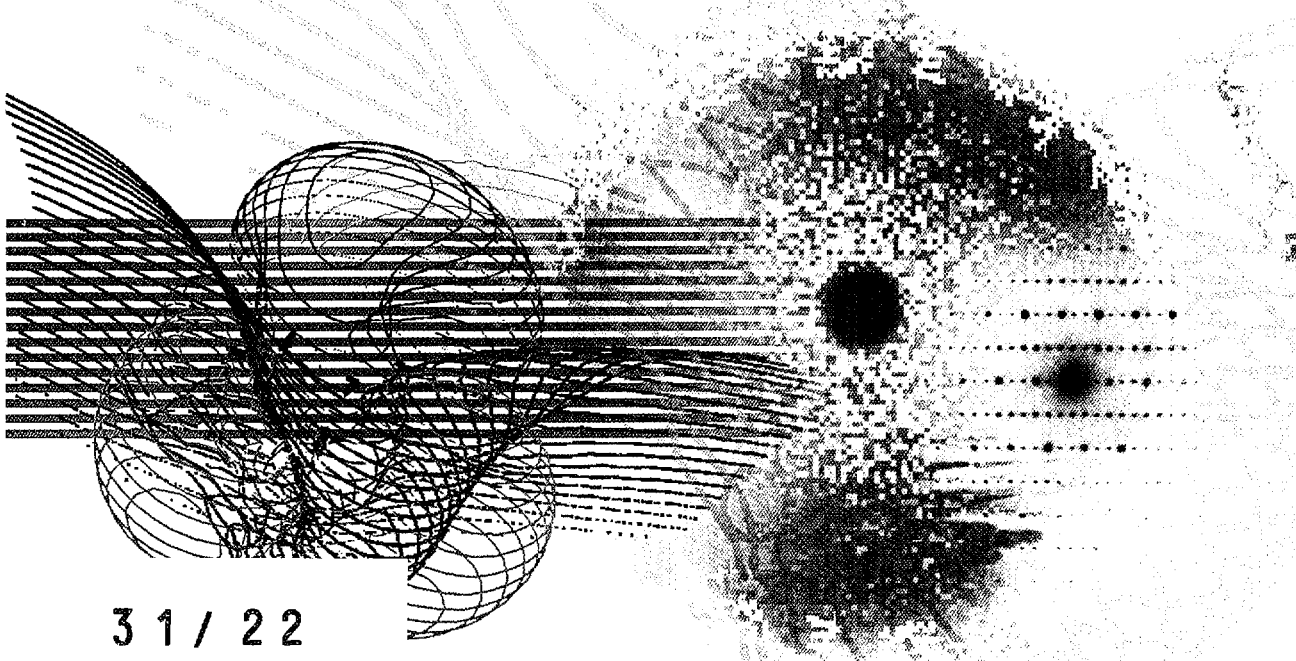
ANNUAL REPORT
1998 - 1999



Australian Nuclear Science & Technology Organisation

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

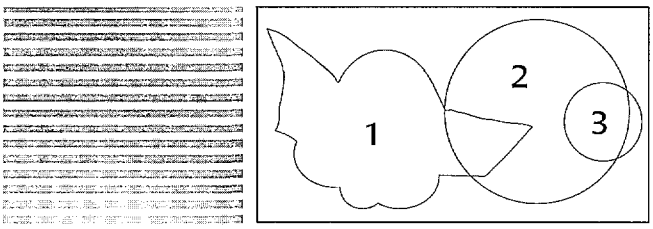
Email communications@ansto.gov.au

Internet: Home Page:
http://www.ansto.gov.au

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

A list of national and international contacts appears on the inside back cover of this report.

Cover montage:
Images:



***1.** Contour lines calculated by computer of fields surrounding a molecule of fluorodeoxyglucose (FDG). These contours help scientists understand how radiopharmaceuticals, such as FDG, bind to molecules in the human body and provide clear images of various organs to the clinician. (Dr Robert Knott, member of the Molecular Radiopharmaceuticals Group)*

***2.** A small angle neutron scattering pattern from a protein in solution. Scientists use this pattern to probe and understand the structure of the protein. (Dr Robert Knott, member of the Neutron Scattering Group)*

***3.** Electron diffraction pattern of trigonal natural zirconolite, collected using ANSTO's JOEL FEG/STEM microscope, (Dr Katherine Smith, Leader of the Transmission Electron Microscope Group).*

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Design Laura Edwards, ANSTO
Photography Tim Tapsell, ANSTO
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ANSTO

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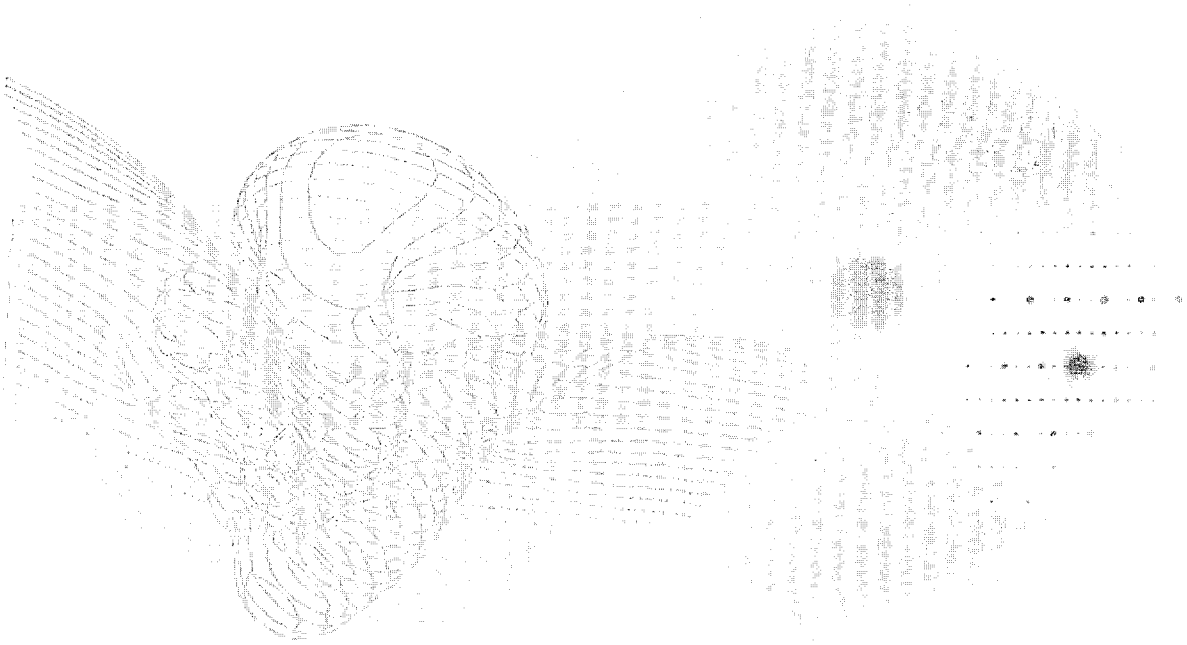


Australian Nuclear Science & Technology Organisation

AUSTRALIAN NUCLEAR SCIENCE
& TECHNOLOGY ORGANISATION

ansto

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

30 September 1999

Senator The Hon Nick Minchin
Parliament House
CANBERRA ACT 2600

Dear Minister

In accordance with Section 63M(1) of the Audit Act 1901, I am pleased to present the Annual report of the Australian Nuclear Science and Technology Organisation for the period 1 July 1998 to 30 June 1999.

Audited group financial statements for the year ended 30 June 1999 are disclosed in the Report. Also included in accordance with Section 63M(2) of the Audit Act 1901 is a report by the Auditor General.

Yours sincerely

S M Richards
Chairman

CONTENTS

ANSTO'S 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 Ministers

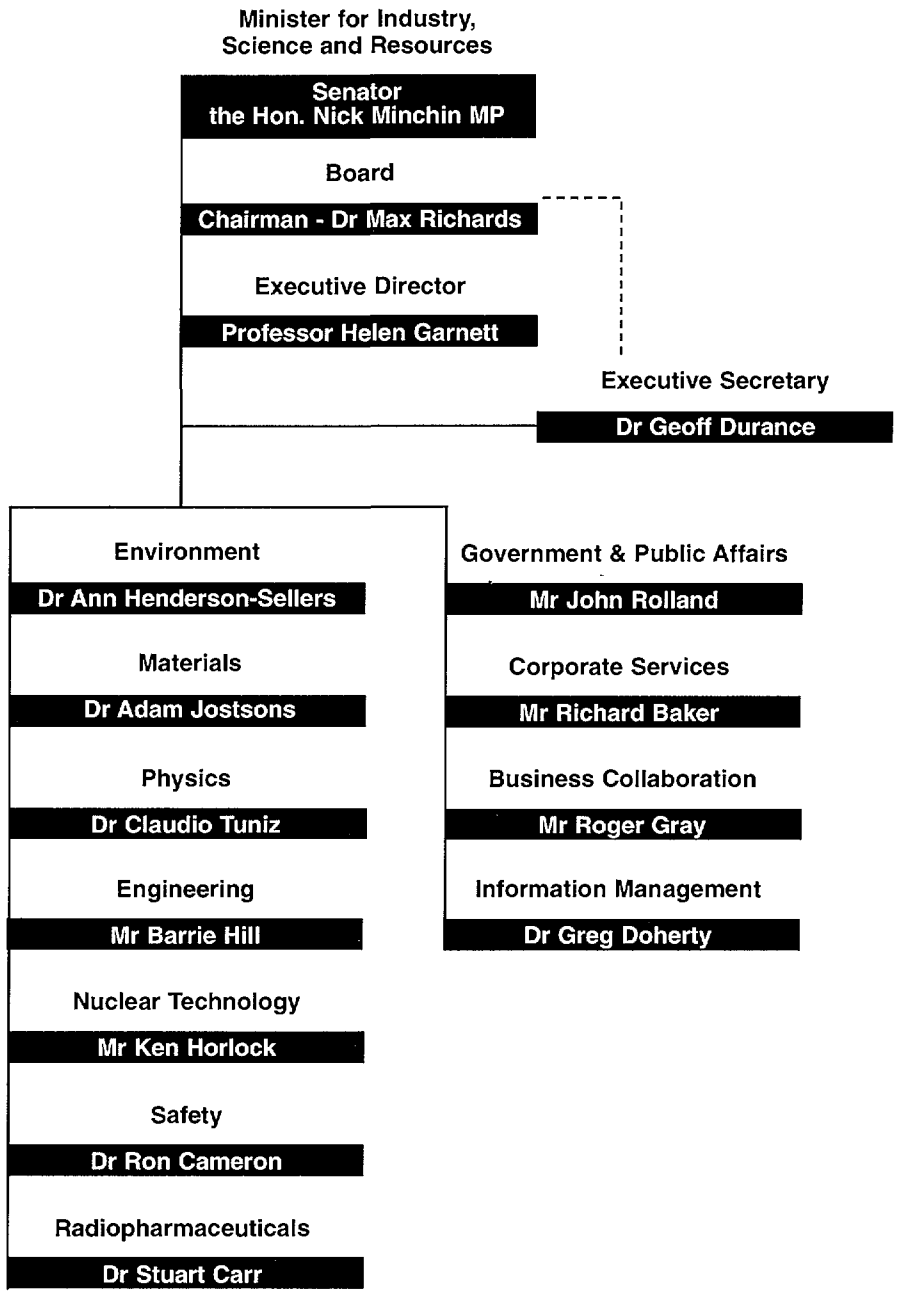
The responsible Ministers during the reporting period were:
1 July 1998 - 21 October 1998 -
the Hon. John Moore, Minister for Industry, Science and Tourism
21 October 1998 - 30 June 1999 -
Senator the Hon Nick Minchin, Minister for Industry, Science and Resources.

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 5.

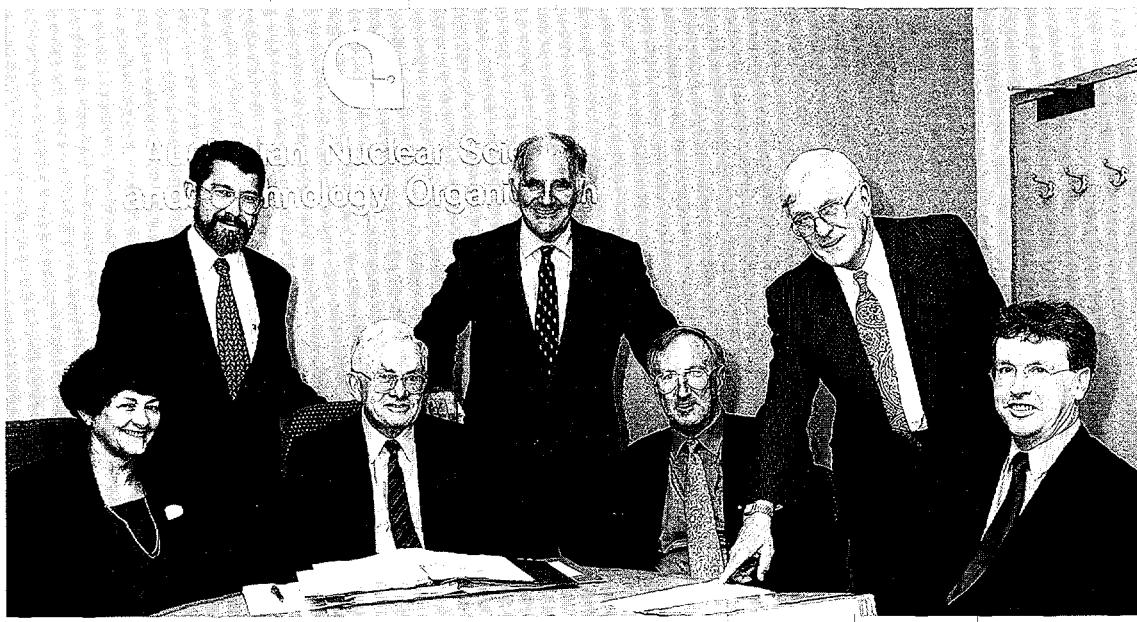

Minister for Industry, Science and Resources
Senator the Hon. Nick Minchin MP
Board
Chairman - Dr Max Richards
Executive Director
Professor Helen Garnett
Executive Secretary
Dr Geoff Durance
Environment
Dr Ann Henderson-Sellers
Materials
Dr Adam Jostsons
Physics
Dr Claudio Tuniz
Engineering
Mr Barrie Hill
Nuclear Technology
Mr Ken Horlock
Safety
Dr Ron Cameron
Radiopharmaceuticals
Dr Stuart Carr
Government & Public Affairs
Mr John Rolland
Corporate Services
Mr Richard Baker
Business Collaboration
Mr Roger Gray
Information Management
Dr Greg Doherty

Professor Helen Garnett
Executive Director, Member of the Board by virtue of Section 9(1) of the ANSTO Act.

Associate Professor Fred Khafagi
Nuclear Medicine Physician, appointed on 14 May 1997 until 31 December 1999.

Dr Max Richards
Chairman, from 1 January 1997. Company Director, appointed on 5 July 1996 until 30 June 2001

Dr Tony Gregson
Primary producer, Company Director, reappointed on 5 July 1996 until 31 December 1998



Mr Mike Codd AC
Deputy Chairman from 1 January 1997. Company Director, appointed on 5 July 1996 until 30 June 1999

Mr John Craker
Appointed on 2 June 1998 until 31 December 2002

Dr Paul Wellings
Head of Science and Technology Division, Department of Industry, Science and Tourism. Appointed on 2 June 1998 resigned 7 May 1999

CHAIRMAN'S REPORT

This is the 47th Annual Report of ANSTO, or its predecessor, the Australian Atomic Energy Commission.

Parliamentary appropriation received in 1998-99 was $78.48 million (1997-98, $72.73 million). This included $4 million for the Replacement Research Reactor Project and $8.47 million to fund the removal of HIFAR spent fuel elements.

Appropriation available for operational and core science and technology activities was $66.01 million, a slight reduction in real terms compared to the previous year. This reduction is due largely to

the cumulative impact of efficiency dividends on the administrative component of running costs, and the continued application of government saving measures. Given that funding for safety and operational activities has to be maintained, the reduction has impacted mainly on the research activities of the organisation.

A special allocation of $0.62 million was received for remediation projects for the Year 2000 computer date problem.

Capital expenditure on equipment and infrastructure was $12.44 million (1997-98, $11.49 million), excluding expenditure on the replacement research reactor project.

With regard to revenue, ANSTO generated $30.73 million (1997-98 $30.00 million) from external services, representing 28.1% of total income, and exceeding the required performance target. Approximately half the revenue was derived from radioisotope sales.

Operations that work with radioactive materials - from uranium mines and medical radioisotope manufacturing facilities to nuclear power stations - attract universal concern with regard to safety. ANSTO's nuclear facilities, while minnows in the nuclear world, give the organisation the knowledge and status to make a disproportionately large contribution to all round nuclear safety. Particular attention is drawn to all facets of safety described in the main body of the report, with the observation that continuous improvement in the technical aspects of safety, and step-changes in waste disposal technology, depend on significant research expenditure, often at the leading edge of equipment capability.

Measures of ANSTO's abilities and attitudes to safety are captured in the following highlights:

Safety record
The organisation's outstanding performance with regard to radiation protection, which covers areas such as on-site exposure, airborne emissions and liquid effluent discharges, continued in 1998-99. While performance was everywhere better than compliance requirements, ANSTO continues to introduce improvements in order to exceed those requirements.

During the year, there was a significant change in regulation with the passing of the Australian Radiation Protection and Nuclear Safety Act. This

necessitated a change in the structure of safety committees to align with the new regulations, and a requirement for ANSTO to apply for licences for its activities. While it is essential to have all the proper checks and balances in place, the key to outstanding safety performance is the underlying safety culture of the organisation. ANSTO continues to improve its own safety culture, and has been able to develop methods for assessing and measuring safety culture. In so doing, it has contributed significantly to Nuclear Safety Culture workshops in the southeast and east Asian region.

Safety services
ANSTO's knowledge and experience is available to the community through training and consultancies. A total of 418 personnel from 110 organisations were trained in the basics of radiation protection in 1998-99. Consultancies were provided in waste management, site remediation, general radiation protection, and risk and reliability analyses.

Safeguards
New methods for strengthening the international nuclear safeguards system continued to be studied. Through ultra-sensitive analysis of environmental samples taken from within and around nuclear installations, the nature of the work carried out at the installation can be deduced and compared with that expected from its declared function. ANSTO has been evaluating the use of accelerator mass spectrometry for such analyses and a new beamline was installed on the Australian National Tandem Accelerator for Applied Research for this purpose. This will provide far more sensitive measurements of isotopic ratios of uranium, plutonium and other relevant radionuclides than is possible with traditional methods.

Synroc-based wasteforms
Commercialising a new wasteform is proving to be an exacting, time consuming business. While synroc has been demonstrated to be an outstanding wasteform at laboratory level, significant progress towards commercialisation can only be made by working in the main nuclear countries. During the year,

- a synroc wasteform, developed by ANSTO and US collaborators, was chosen by the US Department of Energy for the immobilisation of some US surplus weapons plutonium.

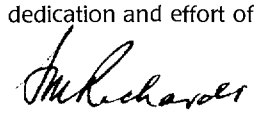
- in cooperation with Argonne National Laboratory (ANL), the use of ANSTO's proprietary hot isostatic pressing cans was successfully demonstrated with the ANL wasteforms in a remotely controlled hot cell environment at a commercial scale.

- collaboration with the French Atomic Energy Commission (CEA) intensified. It aims to develop synroc/glass composite wasteforms by exploiting synergies between ANSTO's synroc formulation capabilities and CEA's cold crucible technology.

Spent fuel management
In 1997 it was decided to ship spent fuel rods to their country of origin and that program is proceeding in a safe and orderly manner. During 1998-99, the United Kingdom Dounreay plant was no longer able to accept reprocessing contracts. ANSTO has reached agreement with the French company, Cogema, for reprocessing UK-origin spent HIFAR fuel, with provisions to include spent fuel from the replacement research reactor. The intermediate level waste so derived will be returned eventually for storage at the National Category S Store.

Progress on the replacement research reactor project has been considerable, so that, at the time of writing this report, the Parliamentary Standing Committee on Public Works recommended that the project should proceed, thus allowing the tendering process to begin.

ANSTO is an exciting and demanding organisation requiring all of its members to take pride in their performance. The Board records its appreciation of the leadership shown by the Executive Director, Professor Helen Garnett, and the continued dedication and effort of all staff.



Dr Max Richards
Chairman

This 1998/99 Annual Report summarises the achievements from an exciting, yet challenging, year for all at ANSTO.

The Organisation has moved further along its path to the future, with considerable progress made on several major infrastructure projects and in its research and development program. It has also progressed activities to improve its processes and assist its staff to develop new competencies.

The Replacement Research Reactor Project commanded significant effort, both in terms of extensive documentation and wide ranging consultations. This effort was directed primarily to meeting the requirements of processes attending the Environmental Protection (Impact of Proposals) Act 1974, the Parliamentary Standing Committee on Public Works, the site licence application to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) and the development of the Request for Tender.

The environmental assessment of the proposed replacement reactor was satisfactorily concluded with the announcement by the Minister for the Environment and Heritage on 30 March, "that there were no environmental reasons for preventing the granting of Commonwealth approval for the replacement nuclear reactor." The approval was accompanied by 29 recommendations.

On 3 May, the Minister for Industry, Science and Resources announced that he had accepted the advice and recommendations of the Minister for the Environment and Heritage supporting a replacement nuclear research reactor at Lucas Heights.

ANSTO will implement plans, in association with the Australian Radiation Protection and Nuclear Safety Agency, Environment Australia, relevant State authorities and other stakeholders to address the recommendations attached to the environmental approval.

While not completed during the financial year, at the time of writing the Parliamentary Standing Committee on Public Works Committee process has been completed (it unanimously recommended that the project proceed); the site licence has been granted by ARPANSA; and the Request for Tender distributed to four prequalified vendors.

There were also significant outcomes from major projects originally initiated to handle legacy waste issues. They have become examples of the

Organisation's capacity to turn problems into opportunities.

These include the completion of contractual arrangements for spent fuel from HIFAR, which also provides for managing future arisings from research reactor operations at Lucas Heights. The interactions during the associated negotiations were utilised to enhance awareness of ANSTO's ceramic technologies, a strategy that has led to positive cooperation on research projects in nuclear waste management.

Similarly, progress on ANSTO's Waste Management Action Plan has resulted, not only in progress to effectively immobilise various solid and liquid wastes in interim storage at Lucas Heights, but also to demonstrate the capacity of a synroc formulation to encapsulate complex wastes from radiopharmaceutical production. Implementation of this synroc-based process in coming years could provide another commercial opportunity in waste management for ANSTO.

Activities planned under the Waste Management Action Plan over the next few years include construction of a new, low-level liquid effluent treatment plant. This has been assured by the Government's decision to reinstate $5m in funding earmarked for this infrastructure.

Three years ago, ANSTO decided to tackle its research and development topics on a cross-divisional basis, bringing to bear all relevant expertise and experience to deliver the best possible outcomes. At the same time, it expanded cooperation with national and international research organisations and universities. This cooperation is reflected through this Report.

The exciting outcomes from these research projects, which are furthering ANSTO's international reputation, include:

- Better management of the coastal marine environment and its pollution is being achieved by the use of isotope and radiation technology in a major regional cooperation project being led by Australia through ANSTO. This is part of a United Nations Development Program Regional Cooperation Agreement International Atomic Energy Agency joint project on 'The application of radioisotope technology to sustainable development in Asia and the Pacific'. Improved understanding of harmful algal blooms in Asia-Pacific has been gained with the assistance of ANSTO's expertise in applying nuclear techniques in the coastal zone.

- Continued development by ANSTO of ultra-sensitive techniques for measuring environmental samples from around nuclear installations confirmed the value of such new technologies in identifying previous activities undertaken at a nuclear site. Such measures further strengthen the international safeguards system.

- ANSTO's Small Angle Neutron Scattering facility provided, for the first time, unique structural information for Australian industrial research. The work included pilot studies on polymers, drilling muds for the mining industry, the microstructure of clay for the environmental industry and alumina gels for membrane technology.

- Assurance of long term stability of materials used in high performance solar heating units was achieved with the assistance of ANSTO's advanced ion beam analysis techniques and the tandem accelerator recoil-time-of-flight facility. The work, in cooperation with the University of Auckland, New Zealand, involved testing and re-engineering various designs to ensure units were able to operate to specification for long periods at their high operating temperatures.

- ANSTO used its unique capability for studying the behaviour of sewage released from ocean outfalls by combining radiotracer techniques with particle characterisation to develop a model to enable environmental authorities to predict, for any oceanographic condition, the level of pollution in the vicinity of an ocean outfall.

- Measurements by ANSTO of the 'radiocarbon bomb pulse' caused by atmospheric nuclear weapons tests of the 1950s and 1960s and trapped as carbon-14 in Antarctic ice has enabled the CSIRO to refine numerical models which describe the trapping of air as bubbles in ice. This has led to improvements in the interpretation of the record of trace gases and isotopic species at Law Dome, Antarctica. As part of this project, ANSTO is participating in a unique collaborative experiment that will provide the first direct determination of the anthropogenic contribution to the global methane budget.

- A kinetic model was developed to describe the leaching of uranium and copper in metallurgical plants. Application of this model has the

potential to improve process efficiency and environmental management by reducing the use of chemicals in mineral treatment plants.

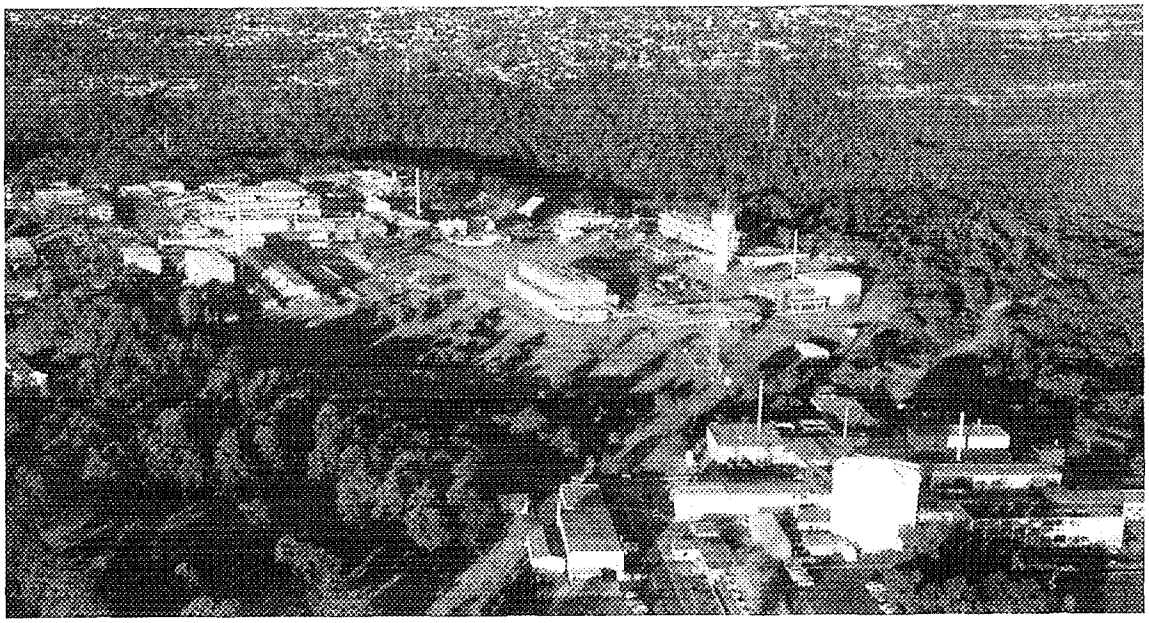
- Cost savings resulting from improved safety and plant performance of pressure vessels in the electricity industry were made possible through the Cooperative Research Centre (CRC) for Materials Welding and Joining, in which ANSTO is a core partner. The project used the unique facilities at the University of Wollongong and ANSTO to study the properties of welded joints in thick section pressure vessels operating at high pressures and temperatures.

- With the CRC for Waste Management and Pollution Control, ANSTO developed innovative oxidation technologies for the treatment of wastes, wastewaters and ground waters contaminated with arsenic and other toxic contaminants. AusAID funded a successful demonstration of a process to remove arsenic from arsenic contaminated tubewell water in Bangladesh.

Other significant outcomes for the year included:

- Nine countries reporting annually against safety culture indicators developed by ANSTO.

- ANSTO produced radiopharmaceuticals at a rate that continued to maintain Australia's almost total self-sufficiency in this important field of medicine. The production of iodine-123 and fluroine-18 FDG at the National Medical Cyclotron was doubled to meet increased medical demand. Technology transfers and new production scheduling were required to allow increased demand for reactor-based radiopharmaceuticals to be met.



ANSTO is located at the Lucas Heights Science and Technology Centre, which is 40 km south west of Sydney city centre.

Given these achievements and the progress on replacing HIFAR, it is somewhat disappointing that the available budget for research and development continues to decline due to efficiency dividends and other Government savings measures. This occurs even while the costs of pursuing technological projects increases in real terms, due to their added complexity. This

reduction is not only impacting on ANSTO's capacity to deliver scientific outcomes but also on its capacity to participate in programs to enhance the general understanding of the value of science in the population at large.

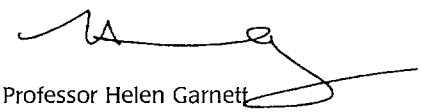
With an increasing investment in science and technology being made by other OECD countries and the proven socioeconomic benefits of ANSTO's nuclear science and technology activities, it is to be hoped that this situation will be addressed in the near future.

