Climate Research Programme (WCRP) Project, 46
World Health Organisation, 95, 161
Y
Year 2000, 25-26, 82, 152
Younger Dryas, 48
yttrium-990, 73
Z
zinc, 12
zirconium, 30
ZrO2 waste, 54