The lessons learnt from implementing cross-divisional project teams at ANSTO over the past three years have led to the introduction of improvements in our systems for project evaluation, project management and project reporting as well as the introduction of several new training programs. The latter are aimed at enhancing the capabilities of ANSTO's staff for mutual benefit.

With new systems in place, the Organisation has developed its 1999/2000 Operational Plan predominantly on a project-based approach, a trend that will be followed through to the next funding triennium.

The achievements during the past year have been gained through teamwork across the Organisation. They have resulted in effective responses to many externally imposed challenges. They have also resulted in improvements to the quality of ANSTO's activities, benefits that will assist ANSTO meet its commitments to effective and efficient management of the Replacement Research Reactor Project.

With adequate stakeholder support, ANSTO will continue to make significant contributions from its services, research, development and technology transfer activities to the benefit of Australia's social and economic development.



Professor Helen Garnett
Executive Director

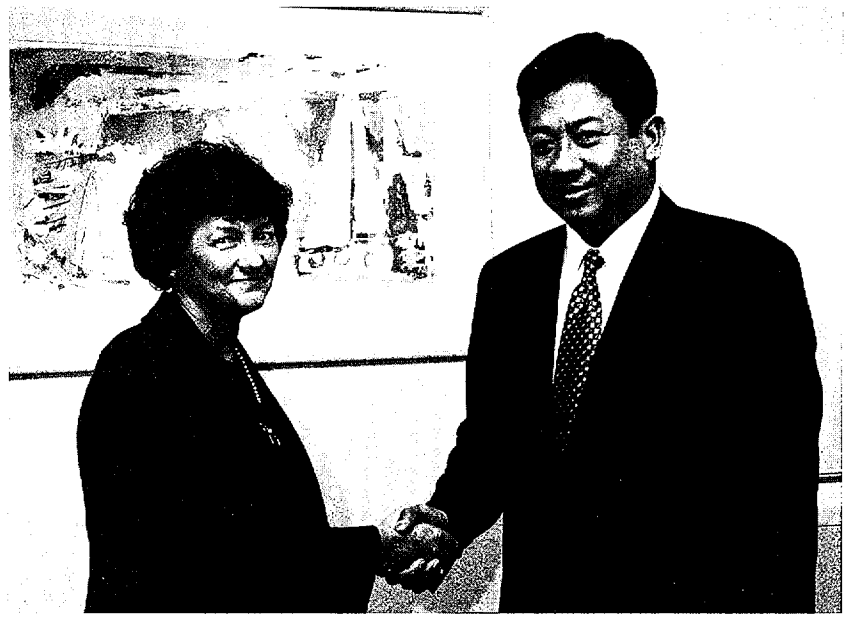
INTERNATIONAL STRATEGIC RELEVANCE OF NUCLEAR SCIENCE AND TECHNOLOGY

Driver: Government

OBJECTIVES:

(a) To provide government with quality scientific and technical advice on the nuclear fuel cycle, including reactor operations, reactor safety and safeguarding of nuclear materials.

(b) To make significant contributions to international research and development in selected fields associated with the nuclear fuel cycle, particularly reactor and radiation safety and safeguards, and be recognised as a leader in the application of knowledge in these fields. These activities will be commensurate with the Government's nuclear non-proliferation and other nuclear-related interests.



The Thai Deputy Prime Minister and Minister of Science, Technology and Environment, His Excellency Mr Suwit Khunkitti, with Professor Helen Garnett. Mr Suwit visited ANSTO in April to discuss, among other things, the contract for ANSTO to design and construct a radiopharmaceutical facility at the proposed Thai Ongkharak Nuclear Research Centre.

OUTCOMES

- Government departments and agencies were assisted by ANSTO's broadly based nuclear expertise, which contributed to Australia remaining influential in international initiatives aimed at encouraging stringent non-proliferation and safety standards.
- Australia, through ANSTO, continued to make a substantial contribution to enhancing nuclear cooperation in the region. ANSTO's Executive Director played a major role in discussions to agree on the future restructuring of the Regional Nuclear Cooperation in Asia (RNCA) and its subordinate activities to ensure they continue to be relevant to the needs of the region and to complement other regional nuclear cooperation arrangements. The discussions took place at the 10th annual International Conference on

Nuclear Cooperation in Asia (ICNCA), held in Tokyo in March. In the IAEA-supported Regional Cooperative Agreement (RCA) for Asia and the Pacific, Australia took the lead in initiatives to upgrade the management structure by defining a practical working structure and operational modalities for the 'Lead Country' concept. ANSTO was also instrumental in revising key documentation defining the guidelines and operating rules for the RCA.

- Australian scientists and researchers were able to access more than two million records in nuclear science and technology through the International Nuclear Information System (INIS), which is managed in Australia by ANSTO. The organisation both distributes information compiled by INIS, and contributes to that compilation, with 1100 new Australian documents being indexed and abstracted during the year. INIS is the only bibliographical database that covers the broad spectrum of nuclear science research and development and has a geographic scope that encompasses existing as well as emerging nuclear countries in South Asia, South America and Eastern Europe. It promotes Australian developments in nuclear science and technology to a world-wide audience and is a major source of information on economic, political and environmental aspects of all sources of energy.

* Better management of the coastal marine environment and its pollution is being achieved through the use of isotope and radiation technology in a major regional cooperation project being led by Australia (through ANSTO) as part of the United Nations Development Program RCA IAEA joint project on 'The application of radioisotope technology to sustainable development in Asia and the Pacific'. An example of the impact of this project is the improved understanding of harmful algal blooms in the Asia-Pacific region, which was achieved with the assistance of ANSTO's expertise in applying nuclear techniques in the coastal zone.

- As a result of ANSTO's work in organising and promoting regional activities in safety culture, all nine countries within the Forum for Nuclear Cooperation in Asia are now reporting annually against a set of safety culture indicators produced by ANSTO. Several of these countries have initiated new activities to promote safety culture in their organisations.

- Health physics services provided by ANSTO for the nine nuclear-powered warship visits to Australian ports helped ensure that these visits occurred with no radiological impact.

- ANSTO met all its national and international safeguards commitments, as confirmed by regular inspections by the IAEA and the Australian Safeguards and Non-proliferation Office of nuclear material and facilities at the Lucas Heights Science and Technology Centre.

- Continued development by ANSTO of ultra-sensitive techniques for measuring environmental samples from around nuclear installations confirmed the value of such new technologies in identifying previous activities undertaken at a nuclear site. Such measures further strengthen the international safeguards system.

ACTIVITIES AND OUTPUTS

Services to the Australian Government and other national stakeholders

ANSTO continued to provide information on a range of nuclear issues, including developments and facilities in particular countries, to government departments and agencies, other organisations, the media and members of the public. The Executive Director continued to be a member of the Commonwealth Government's Coordination Committee on Science and Technology.

A study of the environmental impact on Australia of a potential nuclear accident in our region, undertaken by staff of the Bureau of Meteorology, ANSTO and CSIRO, was completed for the Department of Foreign Affairs and Trade. The study, which has been published by the Department, concluded that even with worst case assumptions about the accident severity and meteorological conditions, the radiation to which Australians would be exposed would be much less than that from natural background radiation. For the radiation doses to Australians to be greater than the average

background level, a combination of non-credible coincidences would be required. Even in such a circumstance the doses would not reach levels at which the National Health and Medical Research Council recommends that emergency intervention actions be considered.

ANSTO officers provided briefing papers on subjects that included the annual Australia-Japan and Australia-Republic of Korea bilateral nuclear consultations. The Power Reactor Status Summary was regularly updated to reflect changes in the numbers of reactors being brought into, or retired from, operation as well as new construction orders and plans for new reactors. The Status Summary, with accompanying notes, is available to the public on the ANSTO Internet website. Four power reactors were connected to the grid in 1998 - three in the Republic of Korea and one in the Slovak Republic. Construction began on a new two-unit nuclear power station in China.

The Asian region continued to be the major area of growth for installed nuclear power capacity. Already some 20% of worldwide installed nuclear capacity is located in six countries in this region. Of the 23 reactors on which construction work has begun in the past decade, 21 have been in Asia - six in China, five in Japan (four completed), nine in the Republic of Korea (seven completed) and one in Pakistan. The remaining two are the last in the present phase of the French nuclear program. Almost half of the 29 power reactors currently under construction are in Asia and, unlike most of the other reactor construction projects, which are stalled in eastern Europe and the former USSR due to financial difficulties, the Asian programs are reported to be on schedule. Also, all nine power reactors currently on order are in Asian countries and the preparatory work for all is well advanced. Sixty power reactors are currently at the planning stage and 46 of these are in Asian countries. There are some signs, however, of a slowdown in the Asian nuclear expansion. Officials in China, the world's largest potential nuclear market, have announced that no new reactors will be ordered in the next three years.

The importance of nuclear power to countries in the region that lack indigenous energy resources was illustrated during the economic recession in the Republic of Korea. In 1998, nuclear power supplied 41% of total electricity there, compared to 34% in 1997. This saved an estimated US$4 billion in foreign currency, the cost of producing the same amount of electricity using imported liquified natural gas.

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

New methods of strengthening the international nuclear safeguards system continued to be examined. Through ultra-sensitive analysis of environmental samples taken from within or around a nuclear installation, the nature of the work carried out at the installation can be deduced and compared with that expected from its declared functions. ANSTO has been evaluating the use of accelerator mass spectrometry for such analyses and a new beamline was installed on the Australian National Tandem Accelerator for Applied Research (ANTARES) for this purpose. This will provide far more sensitive measurements of isotopic ratios of uranium, plutonium and other relevant radionuclides than is possible with traditional methods. A range of environmental materials such as soils, vegetation, and surface waters is being examined as part of this evaluation. The results of the study will be reported to the International Atomic Energy Agency (IAEA) and the Australian Safeguards and Non-proliferation Office (previously the Australian Safeguards Office) in the second half of 1999.

ANSTO staff continued to develop methods for assessing and measuring safety culture in organisations. Trial safety culture activity indicators were developed and nine countries in the region assessed their performance against these indicators. An attitudinal survey, developed with the School of Psychology at the University of New South Wales, was used at ANSTO and in four other countries in the region. This provided information that will assist in safety culture development and in determining the effect of differing national cultures on safety in research reactors.

A project on radiological consequence modelling is examining the potential radiological consequences of any release of radionuclides in our region. The

project created a flexible model capable of handling a wide range of critical groups in climatic zones ranging from temperate regions to the tropical and subtropical areas in South East Asia. The model was used in an international inter-comparison exercise in which it returned results comparable with real monitored exposures.

International Atomic Energy Agency activities

ANSTO, as Australia's national nuclear research institute, continues to provide the principal technical interface with the International Atomic Energy Agency (IAEA), which was established under the auspices of the United Nations and is the world's central intergovernmental forum for nuclear-related issues. Three of the IAEA's major responsibilities are to apply nuclear non-proliferation safeguards measures for civil nuclear programs, to make available the benefits of nuclear science and technology to its member states, and to promote nuclear safety.

Dr Ron Cameron, Director,Safety Division, is also Chairman of the Coordination Group providing regional management of the International Atomic Energy Agency Regional Cooperative Agreement program in radiation protection.

During the past year, 44 of the 52 Australian experts who undertook activities for the IAEA came from ANSTO.

The IAEA's program has been subject to thorough review following the appointment of a new Director-General on 1 December 1997. Australia has been to the fore in assisting the Agency in this review. The Executive Director was requested to serve on the IAEA's Program Performance Appraisal System (PPAS) to review the program of the Department of Nuclear Sciences and Applications. The Director, Safety, was nominated as Australia's representative for the PPAS review of the IAEA program on nuclear, radiation and waste safety. The Director, Government and Public Affairs, was appointed for a second term as a Member of the Standing Advisory Group on Technical Assistance and Cooperation (SAGTAC), which provides advice to the IAEA Director General on the Agency's Technical Cooperation Program. He participated in SAGTAC meetings, which reviewed organisational arrangements for the efficient delivery of the Agency's Technical Cooperation Program. The Director, Materials Division, chaired the IAEA International Radioactive Waste Technology Advisory Committee. A senior ANSTO staff member was reappointed to the International Nuclear Data Committee for a further two years.

Australia assists the IAEA's Technical Cooperation Program in a number of ways. It provides experts, hosts training courses and places IAEA fellows at suitable venues in Australia to receive specialist training. The IAEA has appointed ANSTO as the Australian coordinator for placement and management of all IAEA fellowship holders undergoing training in Australia. In the current year,

of the 78 fellowship applications received by the IAEA for training in Australia, 47 were accepted. Nine fellows were hosted by ANSTO; the remainder received training at 15 institutes and hospitals around the country.

ANSTO continued to support the IAEA Technical Cooperation Program by providing field monitoring systems for measuring radioactivity. To date, ANSTO and Minekin Australia have supplied systems to 19 countries through the IAEA.

A two-week IAEA Regional Training Course on 'Advanced environmental modelling and verification' was hosted jointly by ANSTO and the University of New South Wales in November. It was attended by 20 participants from 10 countries. The course dealt with the use of computer models to predict the impact of developments in coastal areas and the use of radioisotope techniques for model validation. Four other IAEA events were hosted by Australia. These were undertaken by the Westmead Hospital in July, by the University of Queensland in February, by Liverpool Hospital, Sydney, in conjunction with the Royal Australian and New Zealand College of Radiologists in May, and by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) in Melbourne in June.

ANSTO experts were recruited by the IAEA to present lectures for a number of regional training events during the year. In March an IAEA regional workshop was held in Bandung, Indonesia, on the 'Application of chemometrics and statistics for the evaluation of airborne particulate matter data and black carbon analysis of aerosol samples'. The workshop was part of a three-year ongoing IAEA Regional Cooperative Agreement (RCA) program on 'Urban air pollution in the Asian Region'. ANSTO participated in the formulation meetings for the workshop and in the workshop itself. In November ANSTO and the China Institute of Radiation Protection jointly trained emergency response teams from countries in the region at an IAEA expert workshop held in Taiyuan, China. The program included a workshop on radiation monitoring over large areas in emergencies and a test of the different emergency response teams in a range of accidents. This was the first activity of its kind to be held in the region.

ANSTO staff also assisted as lecturers in an IAEA workshop on 'Systems of notification, authorisation, inspection and enforcement' in Thailand in October and at a training course on 'Radiation safety in industrial radiography' in June in Indonesia. ANSTO staff participated in, or chaired committees in Vienna for, the development of the following IAEA documents: 'The IAEA performance requirements manual for the emergency response network', 'A safety guide on the scope of radiation protection requirements: Application of the concepts of exclusion, exemption and clearance', 'Safety requirements in the design and operation of research reactors', and 'A safety guide on training in radiation and waste safety'. ANSTO scientists also participated in IAEA Technical Committee meetings in Vienna on the impact of new environmental and safety regulations on uranium mining, milling and waste management.

ANSTO participated in a number of activities in the IAEA's Coordinated Research Program (CRP). ANSTO scientists participated in Regional Coordination Meetings for CRPs on 'Application of non-destructive examination and in-service inspection to research reactors', 'Improvement of safety assessment methodologies for near-surface disposal facilities' and 'Classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants'. ANSTO also accepted an invitation to participate in a new CRP on 'Ageing of materials in spent fuel storage facilities', which is scheduled to commence in December 1999.

As part of ANSTO's involvement in simplifying the International Nuclear Information System (INIS) database record format, ANSTO's INIS Liaison Officer attended a Liaison Officers' consultative meeting in Vienna and the INIS/Energy Technology Data Exchange technical committee meeting in Oak Ridge, USA. ANSTO was successful in gaining, for ANSTO users, access to current nuclear research information through a new INIS Internet interface, the ability to search on-line the historical data from 1948 to 1976 recorded in the Nuclear Science Abstracts database, and electronic delivery of non-conventional literature, such as reports, indexed in INIS.

To date, 31 360 Australian documents have been

indexed in INIS. The following graph shows the distribution of the Australian research output among the six major subject fields.

ANSTO participated in an air filters intercomparison exercise with the IAEA's laboratory in Seibersdorf, Vienna. This comparison involved the determination of over 20 elements on filters loaded with airborne particulate matter. The results are being compared with those from other major laboratories involved in fine particle analysis and characterisation.

ANSTO participated in and presented a paper at the IAEA International Symposium on 'Techniques for high-dose dosimetry in industry, agriculture and medicine'.

Mary Huxlin is the Australian International Nuclear Information System (INIS) Liaison Officer and coordinates the activities of the ANSTO INIS Centre. ANSTO, which manages INIS in Australia, both distributes information compiled by INIS and contributes to that compilation, with 1100 new Australian documents being indexed and abstracted during the year. INIS is the only bibliographical database that covers the broad spectrum of nuclear science research and development and has a geographical scope that encompasses existing as well as emerging nuclear countries in South Asia, South America and Eastern Europe.

The distribution of the Australian research output among the six major scientific areas of INIS.

Physics	40%
Chemistry, Labelled Compounds, Materials & Earth Sciences	24%
Life Sciences	20%
Engineering & Waste Management	9%
Economics & Legal Aspects	5%
Industrial Applications & Isotope Production	3%

Convention on Nuclear Safety

Australia is a Contracting Party to the IAEA Convention on Nuclear Safety. It is thereby committed to prepare a national report addressing its obligations under the Convention and to participate in a triennial Review Conference at which National Reports are peer reviewed and discussed by other parties. A senior ANSTO safety expert

contributed to the preparation of the national report by ARPANSA and participated with it and Australian Embassy staff in the First Review Conference in Vienna in April.

The Australian report assessed the effectiveness of the regulatory framework and safety practices applied to HIFAR against the sound principles promoted by the Convention for nuclear power programs. This approach was commended by other parties as a suitable model for future reporting by countries that do not have or plan to have a nuclear power program. The Review Conference was judged by all participants to have been open and self-critical in discussing national regulatory arrangements and nuclear power facility safety. It identified good practices to be emulated and aspects of individual country programs that could be strengthened. A baseline of international understanding of regulatory and safety issues in nearly all existing nuclear power programs was established. Any changed situation reported to future Review Conference will be judged against this standard.

IAEA Regional Cooperative Agreement activities

Over the past 22 years, Australia has provided substantial financial and technical contributions to support its membership of the Regional Cooperative Agreement (RCA) for Research, Development and Training Related to Nuclear Science and Technology, which is organised under the auspices of the IAEA. The current 5-year agreement runs until December 2002.

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 formal National RCA Representative and National Project Coordinators' networks provide a substantial framework to support regional collaboration and cooperation, with nine of the 15 Australian positions being filled by ANSTO staff.

The Director, Government and Public Affairs, is the National RCA Representative and attended the RCA General Conference Meeting in Vienna and the RCA Meeting of National Representatives in Singapore. At both meetings Australia continued to take a leading role with initiatives and proposals to achieve a process of increased self-reliance among the 17 RCA Member States, with the purpose of strengthening RCA regional management and decision making arrangements. These changes reflect the maturing status of RCA Member States in nuclear science, which in itself bears evidence of the success of the RCA over the years.

Australia is providing significant financial and technical support to the RCA through an AusAID-funded project entitled 'The application of radioisotope technology to sustainable development in Asia and the Pacific'. ANSTO is responsible for the overall management of the Australian contribution and for two of the three sub-projects. One of these sub-projects is concerned with sustainable development in the coastal zone. The other contributes to the safe application of nuclear technologies through dissemination of quality training material adapted for specific users of radioisotopes in industry and medicine and to strengthening national regulatory control of nuclear technologies.

Australia is providing A$1.662 million through AusAID to support these two activities together with a third component concerned with the training of nuclear medicine technologists. Currently, few of the identified 2000 nuclear medicine technologists in the RCA region have formal training. While the outputs from this component will contribute to the introduction of a standard level of basic skills, the materials will also assist the development of indigenous training schemes and can be adapted to each country's unique circumstances. The material developed has proved so useful that it has also been accepted for use by countries within the African and Latin American regional agreements.

Radiation protection

Australia has been designated as the lead country in the region in RCA radiation protection activities. The Director, Safety, who chairs the Coordination Group managing the IAEA RCA program in radiation protection, chaired the annual review meeting held in the Philippines in February. At this meeting, members planned activities for 2000 - 2002. They also reviewed the effectiveness of the seven project

activities conducted in 1998. It was concluded that these had been valuable to the participating countries. Two newsletters were produced for country coordinators by the Director, Safety, as part of his role as Coordination Group Chair.

ANSTO staff continued to work on developing a range of distance learning material in radiation protection. These materials were distributed for trial use by selected participants in the region. Phase 1 trials were successfully completed last year, with 21 students from the Philippines, Thailand, Korea and New Zealand trialing 12 modules such as basic radiation protection training and industrial/medical applications. Phase 2 trials were begun during the second part of the year with 60 students from Australia, Indonesia, Korea, Mongolia, New Zealand, the Philippines and Thailand trialing 21 modules. The trial is expected to finish in late 1999, when the material will be sent to the IAEA for translation and distribution to member states.

An ANSTO officer presented two plenary talks at an Executive Management Seminar on 'Environmental pollution monitoring techniques', held in Islamabad, Pakistan, in March. The seminar was organised by the Pakistan Atomic Energy Commission and the IAEA under an UNDP/RCA/IAEA agreement and covered issues relating to water and air pollution, monitoring techniques, quality assurance, quality control, and evaluation and impact modelling.

ANSTO and the Office of Atomic Energy for Peace (OAEP), Thailand, undertook successful expert missions to Indonesia and the Philippines to demonstrate gamma ray scanning technology on a large refinery distillation column. The experience gained in supplying nucleonic systems and in training overseas scientists helps ensure that ANSTO remains at the leading edge in the application of radiotracing technologies.

Management of the marine coastal environment

Australia, through ANSTO, is a lead country for the 'Management of marine coastal environment and its pollution', which is part of the UNDP/IAEA/RCA project 'Better management of the environment, natural resources and industrial growth through isotope and radiation technology'. ANSTO is managing four components. These will establish a database on marine radioactivity; determine levels, behaviour and fate of radioactive and non-radioactive pollutants in the environment through isotope or nuclear techniques; apply nuclear and modelling techniques to sustainable development in the coastal zone; and apply nuclear techniques to address specific red tide (harmful algal bloom) concerns. ANSTO participated in the project formulation meeting on harmful algal blooms, which was held in the Philippines in November.

ANSTO played a leading role in the first IAEA/RCA Review Meeting in Pakistan on marine radioactivity.

Radioactive waste disposal

ANSTO participated in the IAEA Regional Co-operation Agreement (RCA) Project on 'Preparation for disposal of low and intermediate level waste with emphasis on non-power sources'. This involved presenting lectures at a Regional Training Course in the Republic of Korea and chairing a meeting of national coordinators in India.

Research reactors and energy

An ANSTO officer attended an RCA project meeting at Taejon, Republic of Korea, on 'Research reactor utilisation and operation'. The meeting finalised details of activities for the next two years and set out plans for 2001-2002. It also supported a proposed ANSTO activity in emergency planning relating to research reactors that will contribute to this project as well as to the Extra-budgetary Program on the Safety of Nuclear Installations in the South East Asia, Pacific and Far East Countries.

ANSTO participated in the project formulation meeting on clean and energy efficient production processes held in Kuala Lumpur in March. This was the fifth and last component of the joint UNDP/RCA/IAEA project 'Better management of the environment, natural resources and industrial growth through isotope and radiation technology', to be formulated.

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.

Towards the end of the reporting period the Steering Committee responded to an independent review by a high level advisory group appointed by the Secretary-General of the OECD. This group recommended that the Agency play a more integrated role with other sectors of the OECD, particularly in broader policy issues surrounding sustainable development. Sustainable development has been identified by the Secretary-General of the OECD as a major focus for the Organisation. In May the Steering Committee approved a new 5-year strategic plan based on this integrated approach, and has begun reviewing its structure to ensure efficient implementation of the Agency's program of work.

In addition to participating in the Standing Committees, ANSTO staff were involved in a number of the NEA working groups. In contributing to the Uranium Group's task of producing the 1999 edition of the Red Book on Uranium Resources, Production and Demand, staff maintained regular collaboration with Australia's Bureau of Resource Sciences and the Department of Industry, Science and Resources. ANSTO staff also participated in three newly constituted expert groups. The group on Integrated Assessment of the Nuclear Fuel Cycle aims to assess fuel cycle options against a set of technical, economic, environmental and social criteria. A second phase activity on beneficial uses and the production of isotopes will develop a database on isotope uses and production capabilities with a view to strengthening international collaboration in this field. A Comparative Study of Accelerator-Driven Systems and Fast Reactors in Advanced Nuclear Fuel Cycles will analyse the potential implications of these technologies for the total fuel cycle. In addition, Australian involvement was secured in the review teams established to extend the NEA thermochemical database, a key source of reliable data for modelling the chemical behaviour of important radioisotopes in geological environments.

Regional Nuclear Cooperation in Asia

In 1990, Australia was a founder member of the Regional Nuclear Cooperation in Asia (RNCA) structure, which holds an annual progress conference, the International Conference on Nuclear Cooperation in Asia (ICNCA). The RNCA is designed to enhance nuclear cooperation among parties to the Nuclear Non-Proliferation Treaty in the region. In addition to Australia, the present membership comprises China, Indonesia, Japan, the Republic of Korea, Malaysia, the Philippines, Thailand and Vietnam. Australia has participated in and supported a number of RNCA activities over the past 10 years, including four workshops on radiopharmaceuticals and nuclear medicine and three on safety culture.

Australia hosted the third RNCA Workshop on Nuclear Safety Culture in Kuala Lumpur in May, with representatives attending from all nine member countries. The workshop focussed on extending the principles of safety culture from research reactors to all nuclear research facilities as well as those that support the nuclear fuel cycle. It reviewed participating countries' programs in safety culture and the outcomes of their reporting against agreed safety culture activity indicators. Attitudinal survey results from research reactor facilities in Japan, Korea, Indonesia and Vietnam were also presented. These surveys were considered useful in highlighting differences in attitudes to safety between management and employees and in identifying the need for greater communication by management of the organisation's safety policies and commitment. Many of the participating countries have launched significant safety programs as a result of these annual workshops.

ANSTO presented two papers at the fourth RNCA seminar on radioactive waste management, which was held in Bangkok in October and attended by 26 delegates from nine countries.

Bilateral cooperation

Australia and ANSTO are party to a number of bilateral nuclear cooperative arrangements that include nuclear and scientific institutes in Korea, Indonesia, Japan, China, France, Russia, the United States and the United Kingdom.

In September, ANSTO participated in a review of technical cooperation between Australia and the Republic of Korea as part of the eighth round of the Australia-Republic of Korea Nuclear Policy Consultations, held in Seoul. In addition to ANSTO/Korea Atomic Energy Research Institute (KAERI) cooperation, the reviews included cooperation between the Korean Institute of Nuclear Safety (KINS) with the Nuclear Safety Bureau (NSB) and the Australian Safeguards and Non-proliferation Office (ASNO).

In September, ANSTO officers held discussions in Jakarta with staff of the Indonesian Atomic Energy Agency (BATAN) to review areas of ongoing nuclear collaboration and cooperation with ANSTO. The Australia-Indonesia Nuclear Science and Technology Cooperation Agreement, signed on 11 November 1997, established a framework for promoting and facilitating cooperation in nuclear science and technology between the two countries. The cooperation takes place through exchanges of scientific and technical personnel, an information and training program, education, joint research and development, and technical consultations. Two senior BATAN staff visited ANSTO in March for detailed discussions on specific areas of collaboration.

ANSTO scientists are contributing to a collaborative project to investigate the mobility of uranium series nuclides in the geosphere. This study is based on determining the microstructure of samples from the Ruprechtov uranium ore body in the Czech Republic. This is a joint undertaking between ANSTO, the Institute for Reactor and Repository Safety (GRS) in Germany, the Australian National University and the Czech Nuclear Research Institute and is the first activity to be carried out under an agreement between ANSTO and the GRS.

A senior engineer from the Gadjah Mada University in Indonesia began working in ANSTO's Materials Division on performance assessment of synroc as an engineered barrier for an ocean-island repository in a tropical environment. His visit is supported by an Australian Government Merdeka Fellowship.

Information on bilateral commercial contracts with US and French organisations is included in the chapter entitled 'Treatment and management of man-made and naturally occurring radioactive substances', which begins on page 37.

External representation

ANSTO continued to maintain specialised overseas representation through three Counsellor (Nuclear) posts located in the Australian diplomatic missions in Vienna (Dr Maurice Ripley), London (Dr Ron Hutchings) and Washington DC (Mr Robert Godfrey). 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 maintained a Canberra Liaison Officer position (Dr Wally Zuk) to facilitate contacts with Canberra departments and agencies.

Emergency planning

One of the emergency plans maintained by the Government deals with responses to the consequences of debris from a nuclear powered satellite re-entering the earth's atmosphere. ANSTO staff participated in exercises to monitor potential radioactive ground contamination using equipment mounted on Australian Defence Force helicopters, as part of the testing of the Australian Contingency Plan for Space Re-Entry Debris (AUSCONPLAN-SPRED).

Nuclear-powered warship visits

ANSTO staff provide a range of support services to the States and the Commonwealth for visits to Australian ports by nuclear-powered warships. This year, ANSTO provided support for nine nuclear powered warship (NPW) visits by single vessels to Perth, Gladstone, Hobart and Brisbane. Staff provided radiation monitoring for the duration of the visits, and trained local emergency response personnel.

Prototype hardware and software were completed for the redesigned Nuclear Powered Warships Early

Warning System (NPWEWS), which will replace a system that has been used since 1981 to monitor radiation dose rates in the vicinity of nuclear-powered warships visiting Australian ports. The new system allows health physics officers to access real-time data anywhere within the visit region. Production units are close to completion, and detailed testing of the radio coverage capability is scheduled to begin in the second half of 1999.

ANSTO staff participated in five Visiting Ships Panel (Nuclear) (VSP(N)) meetings, one involving an exercise to coordinate Commonwealth resources in the event of an incident. The VSP(N) Committee made port validation visits to Gladstone and Darwin.

Staff also carried out radiation awareness and NPW monitoring training for Royal Australian Navy personnel and contributed to the revision of the National Health and Medical Research Council Code on 'Intervention in Emergency Situations involving Radiation Exposure'.

ANSTO staff attended, and presented talks at, the bi-annual NPW workshop held by Emergency Management Australia at Mt Macedon, Victoria. Staff also demonstrated the new NPW monitoring equipment developed at ANSTO.

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 began in 1995, is being sponsored by the International Agency for Research on Cancer at Lyon, France. Australian input is being coordinated by the University of New South Wales. Personnel and dosimetry data for current and past workers at the Lucas Heights Science and Technology Centre were merged into a database for follow-up studies that have commenced in collaboration with the Australian Institute of Health and Welfare in Canberra.

Nuclear safeguards

The Australian Safeguards and Non-proliferation Office conducted monthly inspections and audits of ANSTO's nuclear materials. IAEA safeguards inspectors conducted routine quarterly inspections and eight monthly inspections to verify ANSTO's nuclear materials. IAEA inspectors carried out monthly inspections of HIFAR fuel elements in accordance with the IAEA's safeguards criteria for this class of nuclear material. All inspections were considered satisfactory.

Australia has taken a leading role in the implementation of strengthened safeguards under the IAEA 93+2 Program. This will ensure the IAEA receives considerably more safeguards-related information on nuclear and nuclear-related activities undertaken by Member States. Because ANSTO is part of this program, it was asked to provide the IAEA with 'Complementary Access' to several buildings on site in August and again in March. The IAEA also requested 'Managed Access' to a building on ANSTO's site in October. Complementary Access involves the IAEA requesting access to a building to verify the absence of undeclared nuclear material or activites, during a routine inspection elsewhere on site. A Managed Access visit is one that occurs when the IAEA arrives at the site unexpectedly and requests access to a building or material for verification of its nature and use. ANSTO complied with these requests well within the two-hour period required. Such inspections assisted in demonstrating the efficacy of the new, strengthened international safeguards approach by showing that a facility can efficiently accommodate these types of inspections.

Ministerial and other Commonwealth Department VIP visitors

The Thai Deputy Prime Minister and Minister of Science, Technology and Environment, His Excellency Mr Suwit Khunkitti, visited ANSTO on 8 April. Mr Khunkitti had discussions on a number of issues including the contract for ANSTO to design and construct a radiopharmaceutical facility at the proposed Thai Ongkharak Nuclear Research Centre.

Other visitors during the year included the Minister for Industry, Science and Resources, Senator the Hon. Nick Minchin; members of the Parliamentary Standing Committee on Public Works; and senior staff from the Department of Industry, Science and Resources and the Department of Foreign Affairs and Trade.

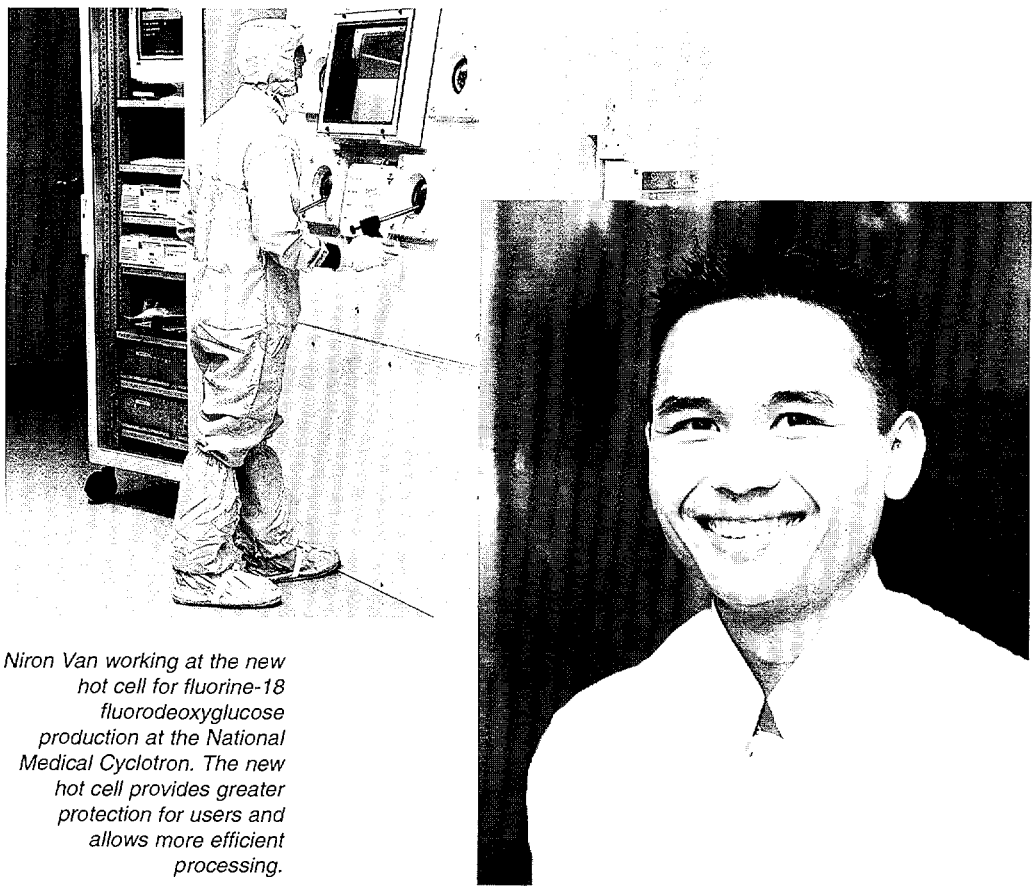
University of Technology, Sydney, student Francesco Ju, has been working on a project in ANSTO's water tunnel laboratory to model the thermal-hydraulic behaviour of fuel elements and radioisotope production targets for HIFAR and the replacement reactor. The data collected will be used to validate computational fluid dynamics calculations, particularly those used to optimise heat transfer in new radioisotope targets. The University of Newcastle and the University of Technology, Sydney, intend to use the system in a number of projects that provide insight into turbulence and its management.

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 core nuclear facilities in Australia and overseas for the benefit of the Australian research and development community and industry; and to enhance and improve the efficiency and effectiveness of these core facilities in order to yield high quality research, products and services. These facilities include the research reactor HIFAR, the National Medical Cyclotron (NMC), the Australian National Tandem Accelerator for Applied Research (ANTARES), the Australian National Beamline Facility on the Photon Factory in Japan and the beamline facilities at the Advanced Photon Source at the Argonne National Laboratory in the United States.



Niron Van working at the new hot cell for fluorine-18 fluorodeoxyglucose production at the National Medical Cyclotron. The new hot cell provides greater protection for users and allows more efficient processing.

OUTCOMES

- Activities to implement the Government's decision to replace the present HIFAR research reactor at Lucas Heights resulted in the project proceeding close to schedule. These included the requisite environmental assessment process, submissions to the Parliamentary Standing Committee on Public Works and the Senate Economic Reference Committee inquiry into the replacement reactor, the prequalification of international tenderers, the preparation of tender documentation, and the application to the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) for a site licence.

- ANSTO's nuclear facilities continued to be operated safely and efficiently. Australia's major national nuclear research facility, the HIFAR research reactor, was available for 97.7% of its scheduled available time to provide neutron beams for research, produce radioisotopes for medicine and industry and irradiate materials for researchers and industrial customers. HIFAR's irradiation service for mineral ore samples and silicon generated an income of $2.25 million.

- ANSTO's new small angle neutron scattering (SANS) facility provided, for the first time, unique structural information for Australian industrial research. The work included pilot studies on polymers, drilling muds for the mining industry, the microstructure of clay for the environmental industry and alumina gels for membrane technology.

- Assurance of the long-term stability of materials used in high performance solar heating units was achieved with the assistance of ANSTO's advanced ion beam analysis techniques and the tandem accelerator recoil time-of-flight facility. The work, which was carried out in cooperation with the University of Auckland, New Zealand, involved testing and re-engineering various designs to ensure the units were able to operate to specifications for long periods at their high operating temperatures.

- ANSTO's neutron scattering facilities on the HIFAR research reactor enabled universities to carry out key materials science research. Specific studies included a systematic investigation of perovskite-related structures and studies of internal stresses in ceramic materials and of the crystal structure of catalysts.

- Radionuclide analyses with an age accuracy of within 40 years and a throughput capability of more than 1000 samples per year were achieved following further upgrades to ANSTO's Australian National Tandem Accelerator for Applied Research (ANTARES) accelerator mass spectrometry (AMS) facility and the supporting sample preparation laboratories. This benefited the wide range of Australian researchers requiring radiocarbon analysis.

- Past climate change chronologies were developed with greater accuracy than was previously possible by using data produced by the ANTARES AMS facility. This enabled scientists to carry out precise radiocarbon analysis of tree rings, sediments and other environmental archives as part of the Australian Quaternary Science Program.

- Production of iodine-123 and fluorine-18 fluorodeoxyglucose (FDG) at ANSTO's National Medical Cyclotron (NMC) was doubled, meeting increased market demand in nuclear medicine clinical practice and the Australian research and development community.

- Information on how the level of radionuclides in certain mineral products can be reduced by modifying mineral processing technology was obtained through use of the Australian National Beamline Facility on the Photon Factory in Japan to map concentrations and chemical forms of uranium and thorium in samples of mineral sands.

* The chemical forms of iron and manganese in marine particulates were determined using the Australian National Beamline Facility as part of an investigation into the role of iron and manganese in algal blooms.

ACTIVITIES AND OUTPUTS

HIFAR research reactor

Operation and general utilisation

During the year the research reactor operated for approximately 8,736 hours at an average power of 10.01 MW. Excluding the 13 scheduled shutdowns for fuel changes (totalling 46 days), the reactor was available for 97.7% of its scheduled operating time.

The reactor was used to irradiate 2,186 targets for research and for the production of medical and

industrial radioisotopes. It should be noted that this figure is lower than in past years because previously the number of irradiations was counted, whereas since July 1998 the targets have been counted, and some are irradiated several times. The reactor was also used to irradiate 877 batches of silicon targets and 28,528 mineral samples for commercial customers. The silicon targets are used in the manufacture of a wide range of products for the electrical and electronics industries.

Irradiation programming efficiency in HIFAR was improved by adding one extra, hollow fuel element rig. Support from HIFAR staff with the additional Sunday reactor unloads allowed greater quantities of molybdenum to be produced, enabling radiopharmaceutical production staff to better meet the increased demand for this product.

University projects funded by the Australian Institute of Nuclear Science and Engineering (AINSE) utilised 375 instrument days, and ANSTO research (both internal and international collaborations) utilised 411 instrument days. ANSTO research involving collaboration with university groups and training of PhD students utilised a further 109 instrument days.

Maintenance and support

HIFAR staff continued to maintain the reactor's quality system certification to the AS/NZS-ISO 9001 International Standard. The external accreditation body, Quality Assurance Services Pty Ltd (the commercial arm of Standards Australia), undertook surveillance audits in November and May and found no non-conformances.

Following issue of the updated HIFAR Safety Case documentation last year, an action plan was prepared, identifying additional work needed to further demonstrate the safety of HIFAR during its remaining operational lifetime (until the end of 2005). The Action Plan also identified further safety analyses required to enhance the current Safety Case documentation.

HIFAR's criticality is controlled by six neutron-absorbing coarse control arm (CCA) blades. Those closest to the core absorb more neutrons and therefore have shorter lives, and have had to be replaced after approximately 50 operating programs. Last year the Nuclear Safety Bureau (now constituted as part of ARPANSA) approved a modification to the composition of the blades that allowed their life to be trebled. The new blades are removed from the reactor after a specified time and visually inspected in a hot cell for evidence of damage or corrosion to the blade and bearings.

After inspection, they are replaced in the reactor in different positions in relation to the core. All blades inspected were found to be in excellent condition. During the year a formula was developed to calculate burnup rates in the different positions and used as the basis for a position rotation program. A submission was forwarded to ARPANSA for agreement to amendments to the HIFAR Operational Limits and Conditions affected by the CCA life extension program.

ANSTO's materials assessment section completed an extensive review of the HIFAR secondary cooling pipework thickness data. Measurements made using sophisticated area thickness gauging techniques revealed gradual but minimal loss of wall thickness. However, a detailed assessment showed that the remaining life of the pipework is greater than the expected operational life of HIFAR. A seismic analysis of the secondary coolant pipework within the reactor containment building was completed. It showed that even a major seismic event would not cause failure of the pipework. An improved ultrasonic and visual inspection system was developed and tested for inspections of the weld between the plenum plate and the skirt inside HIFAR. These inspections will be carried out during the scheduled major shutdown in 2000.

The 40-year-old overhead travelling crane used to transfer fuel flasks and other heavy plant within HIFAR was upgraded to meet current standards for nuclear power plants. The crane was converted from direct current (DC) to alternating current (AC) operation to take advantage of modern technology. Major components replaced during the upgrade included the crab, the long travel drive and electrical controls.

Two projects to improve facilities for the irradiation of silicon ingots were begun. The ingots are irradiated in HIFAR for overseas customers to enhance the electrical properties of the silicon. The first project, to replace the silicon irradiation control system, was completed. The second, the installation of an additional silicon storage block facility, is scheduled for completion next year. Seismic analysis was undertaken as part of the design process for the structure supporting the additional silicon storage block.

A range of components, including silicon irradiation

rig cans, shield plugs and maintenance platforms, were produced by engineering staff to support HIFAR operations.

Probabalistic Safety Assessment and Remaining Life Study

ANSTO's Director, Safety, is a member of the Technical Reference Committee that provides advice to the Department of Industry, Science and Resources on the probabilistic safety assessment of HIFAR. This committee continued to meet during the year to oversee the development of seismic hazard curves for Lucas Heights and the development of response spectra. This work was undertaken by a New Zealand company, Geological and Nuclear Sciences in conjunction with Australian and US collaborators. The work is scheduled for completion in July 1999.

In response to a recommendation in the Probabilistic Safety Assessment and Remaining Life Study of HIFAR completed last year, a project to modify HIFAR's Emergency Core Cooling System pipework was completed, ensuring that the system will operate at its full design capacity.

Reactor analysis

Development of thermal-hydraulic experimental facilities

A joint application by the University of Newcastle, the University of Technology, Sydney, and ANSTO led to the award of a Research Infrastructure Equipment and Facilities Scheme grant of $360,000 for a Laser Doppler Velocimetry System (LDV) for use in ANSTO's water tunnel laboratory. ANSTO is contributing $15 000 plus the use of its water tunnel by the partners. The LDV system will be used to model the thermal-hydraulic behavior of fuel elements and radioisotope production targets for HIFAR and the replacement reactor. The data collected will be used to validate computational fluid dynamics calculations, particularly those used to optimise heat transfer in new radioisotope targets. The universities intend to use the system in a number of projects that provide insight into turbulence and its management.

Methods for computer modelling neutron and photon transport in the reflector of a water cooled reactor with a compact core were investigated. Such modelling will be used to evaluate the replacement reactor's ability to meet safety and performance objectives. A 'Monte Carlo' code was used to construct models that include arrangements of neutron beam tubes, cold and hot neutron sources and irradiation facilities within the reflector. The models were used to develop detailed requirements for the irradiation and beam facilities and will be used when assessing tenders for the replacement reactor.

HIFAR utilisation
Neutron scattering developments

The small angle neutron scattering (SANS) instrument on HIFAR was further upgraded. Detector uniformity was substantially improved through modifications to the 256 channels in the readout electronics. The neutron beam profile at the sample position was also improved, producing a factor of two increase in the incident neutron flux. These developments significantly improve data quality, leading to a reduction in data acquisition time and enabling scientists to carry out more demanding experiments. The SANS instrument is used to characterise the molecular structure of materials to provide a more detailed understanding of the bulk properties of many materials important in advanced technological applications.

A collaboration commenced between ANSTO and the National Institute of Standards and Technology (NIST) Cold Neutron Research Facility laboratory at Gaithersburg in the United States on the development of SANS instrumentation. The design of various items of hardware for the ANSTO SANS instrument was based on published NIST concepts. During the year, work began on planning further detailed hardware design on beamstop, multilayer monochromator and shear cell. In addition, the NIST suite of software routines for data analysis was made available to ANSTO.

Upgrading also continued on the other neutron scattering instruments. Software for data collection with the area detector on the 2TANA single-crystal diffractometer was incorporated in the instrument control program, allowing faster crystal quality assessment and alignment prior to data collection. After an extended upgrade, the long wavelength polarized diffractometer (LONGPOL) instrument began operating with supermirrors for the polariser and for three of the eight detector analyser channels, greatly increasing its detection efficiency. Following extensive work on the control and analysis software, LONGPOL became fully functioning in four of the eight operational modes, allowing polarized neutron spectroscopy to be performed. Work on installing supermirrors on the

remaining analyser channels and implementing the final four operational modes continued.

The LONGPOL upgrade will allow scientists to carry out more detailed studies of magnetic short-range order in binary alloys and intermetallic systems as well as research into the flux-trapping mechanisms in superconducting materials and into magnetic domains in amorphous magnetic ribbons. Scientists will also be able to isolate coherent atomic and magnetic excitations (phonons and magnons) and crystal field excitations in selected intermetallic systems. Planned research includes exploration of a range of diffusion processes in superionic glasses and spin glass systems.

Tests were performed on the use of neutron sensitive image plates as detectors for neutron scattering. The possible uses for image plate detectors are extensive, and range from studies of diffuse scattering to reflectometry, single crystal diffraction and powder diffraction. For both single crystal and powder diffraction, the indications are that it will be possible to do experiments using samples that are at least 10 times smaller than is currently feasible. The availability of a flexible, non-electronic 2-dimensional neutron detector will have a significant impact on the design of some neutron scattering instruments for the replacement reactor and on the possible upgrade of instruments on the existing HIFAR reactor.

ANSTO and the US Brookhaven National Laboratory continued to collaborate on the development of new neutron monochromators. The aim is to boost neutron flux at the sample position without degrading the signal quality. The new design consists of a stack of thin germanium wafers that are deformed under stress at high temperatures. Brookhaven is performing the controlled deformation of the wafers and ANSTO is measuring the neutron characteristics. Once installed, these monochromators will provide better quality neutron beams and enable scientists to perform more complex experiments on smaller samples.

To ensure that maximum benefit arises from investment in present and future facilities, members of ANSTO's neutron scattering group promoted the benefits of their work to various interested parties. In July they made a substantial contribution to the 'Second AINSE Winter School for nuclear techniques applied to natural processes', when 34 third-year undergraduate students from AINSE-associated universities took part in lectures, tours and practical work. In October members of the group represented ANSTO at the Australian Institute of Physics Congress held at Fremantle and used the opportunity to inform the physics scientists of Australia of the latest developments in ANSTO's replacement reactor project. In May a member of the neutron scattering group attended the Horizons of Science Forum held at the Centre for Science Communication at the University of Technology, Sydney. The forum members were chosen to provide a balance between experienced and young researchers and were selected not only on the quality and originality of their work but also on their ability to convey information and ideas to the wider community.

Neutron scattering applications

Scientists from ANSTO and the University of Sydney performed a systematic investigation of materials with structures related to the mineral perovskite. Minerals having these structures are of considerable interest to earth scientists and scientists with an interest in the synthetic rock, synroc. The powder neutron diffraction experiments required use of the research reactors at the Oak Ridge National Laboratories in the United States and the Institute Laue-Langevin in France, and the synchrotron source at the Brookhaven National Laboratory in the United States. Most of these experimental studies were performed at high temperatures to determine any systematic trends in the structures of these related materials versus temperature. The work identified a complex sequence of structural phase changes in calcium titanate at high temperature, a result similar to one seen in strontium-substituted calcium titanate at room temperature using x-ray diffraction.

ANSTO scientists, in collaboration with scientists from the University of Newcastle, continued their study of the effects of applied and internal stresses on ceramic materials and developed a theory to account for the movements of the diffraction peaks in polycrystalline solids under the influence of such stresses. This theory is fundamental to the use of neutron diffraction to estimate residual stress in materials. The theory was successfully tested by comparing calculated results with those observed in the case of neutron diffraction from alpha-alumina under uniaxial compressive stress. Studies of atomic rearrangements induced by applied stresses or voltage fields were also pursued, in collaboration with the University of Newcastle scientists.

The electron density in Y2Sn2O7, the archetypal mineral pyrochlore, was determined by use of x-ray

powder diffraction data obtained from the Australian National Beamline Facility in Tsukuba, Japan and from neutron powder diffraction data recorded at Lucas Heights. This work improves knowledge of the crystal structure and bonding in these minerals, which is of great interest to chemical science.

Following ANSTO's success in 1997-98 in incorporating atoms of rare gas into the lattice of carbon-60 fullerenes, work continued on the insertion of other gases that may be of industrial use. One potential application is as gaseous tracers for determining the efficiency of numerous industrial processes. The crystal structure of fullerenes with carbon dioxide gas incorporated was determined by a combination of x-ray and neutron powder diffraction measurements, the latter being made on the medium resolution powder diffractometer instrument at HIFAR. The expected high and low temperature phases were found. At room temperature, the carbon-60 molecule is freely rotating, but at low temperature its motion is frozen, with its pentagonal faces locked to the carbon dioxide molecules.

AINSE collaborators worked on a diverse range of projects using the SANS instrument. These included an investigation of the hydration of fibrous material for paper manufacture, measurement of the porosity of coal, and analysis of the microstructure of aluminium.

Experiments began under the Collaboration in Neutron Scattering Science agreement between ANSTO and the NIST Cold Neutron Research Facility in Gaithersburg in the United States. Selected questions in Australian industrial research and development were posed in consultation with the Cooperative Research Centre (CRC) for Polymers and major Australian mining and mineral processing industries. The ANSTO/NIST agreement is for SANS science specifically related to experiments of industrial significance. The initial experiments will include studies of polymer phase separation, nucleation in aluminium refinement, structure of drilling muds for the mining industry, microstructure of clays for the environment industry, and behaviour of alumina gels for membrane science and technology.

ANSTO is one of the core participants in the new CRC for Polymers. Others are CSIRO, four universities and 10 companies, with the Defence Science and Technology Organisation and the Strategic Industry Research Foundation as supporting participants. Because of its range of equipment, expertise and international linkages, ANSTO will provide analyses based on the interaction of neutrons, high-energy ions, and synchrotron radiation with polymers. Such information complements more traditional techniques. Neutron scattering of appropriate materials allows interfacial properties of polymer blends to be determined, as well as the shape that polymer molecules adopt in miscible blends. Such properties may provide the key to understanding interactions and mechanical properties of a diverse range of polymer products and processes.

Replacement research reactor

On 3 September 1997, the Government announced that it had agreed to 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 would provide ANSTO and Australian stakeholders with access to a state-of-the-art facility that provides the high degree of research and isotope production flexibility necessary to meet Australia's requirements into the 21st century. 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 has involved moving the project to a point where tenders can be issued. Principal activities are described below.

Environmental assessment

ANSTO engaged a specialist consultant, PPK Environment & Infrastructure Pty Ltd in collaboration with NNC Ltd (UK), to assist in the preparation of the necessary Draft Environment Impact Statement (EIS). This was prepared in accordance with Environment Australia guidelines, which required a 12-week public display period. A subsequent Supplementary EIS addressed the issues raised in public submissions resulting from this process. The Final EIS, which consolidated the Draft and Supplementary EIS, was submitted to the Minister for the Environment, who advised the Minister for Industry, Science and Resources on 30 March 1999 that there were no environmental reasons, including any on safety,

health, hazard or risk grounds, to prevent construction of the replacement research reactor at Lucas Heights, subject to a set of 29 conditions. The Minister for the Environment stated that all the evidence before him confirmed that the replacement reactor would be safe, with no significant risk to the environment or the community.

The Minister for Industry, Science and Resources subsequently announced on 3 May 1999 that he had accepted the recommendations of the Minister for the Environment. ANSTO then formed a project team responsible for addressing the conditions to the satisfaction of the Minister for the Environment. In doing so, ANSTO will liaise with both Environment Australia, ARPANSA and other bodies as appropriate.

Prequalification of reactor vendors and formation of tender teams

In December 1998, ANSTO prequalified four internationally recognised and experienced research reactor vendors who have subsequently indicated to ANSTO teaming arrangements with various substantial Australian engineering and contracting companies to tender for the project. The teams are: AECL (Canada) and its Australian partner Thiess, INVAP (Argentina) and partner John Holland, Siemens (Germany) and partner Transfield, and Technicatome (France) and partner Baulderstone Hornibrook.

Preparation of tender documentation

ANSTO has prepared tender documentation to proceed on the basis of a lump sum, design, construct and commission contract with clear performance acceptance criteria embedded in the contract. It is planned that tenders will be issued in August 1999 and closed in December 1999.

The performance-based specifications have been developed in close consultation with user groups.

A Beam Facilities Consultative Group (BFCG) was formed to define the neutron scattering facilities to be installed on the proposed replacement reactor. It comprises representatives of key Australian interest groups from academia, government, research organisations and industry and covers all mainland States. Detailed specifications of the neutron beam facilities were prepared in consultation with members of the BFCG and overseas consultants in Switzerland, Sweden, Japan and the United States.

The ANSTO neutron scattering group prepared supporting documentation for the specifications and performance requirements. A separate project has been established to provide the initial suite of 8 instruments identified by the BFCG. Throughout the processes of prequalifying reactor vendors and the preparation of tender documentation, ANSTO has involved specialist resources to add value and experience. A core project team has been formed within ANSTO and experienced consultants engaged to work with ANSTO officers to achieve the project objectives.

Application for a siting approval licence

ANSTO submitted an application for a Facility Licence, Site Authorisation, to ARPANSA on 13 April 1999 in order to begin the multi-stage licensing process that will culminate in the issue of a Licence to Operate as part of the commissioning of the reactor. ARPANSA is expected to make a decision on this site licence application in August 1999.

Parliamentary Public Works Committee

In February a statement of evidence was provided to the Parliamentary Standing Committee on Public Works. ANSTO gave extensive evidence to the Committee at hearings held in May. Tendering action is dependent upon a successful outcome to this statutory process.

Senate Inquiry

ANSTO, in conjunction with the Department of Industry, Science and Resources, provided a detailed submission and evidence to the Senate inquiry being conducted by the Senate Economic References Committee into the replacement research reactor.

Phase 2 will involve the issue and evaluation of tenders leading to the selection of a preferred tenderer and ultimately to contract award. Anticipated key milestones in Phase 2 include the close of tenders (December 1999), selection of preferred tenderer (May 2000) and contract award (July 2000).

Phase 3 will consist of the detailed design, construction and commissioning of the replacement research reactor and the issue by ARPANSA of a Licence to Operate. It will also include the contractor's demonstration of performance against ANSTO's contract performance acceptance criteria. This phase will conclude in December 2005, at which time the existing research reactor, HIFAR, will cease operation.

Moata
The Moata research reactor was shut down in 1995, when fuel was removed and the coolant drained, and has remained in this condition since. The fuel will be included with a shipment of HIFAR spent fuel to the United States. The requirements of the project management plan and schedule for decommissioning Moata were met by the preparation of a revised authorisation, quality manual, procedures and instructions. These documents were submitted to ARPANSA for endorsement. A draft radioactive materials inventory and a draft decommissioning options study were also prepared.

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 owned and operated by ANSTO and located adjacent to Sydney's Royal Prince Alfred Hospital.

Routine commercial production runs of fluorodeoxy-glucose (FDG) were increased from one to two a week to satisfy increased demand from local and interstate customers. Production of other radiopharmaceuticals increased in line with market demand.

A new synthesis facility for FDG production was purchased and commissioned, improving process reliability and reproducibility. The method of maintaining the iodine-123 plant was reviewed. The plant endures major extremes of temperature, making frequent maintenance vital. Following a review, it was decided that modular spares should be purchased to allow rapid repairs, and a new hot cell enclosure designed and installed to house and protect a vulnerable gas manifold unit. This new hot cell provides greater protection for users and allows more efficient processing.

Work began on developing the irradiation capacity of a new beamline for single photon emission computed tomography (SPECT) radiochemical production, and on testing a new 40kW amplifier, which is scheduled for commissioning in late 1999. Work began on manufacturing an extra focussing element to increase the effectiveness of the new line.

Processing equipment was developed and installed on the new positron emission tomography (PET) hot cell facilities. This has allowed increased production of PET radiopharmaceuticals and development of improved separation processes in gallium-67 production.

A major upgrade of the ventilation and air conditioning system for the NMC's manufacturing areas was completed. As part of this upgrade, the filtration system's capacity was increased and the existing exhaust fans refurbished. The fume cupboards now meet all requirements of air extraction of Australian Standard 2243 part 8, and nuclear regulations. The NMC's clean rooms meet the new requirements of the standard for Therapeutic Goods Administration, Annex 1 - Manufacture of Sterile Medicinal Products. This rating was based on the high level of air renewals per hour (over 25), air quality and cleanness during full production, and the quick (less than eight minutes) recovery time to achieve clean status after contamination.

ANTARES tandem accelerator

The Australian National Tandem Accelerator for Applied Research (ANTARES) continued to operate in a safe, reliable and efficient manner, meeting the needs of ANSTO and external users. Experimental capabilities were enhanced by the completion of the actinide accelerator mass spectrometry beamline and the heavy ion microprobe beamline. Particle beam transmission through the accelerator was significantly improved by modifying the switch magnet and re-aligning other major components in the beam transmission path. Improved stability at the accelerator's high voltage terminal was achieved through the Pelletron chains charging system, which was installed last year. A stability of 0.15 % (one standard deviation) was readily obtained over a 15-hour running period. Staff also began pursuing licensing of the facility to meet Australian Radiation Protection and Nuclear Safety Agency requirements.

Accelerator mass spectrometry

The ANTARES Accelerator Mass Spectrometry (AMS) facility analyses the long-lived radioisotopes carbon-14, beryllium-10, aluminium-26, chlorine-36 and iodine-129 for dating and tracing applications to accuracies and sensitivities comparable with those obtained at other international laboratories. Most of the AMS analyses are for radiocarbon dating and over a thousand carbon-14 samples were analysed for this purpose during the year. Accuracy for radiocarbon analysis was improved, with routine measurements of modern samples to a precision of

0.5 % (equivalent to an age accuracy of 40 years) made possible. If required, 0.4 % accuracy can be attained. Analyses in oceanography and dendrochronology typically require accelerator measurements with accuracy of better than 0.5 per cent.

ANSTO continued to contribute to Quaternary science in Australia through collaboration with university researchers funded by AINSE and the Australian Research Council (ARC). Because the Quaternary period is that in which modern humans colonised the earth, archaeology is one of the more popular disciplines pursued. Emphasis is generally on Australian Aboriginal and Pacific Island studies, but this year samples were also received from regions as far apart as Thailand, the United States, Italy and the United Arab Emirates. Studies of Australian palaeo-environments and sediments were also made to provide insights into the past climates of our continent and surrounding regions. Such information can lead to a better understanding of local and global climate change.
Water samples associated with the World Ocean Circulation Experiment were analysed as part of a project involving scientists from more than 30 nations to study the large-scale circulation of the ocean and unravel the role of ocean circulation in climate change. This knowledge will provide information on the exchange of the green-house gas carbon dioxide between the atmosphere and the oceans.

Funding from the Research Infrastructure Equipment and Facilities Scheme (RIEF) in support of research on the ANTARES AMS facility ended on June 30. This scheme, run by ARC, supported the Australian academic Quaternary community for five years. Such long-term support indicates the significance attached to the AMS facility and to Quaternary science in Australia. The funds (totalling about $1.5M over the period) were administered by AINSE and distributed via peer group review. Funding for 1998-99 totalled approximately $155,000 and provided support for 26 collaborative projects.

Ion beam analysis

ANSTO's 3 MV Van de Graaff accelerator was used to analyse more than 100 samples of quartz for the Department of Geology at the University of Tasmania, using the particle induced x-ray emission (PIXE) and proton induced gamma-ray emission (PIGME) methods. The trace elements present were used to characterise the ore bodies from which they came and to assist with testing new methods in metals exploration. Several hundred obsidian samples from Papua New Guinea and many clay pottery samples from southern Italy, together with reference standards, were analysed for the Department of Archaeology at the University of Sydney. Metallic encrusted archaeological samples from ancient Egypt were characterised for the University of Sydney and the University of Western Sydney, Nepean, to learn more about ancient manufacturing techniques.

University students attending the second AINSE Winter School held at ANSTO in July were instructed in the method of PIXE analysis using the 3 MV accelerator. This year, students were invited to submit samples for elemental characterisation using the PIXE technique and were provided with reports on their samples, illustrating the x-ray spectra and a list of the elements found.
The thin film analytical capabilities of the heavy ion time-of-flight recoil spectrometry facility on ANSTO's tandem accelerator were used to investigate the effectiveness of a newly designed selective solar absorber which is being developed by industry for solar heating. The work showed that the new design was successful, with films remaining stable up to higher temperatures than had been achieved previously. Scientists from the University of Auckland, New Zealand, visited ANSTO to participate in this work.

ANSTO's 3 MV accelerator was used to measure the natural nitrogen 15N/14N isotopic ratio in micro-samples taken from the honey possum, one of Australia's smallest marsupials. This work, carried out in collaboration with the University of Western Australia, is a first step towards establishing a non-invasive measurement of the total protein content of living animals. It will enable biologists to monitor in-the-field changes in protein content of free-ranging animals so that their well-being can be monitored in relation to available resources. The eventual aim of this project is to provide guidelines and conservation strategies for these species before they become rare or endangered.

High energy heavy ion microprobe

A new scanning system for the heavy ion nuclear microprobe on the tandem accelerator was installed, aligned and calibrated, making spot sizes below 5 μm in diameter and scanned over a 500x500 μm area, possible. ANSTO was assisted in this work by a visiting scientist from the National University of Singapore. The scanning facility was used to analyse a range of materials used in the containment of nuclear waste. These measurements allow a better

understanding of the diffusion and trapping mechanisms of critical elements such as strontium in these materials. Scientists also analysed trace elements in mineral sands as part of a project to characterise the radioactive content of these materials.

Exploratory microprobe measurements of grains in mineral sands proved successful. Information about the location, distribution and correlations of certain elements in naturally occurring minerals is important in minerals processing for the reduction of undesirable components, such as radioactivity, in the product stream. Individual grains of ilmenite were identified, and the iron and titanium composition mapped over the grain's surface. Areas of low concentrations, which corresponded to regions of silicon inclusions, were identified. Work began on obtaining a coherent picture of the matrix of mineral sands, and modifying it by chemical processing techniques.

Australian Synchrotron Research Program

ANSTO manages the Australian Synchrotron Research Program (ASRP), which provides 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 continued to operate overseas synchrotron radiation research facilities for Australian scientists. Five ANSTO staff were located overseas at these facilities to assist visiting Australian research teams; two were based at the Photon Factory in Japan and three at the Advanced Photon Source (APS) in the United States.

The ASRP successfully negotiated with the Photon Factory to obtain preferential access for Australian scientists to a soft x-ray beamline. Since June, an Australian post-doctorate, funded by the Photon Factory for the first 12 months, has been stationed at the Photon Factory to assist Australian users of the beamline. This new access for soft x-ray users is a valuable addition to the program; previously it catered almost exclusively for hard x-ray synchrotron users.
A group led by Professor Veronica James from the Australian National University published evidence of a possible link between breast cancer and changes in the x-ray scattering pattern of hair. This result is based on small angle scattering measurements from single human hairs. The bulk of the work was done at the Photon Factory beamline 15 and the ANBF and was funded by the ASRP. Dr David Cookson, the ASRP staff scientist now attached to the Chemistry and Material Sciences Consortium for Advanced Radiation Sources at the APS, was primarily responsible for obtaining the x-ray scattering images used for this work.

ASRP staff led the task of preparing the proposal for an Australian synchrotron facility. ANSTO members took responsibility for specifying the beamlines and insertion devices for the proposed facility, and preliminary specifications were produced for four insertion devices and nine beamlines.
The ASRP operates a post doctoral fellowship scheme to foster synchrotron radiation based research in Australia. The third ASRP post doctoral fellowship was awarded to the University of Melbourne in December. The successful candidate will conduct research into spatial coherence of x-rays from the APS insertion devices.

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 the ANSTO Physics, Materials and Environment Divisions. The most demanded techniques continued to be x-ray absorption fine-structure spectroscopy (XAFS) and powder diffraction, with growing use of surface diffraction and small angle scattering. The ANBF continued to attract new synchrotron users, with eight first-time groups using the facility for very diverse projects ranging from archaeology to polymers and high temperature super conductor studies.

A helium refrigerator cryo-sample stage was installed at the ANBF in May to allow XAFS data to be measured at temperatures as low as 10 kelvin. This cryostat was fully commissioned during the year, leading to a significant improvement in the data obtained from suitable samples. A highlight was the first reported XAFS study of chromium (IV) compounds by Professor Peter Lay from the University of Sydney and Dr Garry Foran from the ASRP. These compounds have been shown to react readily with DNA and have been implicated in chromium (IV) carcinogenicity.

The Advanced Photon Source, Argonne National Laboratory

The Australian Synchrotron Research Program (ASRP) maintains facilities with three Collaborative Access Teams (CATs) at the APS 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. A total of 13 Australian proposals for beamtime were accepted, including four from ANSTO. The ASRP used all the access time allocated on SRI-CAT. Access to the microprobe beamline, which is in high demand from many non-traditional synchrotron research fields such as environmental science and cell biology, was continually oversubscribed. The three BioCARS protein crystallography beamlines are now operational and were used for 15 Australian experiments during the year. Two protein structures were solved by Australian groups using data obtained at BioCARS.

Construction of the ChemMatCARS beamline facilities neared completion. All major beamline components were received and their installation begun. White undulator radiation was admitted to the experimental stations for the first time and beamline radiation checks were completed. The first experiments are scheduled for late 1999. A collaboration between the Australian National University, ANSTO, and the University of Queensland was successful in obtaining an ARC grant to construct a novel time-resolved reflectometer for the ChemMatCARS beamline.

Waste operations and technology development

A new section, Waste Operations and Technology Development, was formed. It incorporates routine waste management operations and the Waste Management Action Plan and will provide a focus for the development and practical demonstration of waste management technologies.

During the year ANSTO undertook further measures to identify and eliminate unnecessary releases of radioactivity into the site wastewater system. Improvements were also made to the chemical treatment operations for site wastewater. Together, these initiatives reduced the average levels of radioactivity in the effluent discharged from the site. These levels were already well below the limits specified in the Trade Waste Agreement with Sydney Water.

Honours student Carmel Rainbow from the University of Wollongong. ANSTO scientists in collaboration with students from Wollongong are studying catchments in the Blue Mountains. The use of naturally occurring radioactivity enables environmental scientists to unravel the timing and extent of catchment disturbance by humans and natural processes. Present levels of nutrients and metals are compared with radiometrically dated old sediments, dating from before the arrival of European-Australians in the area.

APPLICATION OF NUCLEAR SCIENCE AND TECHNOLOGY TO THE UNDERSTANDING OF NATURAL PROCESSES

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.

OBJECTIVES

To apply nuclear-based techniques to research projects in support of national and international programs, such as investigations of global climate change and environmental pathway analysis, and to applied studies driven by industry and government.

Visiting IAEA fellow Fe Dela Cruz spent 6 weeks at ANSTO working on a project to measure radon emission from soils. The project will assist the Philippine Nuclear Research Institute in evaluating the potential hazard from waste materials, in particular, those associated with the plaster board industry.

OUTCOMES

- Measurements by ANSTO of the 'radiocarbon bomb pulse', caused by atmospheric nuclear weapons tests during the 1950s and 1960s and trapped as carbon-14 dioxide in the Antarctic ice, has enabled CSIRO to refine numerical models which describe the trapping of air as bubbles in ice. This has lead to improvements in the interpretation of the record of trace gases and isotopic species at Law Dome. As part of this project, ANSTO is participating in a unique collaborative experiment that will provide the first direct determination of the anthropogenic contribution to the global atmospheric methane budget.
- New information on glacial chronology of the Southern Hemisphere during the Quaternary period became available following analysis by ANSTO of long-lived radionuclides in surface rock from Tasmania, New Zealand and Antarctica. Such information will benefit the understanding of the timing and intensity of past glacial climate change.
- New methods based on a combination of ion beam and synchrotron radiation techniques were applied to determine concentrations of arsenic and other toxic elements in sub-micro atmospheric particles, enabling ANSTO to distinguish between atmospheric pollution from coal combustion and that from other sources, such as automobiles.
- A reconstruction of vegetation and climate change over the past 200 000 years along a transect from Indonesia to Antarctica was made using measurements of fossil pollen and carbon-13 in sediment cores. This study, involving the application of nuclear techniques to understanding global climate change, has been undertaken by ANSTO in collaboration with the University of Adelaide, Monash University, the University of Tasmania and the University of Wollongong.
- ANSTO used its unique capability for studying the behaviour of sewage released from ocean outfalls by combining radiotracer techniques with particle characterisation methods to develop a model to enable environmental authorities to predict, for any oceanographic condition, the level of pollution in the vicinity of an ocean outfall.
- A study for Environment Australia on the bio-accumulation of lead and other metals, as measured by sensitive isotopic methods, by estuarine crocodiles in Kakadu National Park found crocodiles that had eaten waterfowl shot with lead ammunition had elevated lead levels that could be toxic and might even cause death. Statistical analyses of metal levels in 40 crocodiles also demonstrated water catchment-specific signatures in their bone structures (osteoderms), illustrating the value of the crocodiles as indicators of environmental exposure.
- The international study of large scale air movements benefited from the additional data provided by ANSTO's two new radon measuring stations in the Southern Hemisphere (at Cape Point, South Africa, and on Rottnest Island, Western Australia). ANSTO now has a network of eight such measuring stations.

ACTIVITIES AND OUTPUTS

Environmental dynamics - application of nuclear techniques

ANSTO continued to investigate the behaviour of particles of sewage material discharged via coastal outfalls. Because particles tend to aggregate as the freshwater plume mixes with seawater, the ultimate fate of the particles depends not only on transport processes near the discharge point, but also on the formation rate, resultant sizes and particle densities, which affect buoyancy and settling rates. The interaction of these processes is extremely complex. ANSTO undertook research to extend modelling strategies and incorporate these phenomena. The work involved a combination of modelling, laboratory studies and field studies carried out in collaboration with the Water Research Laboratory of the University of New South Wales and the Hunter Water Corporation. A major field experiment involving both radiotracer and oceanographic inputs was undertaken at Burwood Beach sewage outfall near Newcastle, NSW.

ANSTO, under contract to the Water Research Laboratory of the University of New South Wales, undertook an investigation of sewage dispersal from the Pillar Point outfall in Hong Kong. The project was undertaken in collaboration with Montgomery Watson (Hong Kong) for the Hong Kong Environment Protection Department. ANSTO carried out a systematic study of the dispersion of tritium and gold-198, the results of which are being used in the validation of predictive models of the area.

Global climate change - application of nuclear techniques

ANSTO is coordinating and participating in four strategic research projects aimed at contributing, through the use of nuclear techniques, to the knowledge of climate change over the past 500 000 years, thus providing a basis for predicting future changes. The projects were launched in 1996-97 and are of three-year duration.

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

This collaborative project combines ANSTO's capabilities for accelerator mass spectrometry (AMS) studies with the CSIRO's expertise in studying atmospheric trace gas histories and the Australian Antarctic Division's knowledge of the Antarctic ice sheet. The broad objectives of the project are to refine knowledge of the trapping and diffusional processes, to determine the anthropogenic contribution to the global atmospheric methane budget and to determine the relationship between solar activity and historical climate change in the Southern Hemisphere.

In 1997 a joint expedition to Law Dome, Antarctica, collected samples of ice and firn (the porous layer of packed snow above the ice). Large quantities of air from earlier this century were extracted from the firn, and analysis of this air was begun.

During the year ANSTO's AMS group continued to analyse the air samples, using the ANTARES accelerator. This work is providing the first accurate determination of the anthropogenic contribution to the global atmospheric methane budget. It involves measurement of the carbon-14 content of methane extracted from large volumes of air that was trapped in the firn and that pre-dated nuclear reactors and atmospheric nuclear weapons tests. Aspects of the project have helped stimulate the development of ultra-small radiocarbon sample measurement capability at ANSTO. This has allowed the preparation of targets and measurement of their radiocarbon content for samples containing as little as 10 micrograms of carbon extracted from air trapped as bubbles in the ice.

By comparing the measured radiocarbon bomb pulse trapped in the ice with the known atmospheric signal it is possible to 'tune' the numerical model which describes the diffusion and trapping process. This was done at three different sites at Law Dome. Additionally, techniques were developed (in collaboration with the National Institute of Water and Atmospheric Research, New Zealand) for extraction of carbon-14 monoxide gas from firn air samples, permitting direct evaluation of in-situ carbon-14 production in the ice matrix.

Measurement of the beryllium-10 content from three sites that have a large variation in snow accumulation enabled scientists to determine the factors that affect transport and accumulation of beryllium-10 into the ice sheet. This has allowed an evaluation of the beryllium-10 signal as an indicator of historical snow accumulation rates.

Southern Hemisphere glaciation studies

In this project, the ANSTO AMS group successfully applied the technique of surface exposure dating with in-situ cosmogenic radionuclides to improve the glacial chronology of the Southern Hemisphere during the Quaternary period.

Production of the long-lived cosmogenic radionuclides beryllium-10, aluminium-26 and chlorine-36 in exposed surface rocks can be utilised as radiometric clocks to reveal the exposure history of geomorphic formations that have experienced some event or process that delivers previously unexposed material to cosmic ray irradiation. Knowledge of the chronology of glacial advance and retreat, and of ice volumes and position, is vital to understanding past global climate change initiated by glacial dynamics.

The work combines the AMS capability at ANSTO

with collaborative expertise in the earth sciences at the universities of Melbourne, Auckland, Tasmania and New England, and in the Australian Antarctic Division.

A fully equipped geochemistry laboratory was developed for the difficult and complex task of processing and preparing in-situ AMS rock samples, and AMS techniques were developed at ANTARES to measure the three radionuclides involved with the necessary reproducibility and sensitivity.

Three regions were targeted - Tasmania, New Zealand and Antarctica. The glacial history of the Tasmanian ice cap in the Central Plateau and its piedmont glacier systems on the west coast ranges tend to archive regional climatic effects. The exposure ages indicate a complex series of glacial cycles over the past 800 000 years and the last glacial maximum at about 20 000 years. The Younger Dryas is a major short-term climatic reversal superimposed on the last deglaciation between 11 000 and 13 000 years ago and appears throughout climatic records in the Northern Hemisphere. Evidence for such a reversal in the Southern Hemisphere is equivocal. Preliminary results suggest the appearance of a Younger Dryas signal at 13 000 years ago in Tasmania.

Exposure ages from the Prince Charles Mountains at Lambert Glacier, whose advances and retreats reflect changes in the volume of the East Antarctic Ice Sheet, will add to an understanding of the Pliocene history of the ice sheet. Ages range from 2.4 million years at mountain peaks 1300 m above the ice level to 20 000 years at moraine deposits near the coast at Radok Lake. These data indicate that these peaks emerged above a lowering ice sheet approximately 2 million years ago and that glacier ice persisted at the coast up to 20 000 years ago.

Studies of high resolution terrestrial sediment records to determine paleoclimatic conditions

The global climate change project is a collaborative project instigated and coordinated by ANSTO with collaboration from the University of Adelaide, Monash University, the University of Tasmania and the University of Wollongong. The main objective is to reconstruct vegetation and climate change over the past 200 000 years along a transect from Indonesia to Antarctica.

Seven sites were selected for the project - one from Indonesia, five from north eastern and south-eastern Australia and one from Antarctica. Microfossil records of past changes in vegetation, climate and Antarctic sea and ice conditions from these sites were provided by researchers from the collaborating universities. Chronologies for the records were determined at ANSTO using techniques based on the analysis of the naturally occurring radioactive isotopes uranium/thorium, lead-210 and carbon-14. These studies were complemented by studies of incremental changes in the concentrations of the stable isotopes carbon-13 and oxygen-18, as part of a joint project between ANSTO and Wollongong University.

Estimated climate reconstructions were made from the records from Indonesia and northeastern Australia based on trends in the fossil pollen and carbon-13 records of change. Semi-quantitative reconstructions of major rainfall changes for three sites in south-eastern Australia were made by the team at ANSTO, in collaboration with researchers from Monash University, using modern vegetation and rainfall patterns as analogues. When coupled with the oxygen-18 records of past water temperatures derived from two of these sites, these will provide one of the most complete histories of past climates over the past 200 000 years yet determined for the region. Quantitative estimates of palaeoclimates and changing Antarctic ice and sea conditions were made by researchers in the University of Tasmania.

The project is now in its final stages, with results from the seven sites along the transect now being compared and correlated. The findings of the project will be presented at a major international conference in South Africa in August 1999.

Global baseline pollution

The aim of the global baseline air pollution project is to improve the prediction of future climate change through the study of baseline atmospheres. ANSTO has radon measuring equipment in a network of eight radon-measuring stations that are used in tracing global scale air mass transport.

During the year, two stations were upgraded. At Macquarie Island, the electronics and sampling equipment were refurbished and software installed to allow remote computer access, and at the Mawson Base in Antarctica air intake and flow measurement equipment was installed.

As part of a collaborative project with the Bureau of Meteorology and CSIRO Atmospheric Research at the Cape Grim Baseline Air Pollution Station, measurements were made of the seasonal variation of radon flux in western Tasmania. The work improved the accuracy with which radon can be used as a tracer for the study of transport and the production of other gas species.

Elemental fingerprints of fine particles were measured for air samples characterised by radon concentration and wind sector at Cape Grim. Scientists began using these to analyse samples taken over the past six years, with the aim of determining the anthropogenic component of baseline atmospheric pollution.

Atmospheric fine particle aerosol research

Experiments performed at the Synchrotron Radiation Instrumentation Collaborative Access Team's (SRI-CAT's) facility were successful in detecting, for the first time, very low levels (parts per million) of arsenic and selenium and other trace elements in sub-micron atmospheric particles, in the presence of large concentrations of lead and bromine. This work will enable trace element fingerprints related to automobiles and to coal combustion to be better separated.

A two-year study of fine particle pollution in New Zealand, carried out at several sites including Wellington, Auckland and Christchurch, was completed. Scientists were able for the first time to quantify the contribution from wood fire burning in the winter to atmospheric pollution. Other local council areas in New Zealand have expressed interest in the results and further studies are anticipated. The study was funded by the New Zealand National Institute of Water and Atmospheric Research.

Laboratory quality assurance

The ANSTO analytical chemistry laboratories undertake national and international round-robin exercises as part of the laboratories quality assurance program. In the latest exercise, which was on analysis of water and sediments, the ANSTO laboratories gained the 'Superior' rating from the internationally regarded US National Oceanographic and Atmospheric Administration.

Applications of radon expertise

The South African Weather Bureau took delivery of an ANSTO baseline radon detector. The project was funded jointly by the Bureau and the Fraunhofer Institute for Atmospheric Environmental Research. AusAID met the cost of a visit by an ANSTO officer to install the instrument and train personnel. This increased to eight the number of instruments in the network of radon stations with which ANSTO is involved.

To ensure that the instrument calibrations are referenced to an international standard, ANSTO designed a highly accurate calibration system. This can be used in the field and incorporates a facility to take radon samples from a test source at the remote station. These samples can subsequently be analysed at ANSTO. The cost of the procedure is low enough to permit regular intercomparisons.

An AINSE grant was awarded to support collaboration between ANSTO and Sydney University on the sources and transport of radon in the Jenolan Caves. These measurements demonstrated how the radon concentrations changed under different weather conditions and enabled the doses to cave workers and visitors to be assessed.

Coastal and marine chemistry

The Tropical River-Ocean Processes in Coastal Settings (TROPICS) Project is an international study of processes occurring as tropical rivers flow into the ocean. It has implications for the Great Barrier Reef and involves the Australian Institute of Marine Science, ANSTO, CSIRO, James Cook University and scientists from Japanese and US research organisations. As a contribution to this project, ANSTO is using naturally occurring radioisotopes to investigate the effect of coastal oceanographic processes on the ocean flux of terrestrial material. A monsoon season expedition to the Fly, Kikori and

Purari Rivers in Papua New Guinea was undertaken in January and an expedition to revisit the Sepik region is planned for early 2000. Uranium series isotopes (uranium-238, thorium-234, radium-226, radium-228 and lead-210) were used to determine the rates of transportation of sediments from rivers into the ocean. The chemical oxidation state of the iron and manganese in river particulates was successfully measured using synchrotron radiation at the Australian National Beamline Facility in Tsukuba, Japan. This work improved understanding of the role of iron and manganese as scavengers for contaminants.

Field data collected from the Gulf of Papua showed elevated levels of six trace elements in water with decreasing biological productivity. These findings may be relevant when assessing the environmental implications of declining marine productivity, predicted to arise from enhanced sea surface temperatures associated with global warming.

Secondary Ion Mass Spectrometry

Secondary Ion Mass Spectrometry (SIMS) is an ultra-sensitive technique for determining the isotopic composition of materials on a micro-scale. It is used at ANSTO to study a wide variety of materials, including nuclear wasteforms, minerals and biological samples. ANSTO's unique facility is made available to universities through the Australian Institute of Nuclear Science and Engineering (AINSE).

ANSTO work using SIMS included characterising the lead-208 distribution in crocodile osteoderms sampled from the Kakadu National Park in the Northern Territory; analysing thin films deposited on ceramic substrates as a means of assessing the low temperature joining of dissimilar materials; and investigating small-scale fluctuations in sulphur-34 within sediment-hosted sulphide deposits. The latter was part of a project to determine the mobility of sulfate and the associated environmental generation of acid in sulfidic mine wastes.

During the 1998 calendar year (the university year), 14 university researchers accessed the SIMS facility and all projects were completed. Two collaborative papers went to press and five papers were submitted. Work began on 17 projects approved for 1999. Four commercial projects for industrial clients were also successfully completed.

TREATMENT AND MANAGEMENT OF MAN-MADE AND NATURALLY OCCURRING RADIOACTIVE SUBSTANCES

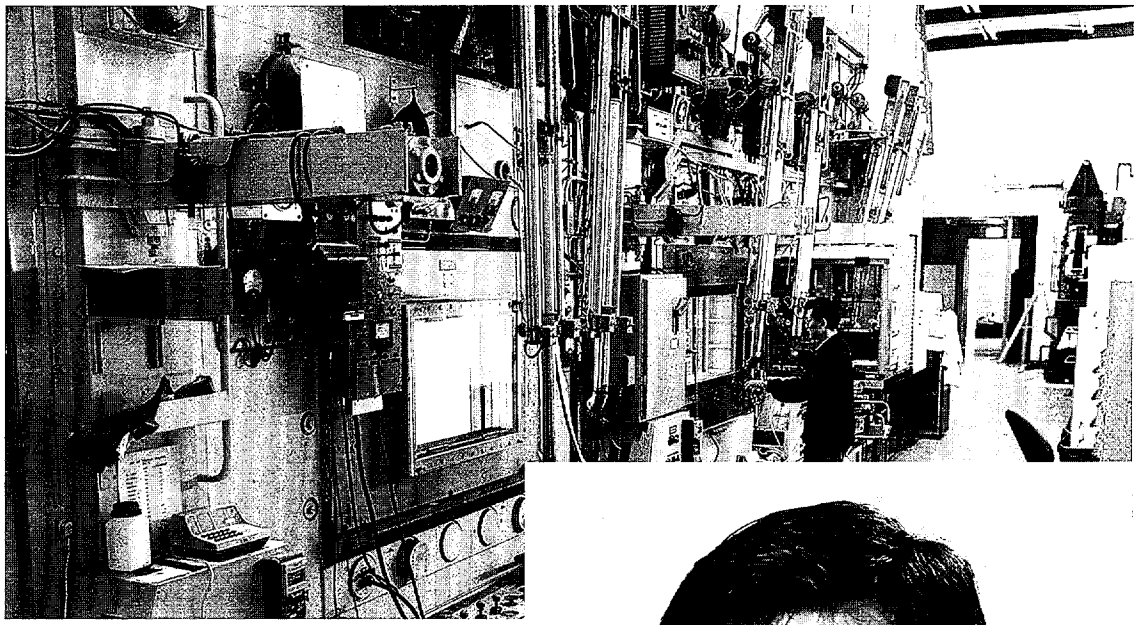
Drivers: Government, ANSTO and industry

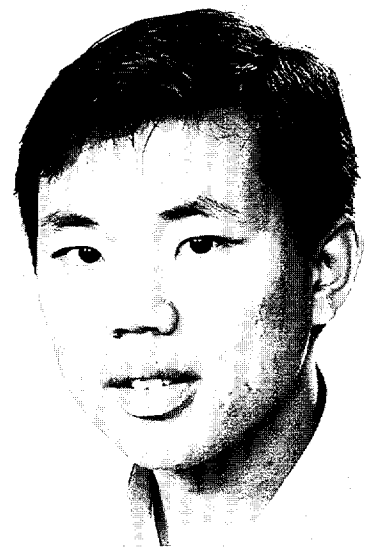
OBJECTIVES

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

(b) To refine or develop new technological approaches for immobilisation and disposal of radioactive waste and minimisation of environmental contamination from the nuclear and mining industries.

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





Jerry Sunarho, a year-in industry student from the University of NSW, is assisting with the operation of a hot cell plant to solidify liquid waste arising from the production of molybdenum-99.

OUTCOMES

- ANSTO successfully completed two projects that will help position the organisation to participate in significant implementation projects with the US Department of Energy. The first was a major contract from Lawrence Livermore National Laboratory to define the compositional and process envelope of the synroc-based titanate ceramic chosen by the US Department of Energy for plutonium immobilisation. The second involved a successful demonstration of ANSTO's proprietary hot-isostatic pressing cans with Argonne National Laboratory radioactive wastes. This was carried out in a remotely controlled hot cell environment under a Cooperative Research and Development Agreement.
- The collaborative research program with the Japan Atomic Energy Research Institute at Tokai-mura on the use of synroc for high-level and actinide-rich wastes was concluded and final reports issued. This 14-year collaboration produced important results on radiation damage effects from alpha-radiation decay and provided independent confirmation of the value of synroc as an advanced second-generation wasteform.
- An amendment to expand the scope of the collaboration agreement with the French Atomic Energy Commission was signed, opening up opportunities for further synroc application projects.
- A kinetic model was developed to describe the leaching of uranium and copper minerals in metallurgical plants. Application of this model has the potential to improve process efficiency and environmental management by reducing the use of chemicals in mineral treatment plants.
- A leaching process was developed to upgrade copper concentrates at a mine site by extracting uranium and iron with minimal dissolution of copper.
- The final volume of a report on the natural analogue study of the Koongarra uranium deposit in the Northern territory was completed during the year. This volume summarised the findings of the interdisciplinary scientific study of the site, and emphasised parallels between the geochemical processes occurring at Koongarra and similar phenomena which are relevant to the safety of radioactive waste repositories.
- A hot cell plant to solidify intermediate level liquid waste from molybdenum-99 production was commissioned and began routine operation. Six hundred litres of this waste were processed and solidified, thus reducing ANSTOs inventory of liquid waste.
- A full-scale experimental rig was designed and built to immobilise the intermediate level liquid waste in a highly durable, ceramic wasteform similar to synroc. Trials involving simulated, non-radioactive wastes were commenced.
- Routine monitoring of ANSTO's spent fuel storage facilities confirmed that these facilities continued to isolate spent fuel from the environment.

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. ANSTO is participating in the implementation of the US plutonium disposition program 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 (ANL) and the Pacific Northwest National Laboratory (PNNL).

The organisation's most recent LLNL contract, completed on time and on budget, further defined the compositional and process envelope of the titanate ceramic wasteform for this application. This forms part of the wasteform qualification process

necessary for regulatory acceptance for disposal.

ANSTO's contribution to work leading to regulatory acceptance will open up further prospects for the deployment of synroc-based titanate ceramics in other radioactive waste remediation projects in the United States. With this in view, ANSTO is well advanced in developing alliances with nuclear engineering companies in preparation for joint bids for design and construction contracts for US waste remediation projects.

Two other collaborative projects with USDOE Laboratories continued. In the first, under the Co-operation Research and Development Agreement with Argonne National Laboratory-West (ANL-West) in Idaho, the use of ANSTO's proprietary hot-isostatic pressing cans was successfully demonstrated with ANL wasteforms in a remotely controlled hot cell environment at a commercial scale. During the second half of 1999, ANL will demonstrate the production of a synroc wasteform using these cans in the same hot cell environment.

In the second, ANSTO is participating in a USDOE environmental management basic science research project managed by PNNL, with involvement by the University of Michigan and the Lawrence Livermore National Laboratory. The project aims to provide basic knowledge about the solubility of radionuclides and neutron absorbers in a range of wasteforms. This will provide a technical and scientific basis that can be used by the USDOE Environmental Management Program to evaluate and select appropriate wasteforms for legacy wastes from past defence programs.

Collaboration with the French Atomic Energy Commission (CEA) intensified following the strengthening of an ANSTO/CEA agreement with provisions for intellectual property sharing and arrangements for commercial exploitation of jointly developed technologies. The collaboration aims to develop synroc/glass composite wasteforms by exploiting synergies between ANSTO's synroc formulation capabilities and the CEA's cold-crucible technology. In April, ANSTO staff accepted an invitation to participate in a two-day workshop at CEA-Saclay on scientific aspects of actinide waste immobilisation in ceramics. This followed the visit to ANSTO by CEA colleagues in December for discussions and review of the collaborative program.

Development of the synroc process technology was enhanced by commissioning ceramic powder blending/milling equipment to support the United States plutonium immobilisation project. A laser dilatometer was commissioned and has provided valuable data on the sintering of pyrochlore-rich ceramics. A cold-crucible melter, based on a design obtained from the CEA under the collaborative program, was constructed for testing synroc/glass formulations.

Work continued on the development of synroc compatible inorganic ion exchangers for removing caesium and strontium from acidic, radioactive waste streams such as the tank wastes from molybdenum-99 production at ANSTO. Scientists have developed a family of such ion exchangers that exhibit good selectivity for both caesium and strontium under acidic solutions. Under comparable conditions, competing commercial ion exchanger technologies are capable of removing either caesium or strontium, but not both.

An advanced field emission electron microscope equipped with full analytical facilities was commissioned. This facility provides atomic resolution and crystal chemical information essential for the study of actinide elements in radioactive wasteforms. It is expected to assist greatly in the formulation and development of synroc for specific wastes and in the study of alteration processes of wasteforms immersed in aqueous media, required as part of the waste qualification process. A senior scientist from the Argonne National Laboratory in Chicago in the United States visited ANSTO for two weeks in March to perform experiments on the microscope.

ANSTO's synroc 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 Argonne National Laboratory, Chicago, the United States, and the Stanford synchrotron facilities, also in the United States.

A senior scientist from ANSTO's Materials Division accepted an invitation to join an Australian delegation to a workshop on 'US Asian Pacific

materials research, technology and education for the 21st century in the service of society' in Hawaii in November. The workshop was sponsored by the US National Science Foundation and supported by the science agencies of the participating countries. Participants discussed possible areas of joint research, networking and cooperation among individual research groups, centres and institutions in Pan Pacific countries, and mechanisms to foster greater cooperation.

Cement wasteforms

Cement-based wasteforms are widely used overseas to encapsulate low and intermediate level radioactive wastes. Studies at ANSTO on cement microstructure using small angle neutron and x-ray scattering neared completion. The appropriate neutron and x-ray facilities were not available in Australia, but access to overseas facilities was provided by a grant from the Department of Industry, Science and Resources under the International Research Collaboration grant scheme. It was decided that future activities on cement wasteforms would focus on their use to encapsulate historic wastes at ANSTO as part of the organisation's Waste Management Action Plan.

Waste Management Action Plan

ANSTOs Waste Management Action Plan was initiated in 1996. It involves upgrading waste management facilities, minimising the quantities of radioactive waste generated and converting stored waste from past operations into stable solids for disposal or long-term storage at the proposed national radioactive waste repository. The remaining intermediate-level waste will be suitable for long-term storage in an above-ground facility at the repository.

Solid waste management

ANSTO is systematically measuring the radioactivity in its accumulated solid wastes in order to produce a precise inventory of waste materials destined for the national radioactive waste repository. Over 80% of ANSTO's 5000 drums of low level radioactive waste have now been scanned using a high sensitivity gamma assay system. The drums have been barcoded, and their radioactivity and other details entered in a computerised database. The majority of the drums satisfy the least restrictive waste criteria (Category A) in the National Health and Medical Research Council's 'Code of Practice for the Near-Surface Disposal of Radioactive Waste in Australia'. The remainder are classified as Category B. Category A and B wastes are suitable for disposal in the national waste repository.

During the year, ANSTO commissioned a second gamma scanning system that allows measurement of non-standard containers with a wide range of radioactivities.

Drums containing thorium hydroxide residues stored at ANSTO for almost 30 years were repackaged into new, 200-litre galvanised drums. These had been painted internally with epoxy paint and fitted with heavy polyethylene liners. The redrumming was necessary because some of the drums were showing signs of corrosion. All the new drums were barcoded, renumbered, placed on new pallets and returned to the storage facility.

Liquid waste management

Over the past 31 years ANSTO has accumulated about 7000 litres of liquid waste arising from the production of molybdenum-99 for radiopharmaceutical production. Two years ago, ANSTO began developing a process to solidify this intermediate level waste, and this year the process progressed from commissioning to routine operation.

The process, carried out in a hot cell, involves concentrating the liquid waste through evaporation, treating it to destroy the ammonium ions and then solidifying the end product.

Before the plant was put into operation, the mechanical and electrical equipment, ventilation and fire suppression systems in the hot cell were upgraded. The commissioning phase involved operating the plant first with non-radioactive waste and then with waste containing tracer levels of radioactivity. The commissioning trials provided valuable information on the distribution of radioactivity in the various process streams.

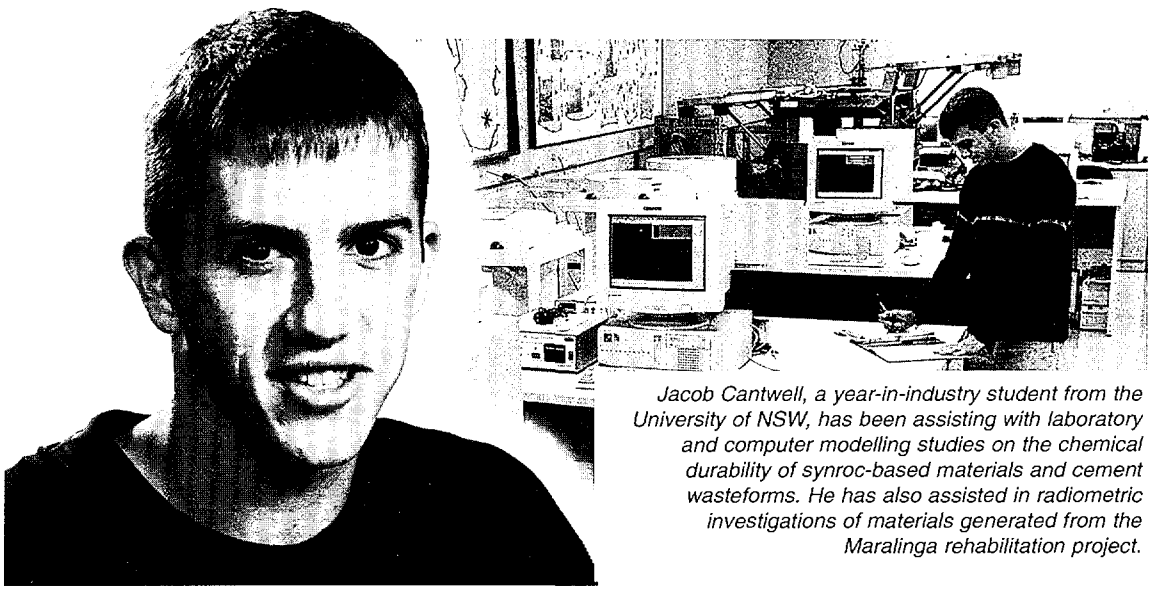
Safety staff undertook a hazard operations analysis, completed safety documentation to ISO 9000 quality management standards and developed and implemented a training program for staff operating the plant.

Following the plant's commissioning, processing of actual molybdenum-99 waste began using liquid from the tank with the lowest level of radioactivity. By the end of June, 600 litres of liquid waste had been processed through the hot cell plant. The solid waste from this plant is suitable for interim storage for up to 50 years.

At the same time, work continued on a project to convert this interim waste into a highly durable ceramic wasteform, similar to synroc, that is suitable for long-term storage or disposal. During the year, a full-scale experimental rig to carry out this operation was designed and built. Demonstration trials using simulated (non-radioactive) waste were begun. The results from these trials will be used to provide engineering data for the design of a plant suitable for installation in a hot cell.

Monitoring of spent fuel storage facilities

Routine monitoring of spent fuel storage facilities continued. Sixteen of the 50 tubes in the in-ground storage facility were emptied of fuel and visually examined. In all cases the tube liners were found to be in good condition. Krypton-85 analysis of the storage tubes, undertaken to provide information on the integrity of the cladding of stored fuel elements, showed that krypton-85 levels were below the limit of detection for all tubes. Further examination of fuel elements has identified minor degradation of the cladding on two elements. These elements were subsequently placed in specially designed stainless steel cans.



Jacob Cantwell, a year-in-industry student from the University of NSW, has been assisting with laboratory and computer modelling studies on the chemical durability of synroc-based materials and cement wasteforms. He has also assisted in radiometric investigations of materials generated from the Maralinga rehabilitation project.

Waste water

Planning began for a new facility to treat ANSTO's wastewaters, scheduled to be operational in 2001/2002. Preliminary assessment indicates that it may be possible to remove almost all radionuclides except tritium from the water. The strategy for tritium reduction is based on segregation at the primary source to limit release into the wastewater system. It should also be feasible to re-use the purified water on the ANSTO site.

The seven flasks used for above-ground dry storage of 175 spent fuel elements were also monitored. Krypton-85 was detected in one flask, but at very low levels. Spent fuel from three of these flasks is scheduled for removal and inspection in the next financial year, and inclusion in the next overseas shipment for reprocessing. The flasks will be decommissioned once the spent fuel has been removed for shipment.

Waste minimisation

One of the objectives of ANSTO's waste management policy is 'minimisation of radioactive waste generated and stored'. To further this objective, a waste minimisation working party was

established with the goal of minimising radioactive waste generation through segregation at source, volume reduction and cleaner production technologies.

For many years, ANSTO has generated uranium and thorium scrap metal through machining operations used to manufacture containers for radioisotopes. The scrap material was converted to a stable form by calcination as part of the Waste Management Action Plan. In order to prevent accumulation of large quantities of such materials in the future, two measures were taken. In some applications, machined uranium metal sleeves that require no further machining were purchased. In other applications, heavy metal alloys were used as a substitute.

Contaminated equipment stored for many years is being progressively decontaminated. After health physics monitoring, most of the decontaminated items are suitable for disposal as non-radioactive waste. This measure, which will continue over the next few years, has resulted in a 70 per cent reduction of waste volume. The remaining contaminated material is drummed and stored, awaiting shipment to the planned national low level waste repository.

Waste generation processes in molybdenum-99 production were reviewed and possible strategies suggested to reduce the volume and radioactivity of the solid, liquid and gaseous wastes.

HIFAR spent fuel

ANSTO is implementing its strategy to reduce the inventory of spent fuel in interim storage at Lucas Heights in line with Government decisions on this issue.

HIFAR spent fuel rods cannot be stored indefinitely in unprocessed form as their aluminium cladding will eventually corrode, making them unsuitable for long-term storage or ultimate disposal. They must eventually be processed into a stable wasteform. Half the original uranium in the spent fuel is unused and can be recovered. The accepted international management procedure is to reprocess the spent fuel, extracting the unused uranium for re-use. This leaves a radioactive residue that can be incorporated into a stable form suitable for long-term storage or disposal.

The Government decided in 1997 that the best management option for the spent fuel rods from the HIFAR research reactor was to ship them overseas. An amount of $88 million was allocated for this purpose. This decision involved repatriating all 689 spent fuel rods of US origin to the United States under the Department of Energy Foreign Research Reactor Spent Fuel Acceptance Program. No waste is to be returned to Australia. A shipment of 240 spent fuel rods was sent to the United States in April 1998. When making its 1997 decision, the Government also decided that it would send the UK-origin spent fuel produced until the closure of HIFAR (about 1300 rods) to the United Kingdom (Dounreay) for reprocessing. Previous shipments had been sent to Dounreay in 1963 (150 rods) and 1996 (114 rods). However, in June 1998, the UK Government announced that the Dounreay facility would not accept any more commercial reprocessing contracts.

ANSTO reached agreement this year with the French company Cogema for the reprocessing of UK-origin HIFAR spent fuel. The arrangements encompass four shipments of spent fuel from Australia to France by 2004, its reprocessing, and the eventual return of the intermediate level reprocessing waste to Australia in a single shipment around 2015. This waste, and that from the 1996 reprocessing of HIFAR spent fuel at Dounreay, will be a small addition to Australia's existing inventory of long-lived intermediate level radioactive waste to be stored at the planned national Category S waste store. The waste will not return to Lucas Heights. The full program of overseas shipments, including those to France, has been subjected to environmental assessment and approval under the Environment Protection (Impact of Proposals) Act 1974.

The arrangements with Cogema include provision for the reprocessing of spent fuel from the replacement research reactor.

As at 30 June 1999, Australia holds some 1460 spent fuel elements in interim storage at Lucas Heights.

Certification of the LHRL-120 spent fuel cask, used to transport spent HIFAR fuel elements overseas, was extended to allow the cask to be used for a wider range of fuel types. This involved revising the

shielding and criticality calculations and the relevant sections of the Safety Analysis Report, and then negotiating with the Australian competent authorities to obtain the required certificates of approval.

Electronic control and monitoring equipment was installed in the spent-fuel element transfer flask to improve reliability and safety.

National Radioactive Waste Repository

The project to site and establish a national repository in Australia for the disposal of radioactive waste is managed by the Department of Industry, Science and Resources. ANSTO is represented on the Repository Technical Assessment Committee and on the Technical Advisory Group. ANSTO provides technical support on international facilities and practices and on technical issues concerning the movement of radionuclides in the environment. A paper jointly authored by ANSTO and the Bureau of Resource Sciences on the site selection was presented at an international conference.

A collaborative CSIRO/ANSTO study investigated water movement and radionuclide retardation in unsaturated soils in the arid zone. The results of this study were used by the repository technical assessment group in assessing potential sites for siting the national repository.

Maralinga

ANSTO scientists measured the concentration of radionuclides and non-radioactive elements in samples taken from full-scale in-situ vitrification melts on pits containing contaminated materials at Maralinga in the area previously used for weapons testing. These data allow the contractor, members of the Maralinga Technical Advisory Committee and officers from the Department of Industry, Science and Resources to assess the volume of materials melted, the melt homogeneity and the total amount of plutonium and americium contained in the pits.

Uranium ore processing

A collaborative project was completed with a major mining company to develop a better understanding of the complex factors controlling the dissolution of uranium and other minerals in leaching circuits. A kinetic model to describe the leaching of uranium and copper minerals was developed. The model predicts the consumption of chemical reagents as a function of leaching conditions and ore composition. ANSTO scientists used scanning electron microscopy with an analytical microprobe to follow the progress of the dissolution of the individual minerals and acquire data for the leaching model. This project has identified several operational strategies with potential to increase metal recoveries and improve environment management by reducing the consumption of chemicals.

At one mining operation, a copper/uranium ore is treated by flotation to produce a copper sulfide concentrate, which is smelted and refined to cathode copper on site. About 10% of the uranium in the ore ends up in the copper concentrate. The concentrate is currently leached in a dedicated circuit to remove the contained uranium before smelting. In addition to removing most of the uranium, the leaching process upgrades the concentrate as a significant amount of the iron is also dissolved. Research to determine the optimum leaching conditions for the removal of uranium and iron, with minimal dissolution of copper, was completed. Conditions that produce substantial upgrading of the concentrate were defined and further work is proposed to better understand the complex reaction system.

A joint paper with Energy Resources of Australia and WMC describing recent initiatives to improve tailings and water management in the expanding Australian uranium milling industry was presented at an IAEA Technical Committee held in Vienna. Two papers were also presented at the first progress meeting of an IAEA Co-ordinated Research Program on 'Treatment of liquid effluents from uranium mines and mills during and after operation', held in Hungary. The papers describe ANSTO research on improved treatment processes for waste liquors and bacterial sulfate reduction in a constructed wetland.

ANSTO completed an extension of a study to assess and develop processing options for the efficient treatment of difficult-to-process, highly weathered (laterite) ores that have been stockpiled at the Ranger uranium mine. Following the first study, it was decided to proceed with separate processing of laterite ore in a separate circuit. The extended work program focussed on the liquid/solid separation of laterite slurries and possible adsorption losses on mixing with primary ore slurries.

The major findings of a pilot plant operation to process Kintyre uranium ore were published. A follow-on project to examine processing options for low-grade ore was also completed.

ANSTO continued to work towards business alliances and commercial arrangements by contacting all the major players in the uranium industry. Technical workshops and discussion groups were set up to provide a better understanding of the industry's needs. By listening to industry concerns, ANSTO is able use its specialist knowledge to target specific applications.

Radionuclide distribution and control in mineral processing circuits

In the processing of ores containing low levels of uranium and its decay products, a knowledge of how radionuclides are transported through the treatment processes is vital for assessing treatment options for unwanted contaminants occurring in the final products and/or waste streams. Pyrometallurgical treatment of copper ores containing uranium can result in elevated levels of polonium-210, the volatile daughter product of uranium, in many process streams. ANSTO scientists compiled the first comprehensive thermochemical polonium database, which allows the behaviour of polonium to be predicted using geochemical speciation codes. Data collected from a mineral treatment plant are being used, together with the predicted speciation, to develop an understanding of the aqueous chemistry of the element.

Several collaborative projects were also undertaken with industry. These included a study to investigate an unexpected increase in the concentration of radionuclides in a by-product from a smelting operation. An experimental program was also undertaken to examine the feasibility of hydro-metallurgical routes for removing radionuclides from a slag product.

A novel solvent extraction process for cerium, developed at ANSTO to treat concentrate from the Mt Weld deposit in Western Australia, was presented at an international rare earth conference. An important aspect of this process was the production of cerium products containing low levels of thorium.

To capitalise on ANSTOs long-term expertise in radioactivity in mineral products, a three-year strategic research project on this topic was planned and approved. The project will cover the areas of existing and pending Australian and international regulations with respect to classification of radioactive materials transport, worker exposure and allowable limits in saleable products and wastes. One of the aims of the project is to develop techniques to determine the mineralogical location of parent and progeny radionuclides. This information will be used as a basis for the development of economically viable selective removal processes.

Separation processes for radionuclides

ANSTO is targeting solvent extraction, ion exchange and membranes as three key separation technologies for applied and strategic research and development with applications in both hydrometallurgy and radioactive waste treatment.

Membrane-assisted solvent extraction has been specifically identified as a new technology with potential for rapid commercialisation because it utilises hollow fibre contactors used in other mature membrane technologies. A study of the application of this technology to the extraction and purification of cerium was completed. The research covered solvent extraction chemistry, reaction kinetics and mass transfer studies with flat sheet configuration. The major resistances to mass transfer were found to be diffusion in the membrane pores and the rate of chemical reaction in the removal of cerium from the organic phase. The work produced an understanding of the relative importance of chemical and physical factors, which can be applied to the development of radionuclide separation processes.

As an extension of this work, a project commenced to investigate the application of microporous hollow fibres to membrane-assisted solvent extraction. The hydrodynamic and mass transfer behaviour of the hollow fibre modules prepared at ANSTO was characterised and knowledge gained on the role of diffusion processes in mass transfer. Another area under investigation was the use of nanofiltration for selectively separating radionuclides and other dissolved metals. The project is being undertaken in collaboration with the UNESCO Centre for Membrane Science and Technology at the University of New South Wales.

COMPETITIVENESS AND ECOLOGICAL SUSTAINABILITY OF INDUSTRY

Drivers: Government and industry

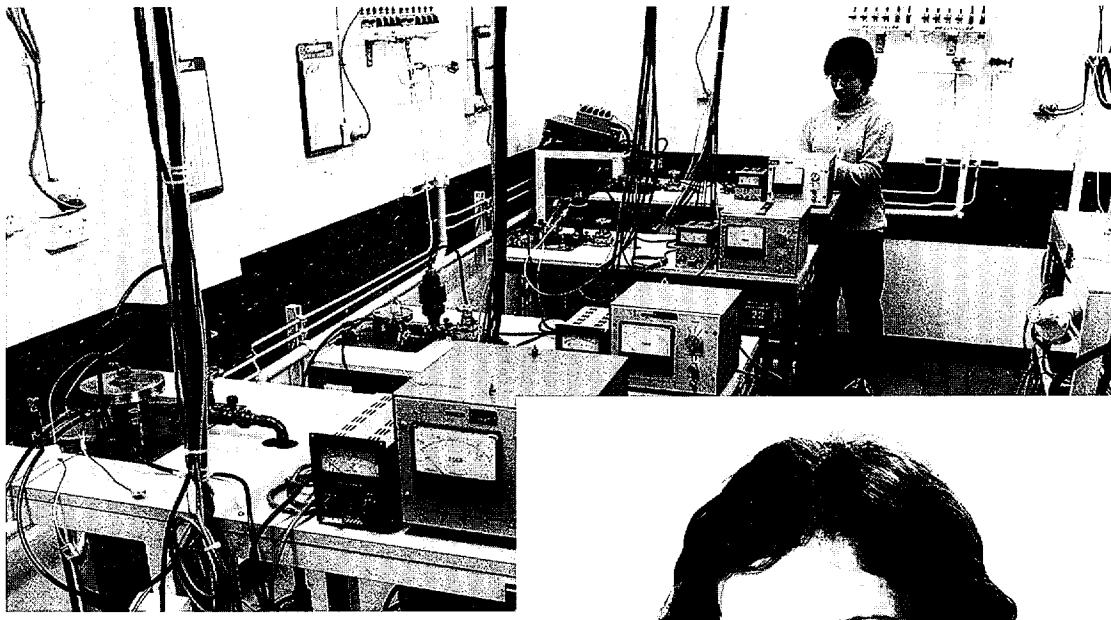
OBJECTIVES

(a) To contribute to the development of critical technologies aimed at enhancing the competitiveness and ecological sustainability of selected industry sectors by applying nuclear science and technology and ANSTO's unique mix of technical capabilities.

(b) To provide scientific and technical advice and services to government and industry, based on radiation and other relevant standards, radiation safety, radiation sterilisation, and plant assessment technologies.

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

Year-in-Industry student from the University of Technology, Sydney, Elizabeth Budzakoska has been assisting with metallurgical testing to assess the remaining life of power station components.



OUTCOMES

- Cost savings resulting from improved safety and plant performance of pressure vessels in the electricity industry were made possible through the CRC for Materials Welding and Joining, in which ANSTO is a core partner. The project used the unique facilities at the University of Wollongong and ANSTO to study the properties of welded joints in thick section pressure vessels operating at high pressures and temperatures. Other work included a study of the structural integrity of steel railway bridges, and research into leak testing of gas pipelines. These data will be used to update the Australian Standard for pipeline welding.
- ANSTO continued to use its nuclear component integrity technologies to benefit Australian industry. In partnership with Pacific Power, ANSTO developed the On-line Damage Assessment System (ODAS), which permits ready estimation of remaining life of high temperature plant. The ODAS system is currently being installed in NSW power stations and is being marketed throughout South East Asia by Pacific Power.
- The first sale of Plasma Immersion Ion Implantation technology to South-East Asia was made with the delivery of a high-voltage pulser to Singapore.
- Australian horticultural, agricultural and manufacturing industries benefited from the availability of ANSTO's gamma irradiation facilities, which successfully met increased demand from medical device and biotechnology manufacturers for materials to be processed within narrow dose range parameters. Some 3.5 million pupae of Queensland fruit fly per week, as well as biological samples, health care material, tissue grafts, polymers, gemstones, and sheep worm larvae, were irradiated for health care facilities, importers, researchers and manufacturers at a range of temperatures and dose rates.
- Jointly with the Cooperative Research Centre for Waste Management and Pollution Control, ANSTO developed innovative advanced oxidation technologies for the treatment of wastes, wastewaters and groundwaters contaminated with arsenic and other toxic contaminants. AusAID funded a successful demonstration of a process to remove arsenic from arsenic-contaminated tubewell water in Bangladesh.
- The release of an ANSTO/CSIRO manual of field techniques to quantify processes in sulfidic mine wastes through the Australian Centre for Mining Environmental Research has provided the mining industry with a means of ensuring that waste management decisions are based on good quality data.
- Regulatory authorities have been provided with a means of quantifying the impact of mine wastes on the ecosystem by using an ecological risk assessment code, AQUARISK, developed by ANSTO. The code, which can be loaded onto any PC, provides estimates of risk to specified aquatic species from specified pollutants. It also has a module to estimate bio-available concentrations of chemicals in fresh water. The code was publicised at the Contaminated Site Remediation Conference at Fremantle, Western Australia, in March.
- An electro-kinetic sounding (EKS) geophysical tool that can be used to characterise sub-surface hydraulic permeabilities and so determine the location of aquifers was demonstrated by ANSTO to water authorities, State government departments and mining companies. ANSTO, which is pioneering the use of this tool in Australia, has developed techniques to improve EKS source seismic signal generation, develop data processing software and construct 3D permeability models. This non-invasive technique has potential applications for characterising ground water at the Lucas Heights site and at waste repositories.
- A novel multiple tracer release system for studying industrial gas plumes was developed and applied.
- Export sales of radiopharmaceuticals to New Zealand and Asia rose by 7.9% despite the economic problems in the area. Overall sales of radiopharmaceuticals and radioisotopes for

medical, industrial and research purposes increased by 7.5% to $14.3 million.

- Development of a new dry bed technetium generator progressed. The generator, which allows better quality nuclear medicine imaging, was trialed at three major hospitals. Following registration, expected in late 1999, it will be released on the national and Asia-Pacific markets.
- A new method of manufacturing the reactor-produced iodine-123 meta-iodobenzylguanidine was introduced. The new method, which produces higher and more reliable yields, incorporates, for the first time, sterilization by filtration.

ACTIVITIES AND OUTPUTS

Environmental management

A number of samples, derived from used automobile catalytic converters, were successfully scanned with ion beams from the 3 MV Van de Graaff accelerator as a commercial project for the NSW Environment Protection Authority. The aim of this project is to better understand the poisoning mechanisms of automobile catalytic converters, with a view to increasing their life expectancy.

A total of 150 aerosol filters were successfully measured using particle induced x-ray emission (PIXE) analysis as a commercial project on behalf of ESR New Zealand Pty Ltd, an environmental science research company. Over 20 different elemental species were identified, helping the company identify key sources of airborne pollutants.

ANSTO's work on fingerprinting fine particle and fine particle source characterisation has been incorporated into a major review conducted by the UK-based Coal Research, Clean Coal Centre, as an activity within the Organisation of Economic Cooperation and Development (OECD) International Energy Agency (IEA), of which Australia is a member. The report discusses the significance and characterisation of particulate emissions from coal-fired powered stations in the 13 member countries.

Treatment of arsenic and other toxic contaminants by advanced oxidation technologies

ANSTO, jointly with the Cooperative Research Centre for Waste Management and Pollution Control (CRC-WMPC), is developing advanced oxidation technologies for the treatment of wastes, wastewaters and groundwaters containing arsenic and other toxic contaminants. During the year, two additional patents that extend the scope of the original invention were lodged. Further funding was obtained from the CRC-WMPC to refine and scale up the newer technologies. The target elements for the research and development work include arsenic, manganese, uranium and selenium.

ANSTO and the CRC-WMPC began developing an integrated strategy for the commercialisation of these technologies. Discussions were held with representatives from the water, mining and other industry sectors and key market opportunities were identified.

The presence of arsenic in groundwaters is a serious health problem in the Indian subcontinent. ANSTO carried out field trials to demonstrate arsenic removal from waters collected from five tubewells in the village of Sonargaon near Dhaka, Bangladesh. The demonstration was funded by AusAID and supported by the Bangladeshi Department of Public Health Engineering and the Bangladesh Atomic Energy Centre. The treatment process involved the use of sunlight and iron compounds to oxidise and immobilise the arsenic. More than 90 per cent of the initial arsenic was removed from the tubewell water to give residual concentrations within the safe drinking water limit.

Arsenic is often a contaminant in geothermal waters used to generate electricity. Tests confirmed that the advanced oxidation process can also be used in this context. Negotiations were initiated with a large multinational company to apply this technology to geothermal power plants around the world.

The Australian Mining Industry Research Association funded research by ANSTO into the management of arsenic wastes from the mining industry. The research aims to recommend best practicable technology for the various forms of arsenic waste generated by the mining and mineral processing industries.

Improved landfill design and operation

ANSTO continued to collaborate with Waste Service NSW in the CRC-WMPC project to increase the rate of degradation of municipal solid waste. The first field-scale test cell suggested that stabilisation would be achieved within 20 years, compared to more than 50 years for conventional landfill. A radioisotope tracer study was conducted to determine the flow pattern and hydraulics of recirculated leachate in the test cell and the experience used in the design and construction of two new test cells. A successful outcome from this project will advance bioreactor landfill as a sustainable development for solid waste management.

Mineral and downstream processing

Radiation technology

ANSTO's high dose calibration and measurement dosimetry service for absorbed gamma radiation dose was used in Australia, Hong Kong, Malaysia and Sri Lanka. ANSTO continued to participate in the IAEA's International Dose Assurance Service and participated in a program of interlaboratory comparisons of its high dose calibration facility with that of the National Physical Laboratory in the United Kingdom. Agreement within 1% was obtained. An Electron Spin Resonance Alanine dosimetry system was commissioned and standard operating procedures initiated, extending the range and capabilities of ANSTO's current dose measurement services.

ANSTO's Gamma Technology Research Irradiator (GATRI) was utilised to meet increased demand from Australian medical device and biotechnology manufacturers to process materials within narrow dose range parameters. A further 740 teraBequerels (20 000 curies) of cobalt-60 produced in HIFAR was installed in GATRI to replenish the facility's activity to near maximum capacity and to maintain uniform irradiation conditions. The cobalt-60 replenishment, several structural modifications and new equipment installation, were carried out during a three-week shutdown.

Biological samples, health care material, tissue grafts, polymers, gemstones and sheep worm larvae were irradiated for health care facilities, importers, researchers and manufacturers at a range of temperatures and dose rates. An average of 3.5 million pupae of Queensland fruit fly per week were irradiated for NSW Agriculture as part of the Tri State Fruit Fly Eradication Program.

ANSTO was audited by the Therapeutic Goods Administration (TGA) for licence renewal as a single stage manufacturer for radiation sterilisation of health care products. The licence was renewed and extended to include medical devices. ANSTO also meets the licensing requirements of the Australian Quarantine and Inspection Service.

Managing mine wastes

The Managing Mine Wastes Project aims to provide a sound scientific basis for decisions taken on management of mine wastes.

Field measurements conducted by ANSTO over the past 15 years have allowed scientists to quantify the effectiveness of earthen covers placed on two waste rock dumps at the Rum Jungle uranium/copper mine in the Northern Territory. Covers are used widely within the mining industry with the aim of reducing heavy metal pollutants in drainage from sulfidic waste piles by stemming the flow of oxygen and water into the wastes. The ANSTO work has shown that pollutant generation rates in the two dumps remain at about 30 to 50 per cent of what they were before the covers were installed in 1983-84. The amount of water infiltrating the cover through to the wastes has doubled over the past few years and is now higher than the design specification, but the infiltration is still less than it was before rehabilitation. The overall effectiveness of the Rum Jungle covers in reducing pollutant loads from the site in the longer term and the implications for the mining industry are being investigated.

A collaborative measurement program with the Institute of Geological and Nuclear Sciences, New Zealand, has been undertaken to monitor the continuing performance of an earthen cover on sulfidic wastes at Martha Mine, which is operated by Waihi Gold Mining Company Ltd. The mine is located in an area of New Zealand that has a high rainfall throughout the year. The site therefore provides an opportunity to study earthen covers under conditions where they are likely to be most effective.

The computer code FIDHELM, which has been ANSTO's main calculational tool in simulating oxidation in large dumps of sulfide wastes, was updated to allow a greater range of problems to be solved. ANSTO and CSIRO began to jointly develop a new code that extends the features of FIDHELM.

ANSTO provided the 'view from science' on mine site rehabilitation at a three-day workshop on the science-policy interface convened by the University of Canberra, Agriculture, Fisheries and Forests Australia, and Environment Australia. This workshop gave senior executives from government and industry the opportunity to discuss policy issues associated with the ecologically sustainable development policy by considering its application to resource management case studies.

Tailings management

ANSTO was an invited contributor to the Australian Mining Industry Council project on 'Definition of research needs for the management and rehabilitation of tailings disposal facilities'. An in-depth review was carried out on issues arising from transport of contaminants from tailings storage facilities. The report was presented to the industry sponsors and to an open industrial forum and is being used as the basis for industry-driven research on tailings management issues.

Industry

Solar reforming test facility

ANSTO conducted a hazard and operability study for CSIRO of a proposed solar reforming/power generation test facility to be located at Lucas Heights. The facility will use sunlight to convert methane to products with industrial potential, namely hydrogen and carbon dioxide under pressure.

Engineering quality control

ANSTO's Quality Control staff provided testing services for 19 local and overseas customers. Some 45 jobs were quoted for and 31 won. Three quotes were made to overseas customers, and all resulted in contracts. Type testing of various types of plastic pipes and fittings was carried out to Australian and international standards. Rubber hoses, cylinders and water filters were pressure tested and reports issued to the customers. They sought the services of ANSTO's Quality Control Unit because of its National Association of Testing Authorities (NATA) accreditation in the field of mechanical testing and on the basis of recommendations from Standards Australia.

Isotope processing facility in Thailand

ANSTO is undertaking, as a sub-contractor to General Atomics, a United States research reactor supplier, the design, construction, manufacture, installation and commissioning of 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 Ongkharak, some 60 km north of Bangkok, in Thailand. During the year, basic designs for the isotope processes and ancillary equipment to be supplied by ANSTO were submitted to OAEP for acceptance. ANSTO also completed a draft preliminary safety analysis report for the facility. For a variety of reasons beyond ANSTO's control, the project has suffered significant delays.

Materials assessment

Under the CRC for Materials Welding and Joining, ANSTO led a project involving life estimation of welded pressure equipment. This was a joint project with the University of Wollongong and attracted local and international sponsors from the power generation industry.

A second project within the CRC program involved a study of the structural integrity of steel railway bridges in collaboration with the Universities of Wollongong and Adelaide, and a third involved research into leak testing and hydrostatic testing of gas pipelines in collaboration with the University of Wollongong. Both projects are supported by industrial sponsors.

In another project under the program, advances were made in the on-line characterisation of defects in electrical resistance welding of gas pipelines. This project has enabled data from the on-line ultrasonic examination of the pipes to be relayed from the manufacturing plant to ANSTO. The data can then be assessed to provide an indication of the defect type. A project undertaken with the support of the Australian Pipeline Industry Association in non-destructive methods for the inspection of gas

transmission pipeline girth welds was completed. The results will be used to update the Australian Standard for pipeline welding.

ANSTO was also involved in the development of a new CRC for Welded Structures, which was awarded $11.5 million funding over the next seven years by the Commonwealth Government. The CRC began planning several new projects that will be supported by Australian industry, including the power and gas pipeline industries.

Following construction at ANSTO of an innovative stress relaxation-testing machine, tests were begun on miniature samples taken from the Mt Piper Power Station, NSW. Data from these tests will be used to develop component-specific creep-fatigue damage algorithms, which will be used in place of generic materials data in the On-line Damage Assessment System (ODAS) developed by ANSTO and Pacific Power to estimate remaining life of high temperature plant (see Outcomes, p46).

ANSTO developed a software program called InverTherm to reliably determine the inside temperature and transient temperature distributions in pressure vessels. This will further enhance the ODAS system. Negotiations were begun with Pacific Power for a software licence. Discussions also commenced with industry to license InverTherm for transient analysis of non-power plant components.

Work on remaining life estimation of pressure equipment, finite element analyses and metallurgical examinations was completed for a number of customers.

ANSTO scientists studied the intrinsic mechanical and thermal shock properties of carbon anodes processed in a new carbon plant at an Australian aluminium smelter. These studies provided crucial information not only for anode processing but also for the aluminium smelting process.

Under an ARC collaborative grant involving ANSTO, BHP and the University of Wollongong, magnesium oxide and graphite-based refractories were processed at ANSTO and their high temperature mechanical and thermal shock properties assessed.

ANSTO continued international collaborations with Industrial Research Ltd, New Zealand, and the University of Bremen, Germany, under which the ceramic Sialon, silicon nitride-bonded silicon carbide, and porous ceramics are being tested at ANSTO.

A collaborative research proposal by ANSTO, CSIRO and the Institute of Metal Research (IMR), China, on the 'Development of advanced CaO-type refractories' was approved by the Australian Academy of Science and the Chinese Academy of Sciences. The project aims to establish the correlation between processing parameters, microstructure and high-temperature mechanical properties, and thermal shock-resistance. It will also study the application potential of this material (as a crucible or lining) to the metal industry and, in particular, to the production of high quality steels and superalloys. The project is potentially of importance to Australia's mineral and metal industry.

As part of this collaboration, two Chinese researchers from IMR visited CSIRO and ANSTO, and an ANSTO researcher visited IMR. Background information about the project was exchanged and room-temperature mechanical properties, microstructures and thermal shock-resistance of samples prepared in China were examined.

Surface engineering (Plasma Immersion Ion Implantation (PI^3))

A commercialisation plan for ANSTO's patented Plasma Immersion Ion Implantation (PI^3) technology was formulated. The major aim is to extend the range of materials and components that can be treated by plasma nitriding - a process used to improve the wear performance, corrosion resistance and hardness of metal surfaces. In support of this plan, trials were begun for PI^3-treated components in a range of industries, including aerospace, and for machine tool and precision die applications.

An improved scientific understanding of the process has been achieved through ANSTO's collaboration with the Department of Materials Engineering at the University of Wollongong and the Division of Physics and Electronic Engineering at the University of New England, Armidale. Of particular interest is the identification of a processing window for forming a hard, wear-resistant surface on austenitic stainless steel while maintaining its corrosion

resistance. This has produced a surface treatment that can be applied in the food and chemical processing industries.

The first sale of PI³ to South-East Asia was made with the delivery of a high-voltage pulser to the School of Electrical and Electronic Engineering at the Nanyang Technological University in Singapore. The pulser is being used for high energy ion-assisted deposition of amorphous carbon coatings in electronic and tribological applications.

Development of advanced ceramics

The development of advanced ceramics at ANSTO builds upon the sol-gel science and technology developed originally to provide improved routes for the production of synroc precursor. The adaptation of sol-gel technology to a range of non-nuclear applications continued.

ANSTO continued to collaborate with Cochlear Ltd to develop a hermetically sealed ceramic housing for implantable medical devices. This development project was supported by a grant from the Department of Industry, Science and Resources. The project concluded with all milestones being met and prototype housings sent to Cochlear for testing.

ANSTO continued a collaboration with Sustainable Technologies Australia (STA) to develop photovoltaic coatings for windows (the so-called electric windows). Scientists from STA were attached to ANSTO to use the organisation's unique facilities and to facilitate technology transfer. STA is taking steps to commercialise the technology developed during the earlier phase of the project, which was funded by the Energy Research and Development Corporation.

Collaborative programs using small angle neutron scattering to investigate the evolution of sols and gels for the production of synroc precursor powders, continued. A project between ANSTO and the US National Institute of Standards (Boulder) provided fundamental insights into the effect of shearing forces on the structure of gels, while a project with the French Atomic Energy Commission (Saclay) investigated the segregation of components in nano-particles.

Functional materials interfaces

Strategic research to engineer and attach chemical functional groups to ceramic surfaces has produced a new sol-gel route for bonding silica and alumina at temperatures below 600°C. Industrial partners have been sought to apply this technology in areas such as specialised electronic packaging. In addition, biocompatible, sol-gel matrices for the controlled release of drugs and radiopharmaceuticals were developed. The release rates can be readily tailored so that total release occurs over intervals ranging from hours to months. Trials began with a series of model drugs, and discussions on potential collaboration and commercialisation commenced.

ANSTO Process Diagnostics (formerly Tracerco Australasia)

Tracerco Australasia was a partnership between ANSTO and Orica Austalia Pty Ltd. It was a commercial operation that applied radioisotope technology to solve problems in industrial process plants.

In September ANSTO negotiated with Orica Australia Pty Ltd to dissolve its partnership in Tracerco Australasia, leaving ANSTO the sole owner of the business. In February, the business name of Tracerco Australiasia was changed to ANSTO Process Diagnostics. The business traded as part of ANSTO until it was transferred to Tru-Tec Services Inc, a subsidiary of the US-based Koch Industries. The sale of business assets took effect on 30 June. The arrangements provide for ongoing services to be provided to the oil and gas and petrochemical industries and for future technical collaboration between Tru-Tec and ANSTO. They include a technology licence from ANSTO and rental of the facilities at the Lucas Heights Science and Technology Centre.

Safety services

Radiation standards

Digital Coincidence Counting (DCC) is an innovative personal computer-based technique being developed by ANSTO and the National Physical Laboratory (NPL) of the United Kingdom for the accurate measurement of radiation activity. The benefit of the DCC technique is that racks of

inflexible and potentially unreliable analogue electronics are no longer required. The data are simply digitised onto a computer file, and then replayed through the appropriate analysis software.

Both ANSTO and NPL took delivery of a working DCC system for testing. Measurement and analysis of some radionuclides commenced and initial measurements with cobalt-60 and americium-241 produced results identical to those of the current analogue technique to within the expected statistical uncertainty. It is anticipated that recognition of the benefits of this new system will lead to future commercialisation, and to its widespread adoption as the activity standardisation method of choice.

Construction of the ANSTO Secondary Standard Dosimetry Laboratory was completed. The teletherapy unit was loaded with a 240 teraBequerels cobalt-60 source and is now capable of providing traceable calibrations for ion chambers and equipment used in hospital dosimetry departments throughout Australia. The safety of operators using the facility was ensured by installing safety interlock systems designed and developed by ANSTO to comply with the National Health and Medical Research Council 'Code of Practice for the design and safe operation of non-medical irradiation facilities (1988).

ANSTO continued to maintain traceability of calibration of its radiopharmaceutical production in association with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA). Calibration to the HIFAR neutron fluence was maintained by precise resistivity measurements of neutron irradiated silicon wafers, as part of the neutron transmutation doping silicon work.

The ANSTO Radiation Standard Group carried out the primary and secondary standardisation of activity for samarium-153. This isotope is used for palliation of bone cancer pain. Only the UK National Physical Laboratory (NPL) and the US National Institute of Standards and Technology (NIST) were previously known to have done any work on the standardisation of this nuclide. All three institutes, NPL, NIST and ANSTO, measured the absolute activity of a samarium-153 solution supplied by ANSTO. ANSTO's measurements agreed with those of the other institutes. This ANSTO standard will now be compared with the International Reference System (SIR) for radionuclides. The ANSTO Radiation Standards Group provides reliable traceable standards for this important medical isotope.

Radiation protection training

ANSTO provided 48 commercial radiation protection courses for external organisations in sectors such as farming, manufacturing, minerals exploration, medical, government and electronics. The courses ranged from general training, often as part of a regulatory accreditation process, to specialist courses for specific uses of sources in moisture or depth gauging. A total of 418 personnel from 110 organisations were trained in the basics of radiation protection. A summary of these courses is given below.

Radiation protection consultancies

Radiation protection consultancies were provided for external organisations in areas including waste management, site remediation and general radiation protection. ANSTO provided advice and technical expertise to the NSW Environment Protection Agency on the containment and amalgamation of material from its radiation store at Lidcombe. ANSTO also provided the CSIRO with radiological expertise for the relocation of a radioactive store.

The University of New South Wales contracted ANSTO to provide the technical expertise required to identify, consolidate and package radioactive material in its radiation store. In addition, ANSTO assisted in the decommissioning of two nuclear chemistry laboratories in the University.

Occupational health and safety

Occupational hygiene staff provided consultancies relating to noise, solvents and fumes for three clients. Two three-day courses on safety in laboratories were given in Melbourne.

Risk and reliability

ANSTO safety and reliability officers continued to provide specialised risk and reliability analysis services to industry. Officers gave a presentation on nuclear safety cases, hazard identification and risk assessment tools to the Occupational Health and Safety Certification Pilot Program run by the

National Association of Testing Authorities
Certification Services International.

The NSW Dams Safety Committee (DSC) and Australian National Committee on Large Dams (ANCOLD) lead the world in the application of probabilistic risk assessment techniques to dam safety assessment. The tolerable risk criteria they use are based on those developed in the UK nuclear and chemical industries and are very similar to those applied by ANSTO, ARPANSA and the NSW Department of Urban Affairs and Planning (DUAP). ANSTO safety and reliability staff participated with staff of ARPANSA, DUAP and the DSC in a Tolerable Risk Forum hosted by the DSC in February.

Radiation Protection Course	Number	Participants
General Radiation Safety Officer (3 day)	2	24
Industrial Radiation Safety Officer (3 day)	6	46
Safe Use of Nuclear-type Soil Moisture and Density Gauges (1 day)	16	141
Radiation Safety for Laboratory Workers (1 day)	3	25
Safe Use of X-ray Equipment (1 day)	5	59
Safe Use of Industrial Radiation Gauges (1 day)	8	47
Radiation Safety for HAZMAT (Hazardous Materials) Technicians (1 day)	2	22
Introduction to Radiation Safety (1 day)	3	19
Radiation Safety for Borehole Logging (1.5 day)	1	4
Safety in Laboratories (3 day)	2	31
TOTAL	**48**	**418**

Following the success of the forum, the four organisations agreed to maintain an exchange of experience. ANSTO and the DSC also identified a strong mutual interest in the seismic activity in the Sydney Basin. The DSC's on-line network of seismic recorders on all the regional dams provides a valuable data source for seismic assessment done for ANSTO.

Radiopharmaceuticals and radioisotopes

Radiopharmaceutical research during the year focused on the short-lived isotope iodine-123, which is produced by the National Medical Cyclotron at Camperdown. Among the isotope's attractions are its pure gamma emission and 13-hour half-life, characteristics that make it ideal for imaging functions of organs or structures within the body when attached to specific biomolecules. Nuclear medicine is essentially about combining a suitable imaging 'tag' with a bioactive molecule to take the tag to a specific site in the body, and iodine-123 is ideal for this purpose. New handling facilities were installed in ANSTO's laboratories for performing the chemical synthesis, and biodistribution studies were performed.

As part of this iodine-123 research, a clinical trial of the use of iodomethyltyrosine as a diagnostic agent for brain tumours was planned. The trial is scheduled to begin in Australia in the new financial year. A second trial, of iododexetimide for epilepsy,

reached the advanced planning stage and a multi-centre study is scheduled to begin in late 1999.

There is currently considerable interest in the development of peptide analogues for the characterisation of certain cancers. Endogeneously expressed peptides have been found in significant quantities on the cell-surface of neurocrine and endocrine tumour cells. Work continued on developing a highly specific iodine-123 labelled analogue of vasoactive intestinal peptide (VIP) for the diagnosis of gastrointestinal adenocarcinomas. Binding studies and functional studies with this new compound were begun.

Work proceeded on bringing the radiopharmaceutical development laboratory's computerised infrastructure and reporting functions up to year 2000 compliance. Staff also worked on achieving quality endorsement to ISO 9001 standard, which should be attained early in the next financial year.

Molybdenum-99 is the parent radionuclide of technetium-99m, the workhorse radionuclide in nuclear medicine. Technetium-99m represents some 85% of all radiopharmaceutical doses used diagnostically. Current molybdenum production in HIFAR is near the limit of capacity, and will soon be unable to meet the increased market demand. To address 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 majority of the work will be performed at ANSTO. The new system will continue to use low enriched uranium as the target material, but will increase production capability.

Engineering staff designed and began installing a new Programmable Logic Control-based computer system used in manufacturing components for technetium generators.

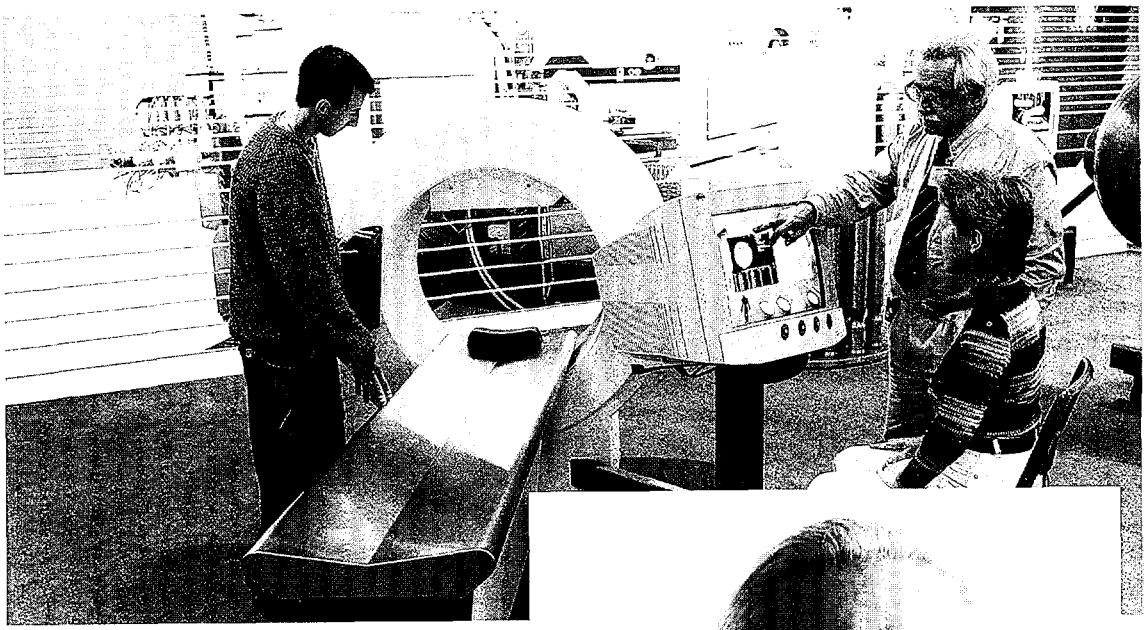
ANSTO continued to supply radiopharmaceuticals to central radiopharmacies and to public and private nuclear medicine centres throughout Australia, New Zealand and Asia. Supplies of industrial radioisotopes were delivered to customers in Australia, New Zealand and the United Kingdom. The radionuclides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

ORGANISATIONAL DEVELOPMENT AND SUPPORT

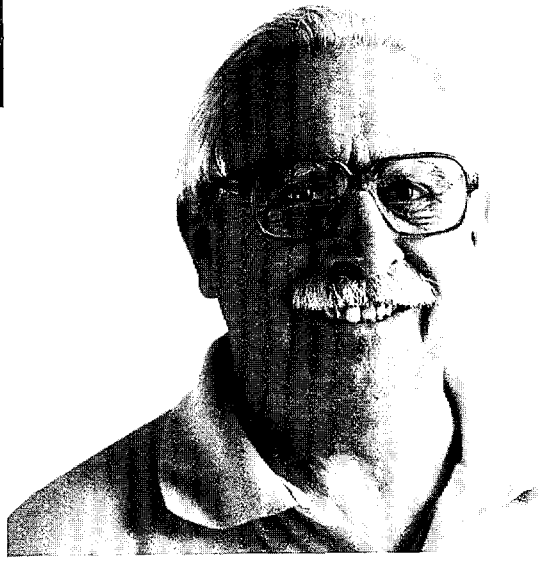
Drivers: ANSTO and government

OBJECTIVE

To provide best practice corporate support, safety management, information and human resource management for ANSTO's staff.



Tour Guide Jim Brough uses the simulated gamma camera in ANSTO's Reception Centre to demonstrate aspects of positron emission tomography scanning. The camera drew large crowds at Sydney's Royal Easter Show, where the ANSTO exhibit won third prize in the Royal Agricultural Society's Technology and the Family section.



OUTCOMES

A smooth transition was achieved in the changeover from a cash to a full accrual system for the organisation's budget framework. The change was required to support Government initiatives.

- Accurate and timely accrual-based estimates were made of expected revenue and planned expenditure, asset acquisition and liabilities. This, together with careful monitoring of receipts and cash payments, assisted the Government and ANSTO in their financial planning.
- The overall strategic direction of the organisation was strengthened by better alignment of business and performance planning with the annual operating budget process.
- New values for plant, equipment and intangibles were established using the deprival value method, as required by new Government requirements.
- The Financial Information Management System and associated business systems were checked to ensure they will continue to operate correctly beyond 31 December 1999 and a contingency plan put in place to ensure business continuity after that date.
- Thirty six new databases, including major subject databases such as the Scifinder, Advanced Neutron Source Project, Aquatic Sciences and Fisheries Abstracts, Ceramic Abstracts, British Pharmacopoeia, GeoRef, Metadex, Microbiology Abstracts, Scanfile, and Weldasearch, were made available to staff at their desktops through either the library website or the site CD-rom server.
- Access to the library's journal holdings, both print and electronic, was widened through holdings being listed on the library website. The list, which includes details of print subscriptions and active links to electronic journals, was updated monthly, and 25 new electronic journal titles were added.
- Inter-library loan turn-around time was reduced and the quality of documents improved by using new software to scan and send or receive documents via the Internet. The same software is widely used in universities and CSIRO.
- Staff access to the library was extended by the introduction of out-of-hours entry.
- Management of paper records throughout ANSTO was streamlined by upgrading the records software. Appropriate training was provided for users.
- Electronic commerce such as automatic credit card disbursement and EFT payments to the Australian Tax Office was made possible by an upgrade of ANSTO's financial information system.
- Improved data management and security was made possible by reorganising the data on the site's primary Novell server. Hardware for the server was also substantially upgraded.
- Modem access to site for staff working remotely was improved through the purchase of more efficient hardware.
- Protection of ANSTO electronic information was improved through a number of upgrades to its Internet firewall. Work also began on installing a virtual private network for dial-in users to provide secure encrypted access to the site network for external authenticated users.
- A voice recording system was installed for radiopharmaceuticals customers. This satisfies legal requirements and enables staff to ensure that orders are filled accurately.

ACTIVITIES AND OUTPUTS

Finance and supply services

The major focus during the year was on implementing new systems and revising existing processes for developing budget estimates in response to the introduction of the Commonwealth Government's financial management reform policy.

Up until October, the Government had been using a centralised financial management system that involved requests for funds by government departments and authorities being handled and recorded in Canberra. In October, the Department of Finance and Administration installed the central Government Accrual Information Management System, which enabled individual organisations to develop and manage their own budgets.

Under this system, ANSTO became responsible for

formulating and maintaining its budget estimates of revenue and expenditure in accordance with accrual accounting principles. Budget statements and forward estimates for next year, including budgeted operating statements, balance sheet, cash flow and capital expenditure, were produced on a full accrual basis. As part of a quality assurance process, a risk assessment on the probability of errors occurring in the budget estimation process was performed and appropriate measures put in place to minimise this risk.

In preparation for input to the 1999/2000 Federal Budget under the new accrual budgeting framework, ANSTO developed and obtained approval from the Minister for Industry, Science and Resources for a new outcomes and outputs structure. The outcomes are directly linked to Government decisions to replace the HIFAR research reactor, to the disposition of spent fuel rods, and to ANSTO's science and technology functions. A comprehensive review of performance measures for projects and activities was begun. This will ensure that performance information on achievements from core business activities aligns with the agreed outcomes and outputs framework.

ANSTO also participated in inter-agency workshops conducted by the Department of Industry, Science and Resources, the Australian Institute of Marine Science and CSIRO to exchange ideas on improving the outcomes/outputs framework and the associated performance measures.

To comply with the Finance Minister's Orders, the Australian Valuation Office undertook a complete re-valuation of ANSTO's plant, equipment and intangibles, using the deprival valuation method. The revaluation forms the basis for the published values of plant, equipment and intangibles disclosed in the financial statements appended to this report. An independent revaluation of land, buildings, electrical and site services was completed in June 1997.

The ANSTO Financial Information Management System (FIMS) was identified as a critical function with respect to possible impact by the Year 2000 (Y2K) computer date problem. A comprehensive test plan and remediation strategy was prepared and conducted between September and December. A Y2K solution provided by the software supplier was installed and all key financial system components and transaction types were tested. Based on the results of this testing, it is expected that FIMS should continue to operate correctly beyond 31 December 1999. In addition, related business systems were tested and, where required, updated, as part of a comprehensive review of the potential impact of the Y2K date problem.

A contingency plan was established as part of an overall FIMS Y2K risk management strategy to ensure that procedures are in place to provide business continuity at ANSTO for the mission-critical financial service functions.

Strategic advice and support was provided to all business units and senior management on a wide range of issues including treasury, taxation, procurement, budget and financial management. Support to ANSTO's related business interests continued to be provided. ANSTO also provided accounting services and budgetary and financial reporting to the Australian Institute of Nuclear Science and Engineering (AINSE), the Major Nuclear Research Facilities (MNRF) and other government-funded programs.

A small project team was established to assess implications of new taxation legislation. Their main focus was on the requirements and impact of the Goods and Services Tax, and on changes to the Fringe Benefits Tax.

The Financial Information Management System (FIMS) was enhanced by the addition of customised features and reporting facilities that meet a diverse range of user requirements.

Consultancy contracts were issued for the replacement reactor project and assistance provided with the pre-qualifying process for reactor vendors. Expressions of interest were invited for Australian companies to show interest in supplying goods and services to the replacement research reactor.

Budget

ANSTO is a Commonwealth authority covered by the Commonwealth Authorities and Companies (CAC) Act and receives government appropriated

funding to carry out the majority of its activities. Funding for 1998-99 was covered by the 1997-2000 Triennium Funding Agreement between ANSTO and the Government.

In support of the Government decision to replace the HIFAR research reactor, ANSTO will receive an equity injection of $286.4 million in 1997 dollars over nine years. This money is to fund the construction of a replacement research reactor at Lucas Heights. Six million dollars have been drawn down to date.

In 1997 the Government announced a decision to remove the existing inventory of spent fuel rods, together with spent fuel rods arising over the remaining operating life of the HIFAR reactor. An amount of $86.40 million (1997 dollars) will be appropriated over time to implement this decision. Of this, $14.039 million has been drawn to date.

Parliamentary appropriation of $78.479 million was received in 1998-99 (1997-98 $72.731 million). This included $4 million for the replacement research reactor project and $8.465 million to fund the disposition of HIFAR spent fuel elements. Appropriation available for core science and technology activities was $66.014 million (1997-98 $65.157 million), which is a reduction in real terms from the appropriation received for scientific research in 1997-98. This is due largely to the cumulative impact of efficiency dividends on the administrative component of running costs and the continued application of government saving measures.

A special allocation of $0.616 million was received during the year to cover expenses against approved remediation projects for the Year 2000 computer date problem.

Revenue

An important component in the Triennium Funding Agreement is the Government requirement for ANSTO to achieve external earnings targets for research and services. In 1998-99 ANSTO generated $30.7 million (1997-98 $30 million) from external sources, representing 39.2 % of total income, which exceeded the required performance target.

In 1998-99 revenue generated from sale of goods and services totalled $27.074 million (1997-98 $26.649 million), and included $14.281million from the sale of radiopharmaceuticals, $3.696 million from contract research and services, $2.355 million from silicon irradiation services and $1.911 million from grants. Revenue from sales of radiopharmaceuticals and radioisotopes increased by $1 million (7.5%).

Expenditure

The task of transforming resource allocation and management from an input/activity base to an output/result base, begun three years ago, was completed and the system fully integrated with the business and resource planning cycle. The broad resource allocation and management framework adopted by ANSTO is consistent with and complements the Government's recent financial management reform agenda.

ANSTO continued to focus its activities in science and technology on the five core business areas, described in this report, in which nuclear science and technology and related capabilities offer strategic and technical benefit to Australia. Within these areas, resources totalling $6.974 million (compared with $7.329 million in 1997-98) were allocated specifically to the seven strategic research topics listed below.

- Ecological sustainability and competitiveness of the mining and mineral (particularly uranium) industries
- International cooperative research to enhance the safety of nuclear facilities and safeguards for nuclear materials
- Environmental dynamics - application of nuclear techniques
- Global climate change - application of nuclear techniques
- Radioactive waste management
- Designer materials
- Radionuclides and radiopharmaceuticals for the 21st century.

Overall expenditure against the core business and

Figure 1 External Revenue

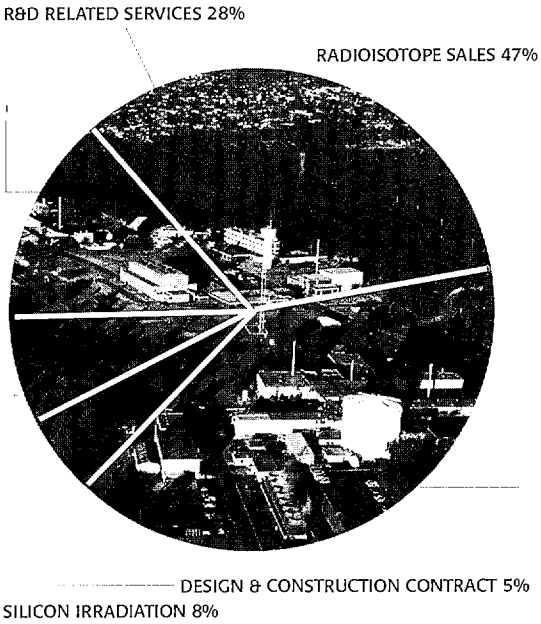
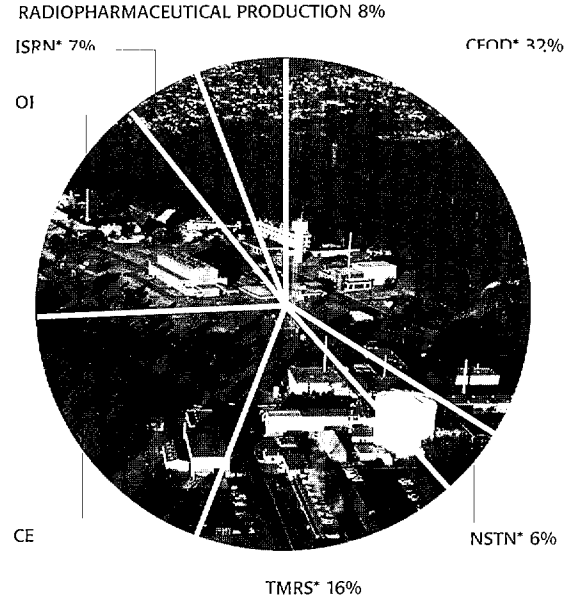


Figure 2 Expenditure Profile



support activities was broadly in line with the business and resource allocation plan. The research projects, support and service activities, together with planned outcomes, are summarised in ANSTO's 1998-99 Operational Plan.

There was a small decrease in expenditure against these core business science activities due to reduced funding from the Government for the science program. Effort was also diverted to managing the replacement research reactor project, and to the environmental monitoring program and the ARPANSA issues. Salaries and payments in the nature of salary remain the single largest component of running costs, representing 48.03 % of total operating expenses.

New operating costs were incurred as a result of the devolution of former centralised government functions such as maintenance of the accrual budgeting process, and devolution of management responsibility for overseas Commonwealth owned and leased property.

ANSTO maintains and manages through its baseline funding its research infrastructure and major national facilities, including the National Medical Cyclotron, the Australian National Tandem Accelerator and the HIFAR Research Reactor. In 1998-99, some $12.44 million was spent to upgrade the capital stock and site infrastructure of the organisation. This included:

Building development and facilities improvement

Building maintenance, refurbishment and development	$4.104m
Electrical System Upgrade	$0.120m
Ventilation System Upgrade	$0.300m
Security System Upgrade	$0.076m
Radiopharmaceutical Production Facilities	$0.542m
Crane Hoist Upgrade	$0.258m
Sub total	**$5.400m**
Equipment for research and scientific services	$7.039m
Total	**$12.440m**

Other significant expenditure during the year included:

Replacement Reactor Project	$3.762m
Disposition of Spent Fuel from the reactor HIFAR	$5.341m
Progression of the Waste Management Action Plan	$1.758m

Insurance

Comcover, the Commonwealth Government's new fund for management of insurable risk, began operations on 1 July 1998. Unless specifically exempted, all organisations within the General Government Sector automatically became an insured member through this arrangement. For ANSTO, all risk previously covered by commercial insurance was reinsured with Comcover when the previous policies expired on 30 September 1998. These policies were on favourable terms and substantially unchanged from the previous year. They cover ANSTO against claims for financial loss, death or personal injuries, or damage to property arising out of activities or products of the organisation.

During the year, ANSTO's non-commercial insurable risk exposure was reviewed with regard to the Government's new policy, which was to effectively cease to self-insure in favour of establishment of the managed fund. In consultation with a risk assessor nominated by Comcover, these risks were identified and individually assessed. As a consequence, a portfolio of new policies with agreed premiums was put in in place. Areas covered by these policies include property, motor vehicles, personal injury, medical malpractice and marine transit.

A Deed of Indemnity was signed on 27 August between the Commonwealth of Australia (represented by the then Minister for Industry, Science and Tourism) and ANSTO to indemnify ANSTO, ANSTO officers and contractors from and against any loss or liability arising from claims caused by ionising radiation.

Human resource management and development

Review, design and development of ANSTO's human resource strategies continued. Refinement of work previously undertaken on competency development, and further development of a competency-based human resource framework to underpin human resource practice was ongoing. This included the trialing of a knowledge management model to assist in the design of HR processes to suit ANSTO's diverse and complex workforce. Validation of the competencies by staff representatives from all levels and skill areas continued.

A review of the organisation's staff management policies and procedures, begun last year, continued. Each policy and practice is being examined, updated and aligned to support organisational objectives. Areas covered included equal employment opportunity, staff induction, long service awards, probation and superannuation.

The recruitment process was reviewed and improvements made. Standardised processes were introduced to assist staff interviewers and greater use was made of advertising agencies and the Internet to better target likely candidates, while recruitment consultants were used to fill selected positions.

Four trade apprentices, including one designated Aboriginal/Torres Strait Islander, were recruited.

Human resources staff continued to provide advice and support services to management and staff. A major focus during the year was on the administration of the career advancement and performance management systems.

Learning programs were developed and made available to support organisational priorities. During the year learning activities included teamwork, project management and performance management. A new middle management learning program was developed, and will be offered in the next financial year. A common thread through many of these programs was the support of change management through learning and development activities. The programs were supported by communications and leadership seminars.

Training carried out during 1998-99

Categories	Number of courses	Males	Females
Computing courses	78	164	71
Engineering courses, seminars and conferences (other than HIFAR-specific training)	14	15	3
Health and safety courses	86	591	133
HIFAR-specific training courses	18	99	22
Management and general administration courses	43	159	59
Quality assurance courses	41	103	53
Science courses, seminars and conferences	84	176	45

Scholarships valued at $346,000 were paid to universities for undergraduate, postgraduate and Year-in-Industry student training.

Work experience for young Australians

The work experience program placed more than 40 secondary school students during the year. Another 20 undergraduate students were provided with valuable experience during the university summer vacation.

Employee and industrial relations

Employee and industrial relations remained relatively stable throughout the year, largely as a result of consultation between management and staff through a formal framework of meetings. Two separate forums have been set up for this. One is the Peak Council, on which employee representatives are consulted on issues to do with strategic planning and higher level management issues. The second is the Joint Consultative Committee, through which employee representatives can review progress in implementing reform measures, review the operation of the current Enterprise Agreement and consider common industrial issues.

ANSTO continued to monitor business and industrial relations trends in government, industry and the science community to ensure that its own policy and practice reflected contemporary attitudes and best met ANSTO's business needs.

ANSTO continued to operate under the terms of its 3rd Enterprise Agreement, which covers the period from August 1997 to February 2000.

In accordance with the requirements of the Workplace Relations Act 1996, management and staff representatives engaged in extensive negotiations to develop a simplified award to replace the current ANSTO General Award 1990. The negotiations reached an advanced stage and it is anticipated that a new simplified Award will be endorsed in the Australian Industrial Relations Commission in the latter half of 1999.

Quality assurance

ANSTO's management systems at corporate and divisional level continued to be developed to meet national, international and organisational objectives in accordance with the requirements of the recognised quality standards AS/NZS ISO 9001. Third party certification to AS/NZS ISO 9000 is currently held by one Division and by a unit in another, with one unit in another Division holding certification to ISO 9001. Three Divisions have third party certification to AS/NZS ISO 9001 as an objective in the year 2000 and a plan for the remaining Divisions is being developed. A decision was taken to expand the system to cover the requirements of ISO 14001 for environmental management.

Quality management training was provided through an internal Quality Management course and other special short courses.

Internal quality system audits continued to be used as a tool to verify the current status of processes against requirements, to identify opportunities for process and product improvement, and to improve safety and environmental management.

Business development

Work continued on developing ANSTO's formal business guidelines, which apply both to doing business with external organisations and to operating internal projects. Parts 1 and 2 (dealing with project development and evaluation) of the guidelines were distributed in July, while parts 3 and 4 (dealing with the conduct and assessment of projects) are scheduled to be finalised in late 1999.

Service Charter

A Service Charter was finalised, in line with government requirements. The Charter states what ANSTO does and the standards of product and service that customers can expect from the organisation.

Patents

ANSTO held 146 patents, patent applications and trademarks at the close of the financial year.

Commercial leasing of ANSTO property

Four tenants from ANSTO's Business and Technology Park took up options to renew their leases during the year. Revenue from commercial leases increased by 10 per cent.

Engineering services

A major project to extend ANSTO's Environment Division's buildings, begun last year, was completed and opened in November by the Minister for Industry, Science and Resources, Senator the Hon Nick Minchin.

Operational facilities continued to be upgraded through the installation of computer-based control and monitoring equipment, enhancing levels of safety, reliability and utilisation.

A statistical process control system was introduced for the manufacture of batches of computer numerically controlled machine components. The system results will be used to verify machine ability to produce components to the required sizes, provide feedback to designers and reduce inspection requirements and production costs. It will also be used in manufacturing components for radiopharamaceutical production.

Work began on developing two electronic databases that will provide users around the ANSTO site with on-line access to key engineering data. A facilities information system will provide graphic displays of site infrastructure and services to groups involved in construction, maintenance, safety and facilities management. A document management system will allow distributed retrieval of, and access to, thousands of engineering documents.

An extension to a radiochemical laboratory used for environmental research was completed.

A Secondary Standard Dosimetry Laboratory was constructed in a building previously used as an electron accelerator cell. A teletherapy head used as a radiation source for calibrating high-dose ion chambers, was upgraded.

Upgrading of an overhead crane to comply with current safety standards for nuclear fuel and material handling was completed. A second overhead crane used to transport nuclear materials and casks was also upgraded.

The radiopharmaceuticals packaging area was extended to provide a larger work area with a low radiation background. This was the first stage of a project to rationalise the radiopharmaceutical production buildings to allow more efficient use of the facilities and improve staff working conditions.

The main gatehouse was extended and refitted so that it could be used for storage of fire fighting equipment. The emergency operations centre was relocated in the same area, which has been redesigned so that it can also be used for contractor screening, safety induction, assessment and training.

Information management

Information Management Division supports ANSTO in the areas of library and records management, computer server and desktop support, and data network and telephony, as well as corporate and database applications development. It also provides computer system support and modelling and programming support to ANSTO scientific staff.

Providing enhanced electronic information to the scientist's desktop continued to be a high priority. The library continued to explore and take up opportunities for resource sharing, mainly within the CSIRO Library Network, of which it is a member.

The library became the first in Australia to sign up for and implement SciFinder, which provides desktop access to the internationally renowned Chemical Abstracts database.

In response to increasing costs of journal subscriptions, the library continued to expand online services. Unfortunately, this did not fully compensate for the escalating journal costs, and some subscriptions had to be cancelled. The library continued to aim for a one-stop, up-to-date desktop

access point to journals through the library website.

The library website became the primary means of disseminating and providing links to new and existing information held by or available through the library.

The integration of the library's card catalogue into the Voyager library management software hosted by CSIRO was completed and the card catalogue retired.

Quick reference guides were created for all new databases made available via the library website. The guides provide access details, background information and search tips.

Records management staff continued to ensure that ANSTO's practices followed standard record keeping procedures used throughout government organisations.

A revised Records Disposal Authority governing retention periods and storage requirements for ANSTO records was agreed with the National Archives of Australia and implemented, along with user training.

Computer staff continued to refine ANSTO's financial information management system and generate software for scientific projects. The main emphasis was on system checking and remediation for Year 2000 compliance, which included work on FIMS and the site dosimetry software.

ANSTO's data network, ANSTONet, continued to be extensively upgraded to enhance its reliability and capability. New switches were installed in several buildings and older cables replaced.

Standardisation of the desktop environment continued, with existing standards being reviewed and updated. The organisation made a commitment to Windows NT Workstation as the preferred operating system and developed documentation to ensure consistent setup of new desktops by support staff.

ANSTO's software licences for the standard desktop environment were reviewed. Where appropriate, software was purchased to ensure that compliance requirements were being met.

The Novell-based site CD server was decommissioned and replaced with upgraded hardware and an alternative operating system platform.

New application servers were introduced to complement existing internal email and datebase systems. A training program was initiated to develop system staff skills in this area.

Information management staff reviewed the telephony facilities management contract for ANSTO, and established an interim contract while negotiations proceeded on a new contract with Telstra.

Virus protection software for servers and desktops was continually upgraded and extended to include several new servers. ANSTO has so far avoided a major virus problem, although new infestations are continually being detected.

Scientific computing staff provided assistance with mathematical modelling for a number of projects, including 'Environmental dynamics', 'Managing mine wastes' and 'Radiological consequences'. Databases for the 'Managing mine wastes' project were developed and applied. The instrument control application for the ion beam project was updated.

In conjunction with Fujitsu Laboratories, Japan, the scientific computing group developed an integrated visual interface for genetic algorithms.

Towards the end of the year, the performance of the main ANSTO scientific multiprocessor computer began to deteriorate under increasing load. Computing staff investigated the problem and began exploring options to meet the increasing demand.

Year 2000 compliance

ANSTO reported quarterly to the Office for Government Online (OGO) and monthly to the Department of Industry, Science and Resources. ANSTO met the Government's Year 2000 compliance target date of 30 June 1999 for its critical systems.

Two external Year 2000 audits, one a topdown analysis of business function and system dependency, and the other covering documentation, testing procedures, and contingency plans, were

conducted during the year. These audits assisted in achieving the final compliance result for this project.

Year 2000 remediation has been an organisational priority for ANSTO since it launched its Year 2000 project in July 1997. All Divisions have participated, with information management staff supplying project coordination, external liaison, and technical effort. The Federal Government, through OGO, provided seed funding of $616 000 to assist ANSTO to complete its Year 2000 remediation.

Security

Physical protection of the Lucas Heights Science and Technology Centre, including responsibility for counter terrorism first 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.

Protection of the Lucas Heights Science and Technology Centre site is recognised by government as a core, or non-contestable activity of the APS. As such the principles of competitive neutrality in the context of the pricing agreement with ANSTO do not apply.

Physical protection of all facilities and materials was satisfactorily maintained in accordance with national and international obligations. Physical protection technology continued to be upgraded as part of a program of continuous improvement. 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.

Communications

As part of the environmental assessment of the replacement research reactor, ANSTO initiated an active consultation program with the public under the terms of the Environment Protection (Impact of Proposals) Act 1974.

During this process, ANSTO retained a consultant to independently assess whether it had met the requirements of the Act in terms of public consultation and to suggest methods that might better involve and inform the public. The review report, which is public, found that ANSTO had met the formal requirements, and made a range of further suggestions on consultative activities to produce a leading edge program. All were adopted and implemented by ANSTO. These included a series of public workshops where independent and ANSTO experts discussed with the community major issues that had been identified in prior focus groups and public debate about the replacement reactor.

A debate between ANSTO's Executive Director and a representative of opponents of the replacement reactor was held on the Sutherland Shire community radio station, 2SSR-FM. The discussion included questions submitted by members of the public. Free audio cassettes of the debate were made available.

ANSTO's Internet website, which is at http://www.ansto.gov.au/, was widely used by the public as a source of information on the replacement reactor proposal. It also continued to be strongly patronised as a general information resource on ANSTO. Its ease of use was further assisted by the implementation of a series of recommendations by an E-team of senior secondary students from the Lucas Heights Community School, who carried out a week-long evaluation of the website. The Home page also continued to provide public and internal access to ANSTO Library's comprehensive electronic and other information services. Users can contact ANSTO direct using e-mail or through interactive forms. Effort was expended during the year to replace traditional hard copy internal information processes with more cost effective and accessible electronic practices. ANSTO's Home page contains approximately 2,200 files, of which 400 are accessible externally. It received approximately 33,000 external hits and 243,000 internal hits in the year, increases of 10% and 34% respectively over the previous year.

Regular meetings with community groups, chaired by an independent facilitator, continued to be held.

The meetings provided an opportunity for the community to invite speakers to address them on specific areas of interest. During the year speakers and their subjects included representatives of the Australian Radiation Laboratory on radiation, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) on its role in regulating all Commonwealth activities involving radiation and radioactive materials, the Australian Safeguards and Non-proliferation Office (ASNO) on safeguards arrangements for nuclear materials, and an ANSTO update on the implementation of its Waste Management Action Plan. A major focus continued to be on finalising a mutually agreed Community Right to Know Charter. However, after a great deal of effort by both members of the community and ANSTO, it was disappointing for both parties that agreement could not be reached on a common document.

After a break of some years, ANSTO exhibited at Sydney's Royal Easter Show. Staffed by volunteers from across the organisation and showing off a broad range of ANSTO's science and technology and how it is applied on an everyday basis, it was visited by many thousands of people. A simulated gamma camera, which drew on a stored bank of head, chest and abdominal scans, often had long queues of people waiting. The ANSTO exhibit won third prize in the Royal Agricultural Society's Technology and the Family section.

The organisation also took part in the Australian Science Festival in Canberra.

ANSTO's Reception Centre has had its role as a nuclear science information centre expanded by the addition of a series of interactive education exhibits. Computer-based quizzes, a demonstration of radiation half-life, the previously mentioned simulated gamma camera, a display showing the radioactivity of everyday items and a cutaway Van De Graaf accelerator added interest for the thousands of visitors who took guided tours of ANSTO during the year.

The organisation's speaker program continued to be popular, with staff delivering some 24 talks to community groups. Subjects ranged from the general activities of ANSTO to the replacement reactor.

A second information day for staff in local schools with responsibility for occupational health and safety was held in November. More than 20 schools attended. The visitors were provided with extensive detail on ANSTO activities by both the organisation and involved Federal and State emergency response agencies. It was disappointing that another such workshop, scheduled for March, had to be postponed because insufficient numbers responded. At the suggestion of the NSW Department of School Education, one such workshop will be held annually, with the next scheduled for late 1999.

ANSTO's nuclear science educational document, A Nuclear Source, was rewritten. After review by internal and external experts it will be produced as an Internet publication and on CD-ROM in the next financial year.

During the year ANSTO supported a trial of a broad-scale community alerting system, PC Cops. This was done in conjunction with Sutherland Shire Council, the Sutherland and Miranda Patrols of the NSW Police Force, the State Emergency Service, Caltex, and Westfield Miranda. The system, based on combining telephone and computer technologies, uses a voice mail system with the capability to call individual homes and businesses in specific areas to alert occupants to emergencies or other threats to community safety. The trial of the system, which has been used successfully by police in Perth, is being evaluated.

High quality photographic services were provided for internal scientific and general users, and there was a strong demand for pictures of ANSTO activities from external publications.

ANSTO's graphic design capability maintained its high standards in traditional print and, increasingly, in electronic publications, for a diverse range of scientific and general customers.

There continued to be strong media interest in ANSTO's activities, especially in regard to the replacement reactor.

PERFORMANCE INDICATOR INFORMATION

The Triennium Funding Agreement for the period 1997-98 to 1998-99 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 uses of practices, instruments and processes developed by ANSTO, is covered in the general reporting under core business.

Performance Indicator 1

Total contracts 1998-99: 316

Total contracts 1997-98: 340

Source: ANSTO Executive, Financial records, Business Plan

LEGEND: Core business areas

ISRN: International Strategic Relevance of Nuclear Science and Technology

CFOD: Core Nuclear Facilities Operation and Development

NSTN: Applications of Nuclear Science and Technology to the Understanding of Natural Processes

TMRS: Treatment and Management of Man-made and Naturally Occurring Radioactive Substances

CESI: Competitiveness and Ecological Sustainability of Industry

Performance Indicator 1

ANSTO contracts 1996-97 to 1998-99 ($ value over $1,000)

Number of Contracts

Core Business	1996-97	1997-98	1998-99
ISRN	8	14	15
CFOD	14	10	24
NSTN	64	48	57
TMRS	9	27	29
CESI	165	241	191

Percentage of contracts completed

Core Business	1996-97	1997-98	1998-99
ISRN	100	86	93
CFOD	100	100	100
NSTN	98	100	100
TMRS	89	81	79
CESI	83	80	85

Performance Indicator 2

ANSTO allocation of resources into agreed priority areas

Expenditure ($'000)	1996-97	1997-98	1998-99
ISRN	6,459	6,668	7,385
CFOD	29,299	33,270	33,037
NSTN	6,347	5,816	5,804
TMRS	8,997	14,660	16,256
CESI	16,611	16,465	17,092
ORDS	13,688	14,208	13,873
RADPH OPS	7,357	8,178	8,301
Totals	**88,758**	**99,265**	**101,748**

Performance Indicator 4
Science and technology based gross revenue ($'000)

	1996-97	1997-98	1998-99
ISRN	942	2,601	2,298
CFOD	3,632	4,313	5,154
NSTN	965	716	489
TMRS	1,614	949	932
CESI	2,834	3,735	3,227
ORDS	1,200	1,025	1,261
RADPH OPS	12,310	13,310	14,313
Totals	**23,497**	**26,649**	**27,674**

Performance Indicator 5
Publications by type

	1996-97	1997-98	1998-99
Journal Articles	133	129	105
Conferences	304	272	272
Papers/Abstracts Commercial and Technical Reports	175	161	120
Books/Chapters Published	4	6	3
Monographs	0	0	9
Other	9	7	17
Totals	**625**	**564**	**519**

Performance Indicators 6 & 10
Cooperation with Industry, Research Organisations and the University Sector 1996-97 to 1998-99

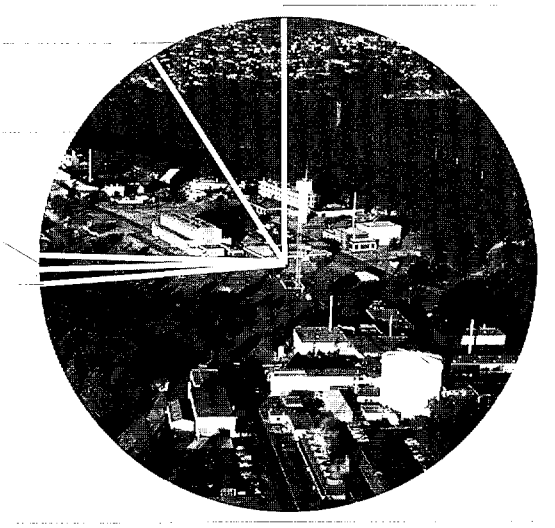
	1996-97	1997-98	1998-99
Number of visiting scientists who undertook research at ANSTO during the year	46	35	53
Total number of students using ANSTO facilities	260	237	189
Number of postgraduate students fully or partially sponsored by ANSTO	30	60	64

Performance Indicator 7
Provision of advice to Government

Total person years 13.1

Performance Indicator 8
Contribution to international networks and to international Policy Developments

Total person years 14.5



Performance Indicator 9
Degree of usage of maintained facilities by external users 1998-99

Major Facilities

HIFAR Research Reactor	University projects funded by the Australian Institute of Nuclear Science and Engineering (AINSE) utilised 375 instrument days. ANSTO research (both internal and international collaborations) utilised 411 instrument days. ANSTO research involving collaboration with university groups and training of PhD students utilised a further 109 instrument days.
ANTARES Tandem Accelerator	External users accounted for 34% of operational time (lower than previous years due to major upgrades).
3MV Van de Graaff Accelerator	External users accounted for 65% of operational time.

SAFETY ARRANGEMENTS AT ANSTO FACILITIES

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

OBJECTIVES

- Promote best practice in health and safety and promote a positive safety culture across the organisation.
- Provide and maintain safety systems and assessment procedures that are in accordance with national and international standards.
- Ensure that risks to staff and the public associated with ANSTO's operations are kept as low as is reasonably achievable.

OUTCOMES

Implementation of the safety policy on site resulted in a safe working environment for employees, visitors and contractors. Contractor awareness of ANSTO safety requirements was raised by implementing additional features in the revised induction scheme introduced last year. The scheme now includes the use of a contractor induction video developed during the year.

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 '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 new Australian Radiation Protection and Nuclear Safety (ARPANS) Act and regulations was introduced.

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 12 millisieverts (mSv), compared to the internationally agreed limit of 20 mSv.

Controls, monitoring and assessment ensured that off-site exposures from airborne emissions from ANSTO were less than 1% of the public dose limit of 1mSv per year.

Effluent discharged into the Sydney Water sewer system met all limits for radioactive pollutants in accord with the Trade Waste Agreement with Sydney Water. This agreement requires compliance at the Cronulla Sewage Treatment Plant with World Health Organisation drinking water standards for radioactivity.

The effectiveness of the ANSTO emergency management plans was recognised by the NSW Emergency Services as significantly exceeding all recommended standards and guidelines.

ACTIVITIES AND OUTPUTS

The Australian Radiation Protection and Nuclear Safety Agency

The passage of the Australian Radiation Protection and Nuclear Safety Act (the ARPANS Act) in December 1998 and the ARPANS Regulations in February 1999 has required ANSTO to prepare applications for licences covering all activities involving the use of ionising and non-ionising radiation, and the operation of nuclear facilities. Prior to the ARPANS Act, HIFAR and Moata received operating authorisations from the Nuclear Safety Bureau. The new Agency, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), which is responsible for implementing the requirements of the ARPANS Act and Regulations, was formed by the amalgamation of the Nuclear Safety Bureau and the Australian Radiation Laboratory of the Commonwealth Department of Health and Aged Care. The main function of ARPANSA is to regulate all Commonwealth entities (including departments, agencies and bodies corporate) using radioactive materials or operating facilities. The ARPANS legislation has required ANSTO to restructure its safety committees and safety assessment arrangements as described below.

Health and safety policies

A new policy, the 'ANSTO Health, Safety and Environment Policy' was issued during the year. This is one of a number of organisation policies and sets the framework for managing ANSTO's activities with due regard for health safety and the environment.

The Occupational Health and Safety Policy, which is one of a number of policies under the ANSTO Health Safety and Environment Policy, was published in full in the 1992-93 ANSTO Annual Report in compliance with requirements of the Occupational Health and Safety (Commonwealth Employment) Act 1991. It has not been necessary to make any changes to the policy. ANSTO, through the Executive Director, continued to implement all parts of the policy, which is widely distributed throughout ANSTO as Safety Directive 1.2 'Occupational Health and Safety Policy', re-issued on 27 September 1996.

In compliance with the Act, new health and safety representatives and deputies, together with new health and safety committees, were elected during the year, with an encouraging level of staff participation.

In recognition of ANSTO's performance in complying with the requirements of the Act, the government agency COMCARE approved self-audit status to ANSTO. 'Safety Map', a safety performance assessment system developed in Victoria, will be used with the ANSTO risk assessment and audit system as the principal tools for this process.

Contractor safety

Contractor awareness of ANSTO safety requirements was significantly raised by an initiative requiring all contractors renewing their passes to view a LHSTC-specific contractor safety induction video and satisfactorily answer questions about safety and emergency arrangements. A video on radiation safety for contractors was also produced and will be compulsory for contractors required to enter a radiation controlled area. In addition, an occupational health and safety graduate was employed to demonstrate safety procedures to staff and customers.

Accidents and incidents

Staff are required to report all incidents, accidents and near misses. All reports were investigated and actions taken where appropriate to prevent recurrence. A significant initiative was the introduction of a formal procedure for following up recommendations resulting from accident/incident investigations to ensure they have been implemented. The internal auditors assessed this process during the year and reported favourably on its effectiveness.

In addition to the ANSTO internal reporting and investigations systems, certain types of accident or injury must be reported to the government agency COMCARE under the provisions of Section 68 of the Occupational Health and Safety (Commonwealth Employment) Act. This reporting does not include accidents relating to sporting activities or accidents that occur while travelling to and from work. Significant changes to the COMCARE reporting requirements occurred on 1 January. The most

significant involves the previous requirement to report work-related injuries resulting in an absence of more than five working days; in the new requirements this period is extended to 30 working days.

During the six months to 31 December eight accidents were notified and subsequently reported under the Act. Five of the incidents were classified as extended absences greater than five days, two as serious personal injuries and one as a dangerous occurrence. The dangerous occurrence was a contractor using an elevated work platform that toppled over due to incorrect setting up. Assurances that action has been taken to prevent a recurrence have been obtained from the company.

One of the serious personal injuries was a laceration from a knife being used to open a package, and the other a broken leg resulting from a fall. Preventive action has been taken in both cases. One extended absence was due to a recurrence of a long-standing work-related anxiety condition and two related to manual handling.

In the six months to 30 June under the revised arrangements, ANSTO has reported three cases of serious personal injury. Serious personal injury is now defined as that 'for which a person needs to be given emergency medical treatment by a registered medical practitioner; or treated in a hospital as a casualty, without being admitted to the hospital; or admission to hospital'. One of the cases involved a staff member who tore upper arm muscles trying to save five boxes of paper that were falling from a two-wheeled trolley. Another involved a laceration on a sharp metal edge when a spanner slipped, and the third, a laceration caused by a workshop band saw. Two of the notifiable accidents reported in the period July to December occurred before 1 July 1998, but were not reported to COMCARE until after that date. Consequently, they did not appear in last year's annual report and have been included here.

Radiation protection

As part of the assurance of safety at work for all staff, the ANSTO Personal Dosimetry Service monitored the external radiation exposure of 772 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 11.1 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 dispatch area for products manufactured under the Australian Radioisotopes (ARI) trademark.

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

Table 1: Effective dose

	1995-96	1996-97	1997-98	1998-99
Maximum effective dose mSv	14.8	15.0	12.6	11.1
Average effective dose mSv	0.9	1.0	1.0	1.0
Collective effective dose Person mSv	701	730	811	754

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

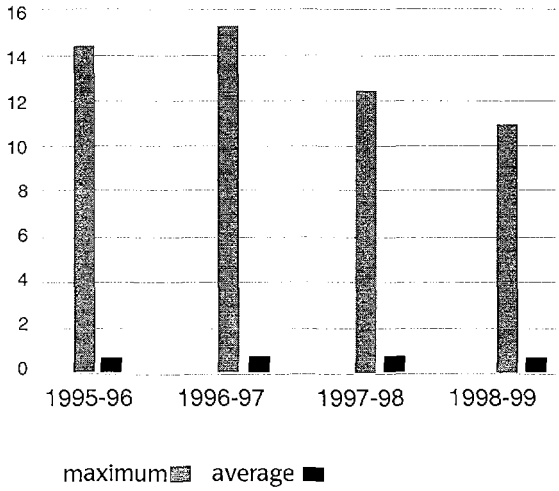
Table 2: Distribution of individual effective dose

Individual effective dose ranges (mSv)	1995-96	1996-7	1997-98	1998-99
≤2	671	657	670	672
> 2 to 5	87	66	80	75
> 5 to 10	17	28	29	24
> 10 to 15	5	3	3	1
> 15 to 20	0	0	0	0
> 20	0	0	0	0

Seventy-five per cent of workers monitored received less than 1 mSv and no worker received more than 12 mSv. The highest dose was received by a dispatch worker in ANSTO's radioisotopes dispatch area, and 22 of the 24 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 35 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 681 mSv, which exceeds the annual dose limit of 500 mSv. (Extremity doses for all other personnel were less than 242 mSv for the year.) The same worker received the highest shallow dose. Investigations revealed that the worker followed inappropriate isotope handling procedures. The procedures have been improved to reduce direct handling of samples, and the method of tracking abnormal doses has been reviewed and improvements implemented. Other extremity doses to personnel in the area have decreased significantly.

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. There was only one case where a dose assessment was necessary and this resulted in an increase of less than 1mSv to the dose record for that individual.

Environmental discharges

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 be detected normally, so an atmospheric dispersal model is used to estimate the doses to the surrounding region and the public.

Prior to 1998, ANSTO used its own dose estimation program for estimating doses from routine airborne releases from HIFAR, but as part of continual improvement initiatives it was decided to change to the internationally used software package PC-CREAM. This was formally accepted by ARPANSA. During the year staff began extending the use of this method to estimating routine release doses from facilities other than HIFAR. ARPANSA agreed to this in principle and full agreement on the authorised discharge levels is expected in the new financial year.

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, which is only 1% of the annual limit recommended by the National Health and Medical Research Council. The doses are well below the average dose of 2 mSv per year received from natural background radiation. A dose of 0.01mSv corresponds to the dose received from a return commercial airline flight from Sydney to Melbourne.

The Australian Radiation Laboratory and the Safety Review Committee continued to provide independent monitoring of ANSTO's airborne

discharges. This role was transferred to ARPANSA in February 1999.

During a period of three weeks in February, there were two occasions when releases above routine levels required nuclear medicine production to be shut down. One involved a release of the inert noble gases, xenon and krypton, and the other, iodine gas. On neither occasion did the release exceed the permitted level of emissions. There were no significant personnel exposures and no off-site health impacts. The appropriate authorities were informed, even though no limits were exceeded.

Tracing potential airborne contaminants

ANSTO continued its work in developing the use of perfluorocarbons as ultra-sensitive tracers for studies of airborne dispersion. The main purpose of this work is to evaluate the model used for potential airborne releases from the Lucas Heights Science and Technology Centre. Portable tracer release systems were constructed, allowing simultaneous release of up to four tracers, which enables testing of the effects of different sources on downwind locations. The technique allows the dispersion of airborne contaminants to be measured.

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.

Discharges of non-radioactive materials complied with the Trade Waste Agreement. The Australian Radiation Laboratory continued to validate the measurements taken in 1998, with ARPANSA assuming this role following its creation in December 1998. A new Trade Waste Agreement was signed in June.

In May, a backhoe being used by contractors of Sydney Water about 1 km beyond the ANSTO boundary caused a small crack in the sewer line through which ANSTO's liquid effluent is discharged. The effluent was sampled and analysed and was well within the levels required by the Trade Waste Agreement. A radiological assessment was performed and it was shown that the doses were insignificant due to the low concentrations of radionuclides in the effluent.

Environmental survey

ANSTO regularly surveys radioactivity levels across the ANSTO site and at remote locations, using samples of soil, creek water, stormwater, seawater, vegetation and air. Results are published annually and are publicly available in local libraries. These results confirmed compliance with all relevant regulatory limits.

Safety assessment

All facilities, experiments and processes on the LHSTC site with potential hazards are assessed and approved by safety committees. For the majority of the year, the Safety Assessment Committee and the Reactors Safety Committee maintained an effective approval and assessment process over all facilities. The Safety Review Committee, which advises the Minister for Industry, Science and Resources, also met twice during the year prior to its role being assumed by ARPANSA.

During the year there was a significant change in regulation with the passing of the ARPANS Act, 1998, and Regulations, 1999. This necessitated a change in the structure of the safety committees to align with the new regulations and a requirement for ANSTO to apply for licences for its activities by 5 August 1999. A new safety directive was issued to describe the new safety assessment and approval process. The committees are described below.

Safety Assessment Committee

For all potentially hazardous activities not directly involving higher category facilities, approval is given by the Safety Assessment Committee (SAC), which consists of representatives from a range of ANSTO Divisions together with an external independent expert. During the year, the committee reviewed some 135 submissions. All submissions are examined by assessors before being presented to the committee and are renewable annually. Conditions on the proposed operations are followed up to ensure they have been implemented.

The revised assessment procedure introduced two

years ago is working well. It strengthens the risk assessment process and emphasises the need to minimise and segregate radioactive waste.

ARPANSA has a review and audit role for the workings of the SAC.

Reactors Safety Committee

The Reactors Safety Committee (RSC) met twice during the year, prior to its functions being transferred to the new ANSTO Health, Safety and Environment Committee. The objective of the RSC was to ensure the existence of an adequate safety system based on appropriate national and international standards. With this aim, the Committee gave special attention to the following: a review of the follow up to abnormal occurrence reports on HIFAR; the use of the International Nuclear Event Scale (INES); completion of actions on recommendations arising from a probabilistic safety assessment of HIFAR; progress on the proposed replacement research reactor; the status of the care and maintenance phase of the shutdown Moata research reactor and project planning for its decommissioning; and the proposed regime for the safety assessment of facilities under ARPANSA.

The ANSTO Health, Safety and Environment Committee

The ANSTO Health, Safety and Environment Committee (AHSEC) monitors the efficiency and effectiveness of all safety and environmental management systems at the Lucas Heights Science and Technology Centre (LHSTC). It reviews and approves all licence applications and requests for modifications to identified facilities. It also monitors the safety of all activities on the LHSTC site and the National Medical Cyclotron and reports to the Executive Director on the effectiveness of the overall safety arrangements.

The Committee also reviews ANSTO's interactions with ARPANSA and either conducts or commissions audits and reviews of the safety and environmental protection of operations on site. Consistent with the new legislation, it also reviews all reports on accidents and incidents involving licensed facilities and ensures that ongoing review of safety cases takes place after licensing.

The Facilities Safety Unit

To assist the safety committees, a new technical unit, the Facilities Safety Unit (FSU), was established. The FSU is responsible for the safety assessment of submissions concerning the design, construction, operation, modification and decommissioning of facilities. It reviews facility Safety Analysis Reports and applications for modifications to either plant or operations. It also reviews facility incident reports together with any subsequent proposals for modifications. It reports its findings and recommendations to the AHSEC.

Emergency Response

Emergency arrangements

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

The NSW Emergency Services organisations with responsibility for fire have stated that the bush fire prevention and preparedness arrangements at ANSTO are exemplary and significantly exceed all recommended standards and guidelines. A number of staff volunteers have been provided with full NSW Rural Fire Service bush fire training and appropriately equipped.

Emergency planning at the Lucas Heights Science and Technology Centre is conducted under the provisions of the NSW State Emergency and Rescue Management Act 1989. This Act requires that a range of plans, generally known as DISPLANs, are 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 arrangements 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 only, are covered by two plans. The Lucas Heights Science and Technology Centre Emergency Plan describes the on-site emergency arrangements for situations 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 very high level of participation by the NSW emergency services organisations.

The Environmental Response Atmospheric Impact Modelling System

The Environmental Response Atmospheric Impact Modelling System (ERAIMS) is based on a transport and dispersion model developed by the Riso National Laboratory in Denmark. This model has been adapted and integrated with a geographical information system to determine the real-time response to any potential accidental airborne release from operations at the Lucas Heights Science and Technology Centre. High quality meteorological data are collected every 15 minutes from three stations in the Lucas Heights region. These data are then available for immediate use by ERAIMS. The data is also placed on ANSTO Internet Site Staff Home Page and on the Bureau of Meteorological Olympics Web Site, where it can be compared with other data from the Sydney region.

Other safety services

A full range of health physics, occupational health and safety, medical, nuclear safety and risk and reliability services were provided to ANSTO facilities, including HIFAR and the National Medical Cyclotron.

A project was set up to develop the documentation necessary for applying for ARPANSA licences for facilities and sources. This has been an effective process for collating the information from divisions and will terminate when the licence applications are submitted in August.

ASSOCIATED ORGANISATIONS

Australian Institute of Nuclear Science and Engineering Incorporated (AINSE)

AINSE is a consortium of Australian and New Zealand universities 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 to provide training in the nuclear field.

By the end of 1998 all Australian universities had joined the consortium. The University of Auckland is also a member, bringing the total memberships to 36 universities and ANSTO.

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.

The objectives of the organisation are:

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

(2) to facilitate graduate and undergraduate education and training experience utilising major nuclear science and technology facilities

(3) to encourage collaboration and co-operation between member organisations of AINSE in areas primarily related to nuclear science and engineering and their applications and

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

Funds received by AINSE are used to support university research. This is done mainly through grants to cover costs associated with operating and developing ANSTO's facilities.

AINSE operates on a calendar-year basis. This report covers 1 January to 31 December 1998. In 1998, income of $2,445,046 was made up of $1,133,400 from ANSTO, $551,850 from university subscriptions, $625,000 from external grants, and $134,796 from interest on investments.

AINSE acts as a peak body on behalf of its member organisations in applying for and administering major research infrastructure grants. In 1998, three Australian Research Council (ARC) grants under the Research Infrastructure and Equipment Program were awarded. They consisted of $150,000 in support of Quaternary Science utilising the ANTARES Accelerator Mass Spectrometry (AMS) facility, $150,000 for neutron scattering equipment, and $300,000 for access to the UK ISIS facility, the most powerful neutron spallation source in the world.

These sums were supplemented by funds from ANSTO and AINSE to meet the full cost of the projects.

An application was submitted and accepted for $240,000 ARC funding in 1999 for a supermirror on ANSTO's long wavelength polarisation instrument, a reflectometer with Langmuir trough and a cryomagnet on the HIFAR research reactor. In addition, the Department of Industry Science and Resources provided $350,000 of the $400,000 needed for Australian membership of ISIS in 1999. This sum will be supplemented by $25,000 provided by ANSTO and a further $25,000 provided by AINSE.

A total of 148 university projects were supported in 1998 under the AINSE grant scheme with a further 26 AMS projects funded from the ARC grants, bringing the total number of projects funded to 174.

In 1998, 22 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.

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.

Three national conferences were organised and supported by AINSE in 1998. These were the 19th AINSE Radiation Conference, held at Melbourne University from 15 to 17 November; the 17th Nuclear and Particle Physics Conference held in conjunction with the 13th AIP Congress in Fremantle, WA, from 27 September to 2 October; and the AINSE 40th Anniversary Conference, which was held at Lucas Heights from 2 to 3 December.

AINSE continued to provide information on forthcoming conferences and other AINSE activities, as well as copies of grant and studentship application documents, on its web page (www.ansto.gov.au/ansto/ainse/ainse1.html).

AINSE is the umbrella organisation for the Australian chapter of the International Association for Radiation Research and is organising on behalf of Australian radiation researchers the International Congress for Radiation Research in year 2003. It will be held during August 17-22 at the Brisbane Convention Centre.

The 1998 AINSE Gold Medal for Excellence in Research supported by AINSE was awarded to Professor Ian McDougall at the Australian National University for his pioneering work in the development of potassium-argon and argon-40/argon-39 dating techniques, which have made fundamental contributions spanning a broad spectrum of application over four decades. His contributions have been particularly significant in establishing the geomagnetic polarity time scale as one of the foundations of the theory of plate tectonics, characterising the evolution of oceanic island chains and demonstrating their relationship to underlying plate motions, development of a highly precise time framework for hominid evolution in East Africa, development of Argon-40/Argon-39 step heating methods as a powerful tool for understanding time-dependent relationships in the evolution of geological terrains, and application of noble gas geochemistry to study mantle-derived materials, including the identification of a primordial solar noble gas component within the earth.

Dr Ismunander at the University of Sydney was awarded the Student Gold Medal for his work as a postgraduate student on the structure of metal oxides using the combined techniques of neutron scattering and anomalous dispersion diffraction. His work has resulted in the first insight into the thermal effects on cation disorder in lead-bismuth oxides, which has important implications for the fabrication of ferroelectric devices.

The second AINSE Winter School at ANSTO, incorporating undergraduate experiments and involving a student from every member university

of AINSE, was held from 4 to 7 July. A scholarship was provided to every 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 1999. AINSE is very grateful to the staff at ANSTO who give their time and expertise to this important program. It significantly contributes to the public profile of AINSE and ANSTO, and is especially effective as a shopwindow for potential users of ANSTO's facilities.

The President of AINSE for 1997 and 1998 was Professor Trevor Ophel from the Australian National University. The Vice President was Professor Ron MacDonald from the University of Newcastle. The Executive Officer at the beginning of 1998 was Dr Roger B Gammon. Dr Gammon retired in late March 1998 and was replaced by Dr Dennis Mather, who commenced in early March as Scientific Secretary.

Member organisations of AINSE as at 31 December 1998:

ANSTO

University of Adelaide

University of Auckland

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.

For further information, look up the AINSE website (http://www.ansto.gov.au/ainse/ainse1.html).

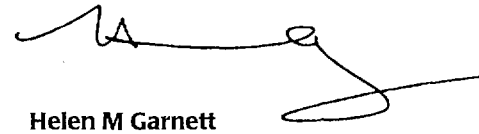
STATEMENT BY DIRECTORS

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 1999 represent fairly the information required by the Commonwealth Authorities and Companies (CAC) Orders (Amendment) 1998 For The Financial Statements of CAC Bodies.

Signed in accordance with a resolution of the members of the Board.

S M Richards
Chairman

17 August 1999
Sydney



Helen M Garnett
Executive Director

17 August 1999
Sydney

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

OPERATING STATEMENT

FOR THE YEAR ENDED 30 JUNE 1999

	Note	1999 $'000	1998 $'000
NET COST OF SERVICES			
Operating expenses	4		
International strategic relevance of nuclear science		**7,385**	6,668
Core facilities operation and development		**33,037**	33,270
Application of nuclear science and technology to natural processes		**5,804**	5,816
Treatment and management of radioactive substances		**16,256**	14,660
Competitiveness and ecological sustainability of industry		**17,092**	16,465
Organisational development and support		**13,873**	14,208
Radiopharmaceutical operations	6	**8,301**	8,178
Total operating expenses		**101,748**	99,265
Operating revenues from independent sources	5		
International strategic relevance of nuclear science		**2,298**	2,601
Core facilities operation and development		**5,154**	4,313
Application of nuclear science and technology to natural processes		**489**	716
Treatment and management of radioactive substances		**932**	949
Competitiveness and ecological sustainability of industry		**5,163**	6,088
Organisational development and support		**2,376**	2,025
Radiopharmaceutical operations	6	**14,313**	13,310
Total operating revenue from independent sources		**30,725**	30,002
Net cost of services		**71,023**	69,263
REVENUE FROM GOVERNMENT			
Parliamentary appropriations received			
Operating	7	**57,687**	56,284
Capital	7	**20,792**	16,447
Total revenue from government		**78,479**	72,731
Surplus of revenues from government over net cost of services		**7,456**	3,468
Gain on extraordinary items	13	**321**	–
Surplus	9	**7,777**	3,468
EQUITY INTEREST			
Accumulated surpluses at beginning of reporting period	9	**97,240**	91,881
Amounts transferred (to) / from reserves	9	**(887)**	1,891
Accumulated surpluses at end of reporting period		**104,130**	97,240

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

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

STATEMENT OF ASSETS AND LIABILITIES

AS AT 30 JUNE 1999

	Note	1999 $'000	1998 $'000
PROVISIONS AND PAYABLES	8		
Employees		**17,726**	16,603
Suppliers		**8,100**	3,033
Other payables		**3,327**	2,857
Other provisions		**2,978**	4,372
Total provisions and payables		**32,131**	26,865
Total liabilities		**32,131**	26,865
EQUITY	9		
Reserves		**100,640**	88,051
Accumulated surpluses		**104,130**	97,240
Total equity		**204,770**	185,291
Total liabilities and equity		**236,901**	212,156
FINANCIAL ASSETS	10		
Cash		**23,292**	14,285
Receivables		**8,468**	4,758
Total financial assets		**31,760**	19,043
NON-FINANCIAL ASSETS	11		
Land and buildings		**124,362**	123,610
Infrastructure, plant and equipment		**72,206**	58,355
Inventories		**7,849**	8,819
Intangibles		**309**	277
Other		**415**	2,052
Total non-financial assets		**205,141**	193,113
Total assets		**236,901**	212,156
Current liabilities		**19,277**	11,793
Non-current liabilities		**12,854**	15,072
Current assets		**33,971**	22,856
Non-current assets		**202,930**	189,300

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

STATEMENT OF CASH FLOWS

FOR THE YEAR ENDED 30 JUNE 1999

	Note	1999 $'000 Inflows (Outflows)	1998 $'000 Inflows (Outflows)
OPERATING ACTIVITIES			
Cash received			
Sales of goods and services		**25,641**	30,283
Interest received		**962**	758
Parliamentary appropriations		**78,479**	72,731
Total cash received		**105,082**	103,772
Cash used			
Employees		**(47,743)**	(47,000)
Suppliers		**(35,037)**	(46,623)
Total cash used		**(82,780)**	(93,623)
Net cash from operating activities	12	**22,302**	10,149
INVESTING ACTIVITIES			
Cash received			
Proceeds from sales of property, plant and equipment		**16**	148
Total cash received		**16**	148
Cash used			
Purchase of property, plant and equipment		**(13,311)**	(9,249)
Total cash used		**(13,311)**	(9,249)
Net cash from investing activities		**(13,295)**	(9,101)
Net increase/(decrease) in cash held		**9,007**	1,048
Cash at 1 July		**14,285**	13,237
Cash at 30 June	10	**23,292**	14,285

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

SCHEDULE OF COMMITMENTS

AS AT 30 JUNE 1999

	Note	1999 $'000	1998 $'000
BY TYPE			
CAPITAL COMMITMENTS			
Property, plant and equipment		**3,497**	4,964
Waste treatment and disposal project	8	**3,988**	5,115
Total capital commitments		**7,485**	10,079
OTHER COMMITMENTS			
Disposal of spent fuel (a)		**75,226**	80,826
Total other commitments		**75,226**	80,826
Total commitments payable		**82,711**	90,905
Commitments receivable			
Disposal of spent fuel (a)		**72,361**	80,826
Major international design and construction contract (b)		**14,657**	18,571
		87,018	99,397
Net commitments		**(4,307)**	(8,492)
BY MATURITY			
Commitments payable			
One year or less		**9,743**	5,386
From one to two years		**607**	2,678
From two to five years		**–**	2,015
		10,350	10,079
Commitments receivable			
One year or less		**(6,869)**	(7,727)
From one to two years		**(856)**	(1,550)
From two to five years		**(6,932)**	(9,294)
		(14,657)	(18,571)
Net commitments		**(4,307)**	(8,492)

(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 $14.039 million has been received as at 30 June 1999, of which $11.174 million was used to meet two contract payments. The unspent $2.865 million will be carried forward to 1999-2000 to meet commitments yet to mature. The remaining $72.361 million will be drawn down by year 2020 in accordance with a schedule agreed with Government. The amount of $72.361 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.

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

AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION

SCHEDULE OF CONTINGENCIES

AS AT 30 JUNE 1999

	Note	1999 $'000	1998 $'000
CONTINGENT LOSSES			
Total contingent losses		–	–
		–	–
CONTINGENT LOSSES			
Total contingent gains		–	–
		–	–
Net contingencies		–	–

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

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 30 JUNE 1999

NOTES TO AND FORMING PART OF THE FINANCIAL STATEMENTS

FOR THE YEAR ENDED 30 JUNE 1999

1 ECONOMIC DEPENDENCY

ANSTO is dependent on appropriations from Parliament to carry out its activities.

2 SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

The financial statements 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, the ANSTO Amendment Act 1992, and the Commonwealth Authorities and Companies Act, 1997.

ii. in accordance with Schedule 2 of Commonwealth Authorities and Companies Orders (Amendment) 1998 for the Financial Statements of CAC Bodies issued by the Minister for Finance and Administration, which requires that the financial statements be prepared in compliance with Australian Accounting Standards and related Guidance Releases and Urgent Issues Group consensus views issued by the Australian Accounting Research Foundation and having regard to accounting concepts.

Basis of accounting

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.

The principal accounting policies adopted in the preparation of these financial statements are:

(a) 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.

(b) 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.

(c) 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 allocation of overhead expenses.

(d) Property, 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

In accordance with the Finance Minister's Orders property, plant and equipment are required to be revalued in accordance with the deprival method of valuation by no later than 1 July 1999 and thereafter at three yearly intervals. ANSTO has implemented a progressive revaluation to July 1999 as follows:

Land and buildings were revalued as at 30 June 1997 by Mr John Starr and plant and equipment as at 30 June 1999 by Mr Simon O'Leary of Australian Valuation Office.

Application of the deprival method of valuation values land at current market buying price and the buildings, plant and equipment at depreciated replacement value. Assets acquired after the commencement of revaluation are reported at cost as at 30 June 1999. Assets where the revalued amount was below the capitalisation threshold of $3,000 continued to be disclosed at cost less accumulated depreciation.

The major national facility, HIFAR reactor has been reported at cost and is programmed to be revalued during the financial year ended 30 June 2000 effective from 1 July 1999.

Any assets classified as "not be replaced" or which are surplus to requirements are valued at net realisable value at 30 June 1999.

All valuations are conducted by independent qualified valuers.

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 as follows:

	1999	1998
Buildings on freehold land	**30 years**	30 years
Plant and equipment	**2 to 30 years**	3 to 30 years
Infrastructure	**20 years**	20 years
Major facilities	**9 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 are found to be appropriate.

(e) 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 1999 there were 146 patents (122 at 30 June 1998) registered to ANSTO and no associated costs are recognised as an asset.

(f) Employee entitlements

The provisions for employee entitlements encompass annual leave and long service leave which 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 30 June1999 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.

(g) Revenue recognition

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.

Parliamentary appropriations

Parliamentary appropriations are recognised in the year in which they are drawn down.

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.

(h) 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. 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.

Contributions during the financial year are detailed at Note 4.

(i) 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.

(j) Taxation

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

(k) Intangible assets

In accordance with the Finance Minister's Orders the asset class Intangibles also required revaluation based on the deprival method of valuation by 1 July 1999. Where recognised, intangible assets are reported at valuation as at 30 June 1999.

(l) 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.

(m) Comparatives

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

(n) 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 REPORTING

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

4 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 6 refers).

The breakdown of operating expenses is:

	1999 $'000	1998 $'000	**1999 $'000**	1998 $'000
Employee expenses:				
Salaries	**37,846**	36,398		
Superannuation	**6,423**	6,134		
Redundancy	**112**	184		
Annual leave	**3,277**	3,283		
Long service leave	**1,210**	1,338		
Total employee expenses			**48,868**	47,337
Supplier expenses:				
General expenses	**10,366**	10,507		
Stores	**6,090**	7,278		
Maintenance and external services	**9,278**	8,406		
Power and water	**1,397**	1,252		
Reactor supplies	**1,067**	1,138		
Disposition of spent fuel rods	**5,177**	5,358		
Variable production costs	**2,977**	2,955		
Operating leases	**142**	135		
Total supplier expenses			**36,494**	37,029
Depreciation and amortisation:				
Depreciation of property, plant and equipment	**14,958**	14,193		
Amortisation of intangible assets	**111**	89		
Total depreciation and amortisation			**15,069**	14,282
Other:				
Doubtful debts	**50**	128		
Loss on disposal of plant and equipment	**336**	139		
Share of partnership loss	**59**	211		
Unrealised foreign exchange loss (see also Note 21)	**860**	–		
Nuclear materials stock revaluation	**12**	139		
Total other expenses			**1,317**	617
TOTAL			**101,748**	99,265

5 OPERATING REVENUE FROM INDEPENDENT SOURCES

	1999 $'000	1998 $'000	1999 $'000	1998 $'000
Sales of goods and services:				
Radioisotope sales	**14,281**	13,288		
Services and contract research	**3,696**	4,867		
Major international design and construction contract	**1,674**	1,838		
Silicon irradiation	**2,355**	2,196		
CSIRO site support	**903**	932		
Training courses	**190**	266		
Land management	**1,936**	1,689		
Synchrotron project	**733**	508		
AINSE interactions	**1,306**	1,065		
Total sales of goods and services			**27,074**	26,649
Grants			**1,911**	1,254
Interest			**1,054**	901
Profit on disposal of plant and equipment			**635**	470
Other revenue:				
Non-speculative foreign exchange gain (see also Note 21)	**3**	233		
ACARRE contributions	**45**	–		
Prior year adjustments	**–**	457		
Nuclear material stock revaluation	**3**	–		
Asset received free of charge	**–**	38		
Total other revenue			**51**	728
TOTAL			**30,725**	30,002

6 RADIOPHARMACEUTICAL OPERATIONS

Trading as Australian Radioisotopes (ARI)

	1999 $'000	1998 $'000
ARI operating results, as an independent commercial unit within ANSTO, are as follows:		
Revenue		
External sales and other revenue	**14,313**	13,310
Internal sales	**151**	67
Total revenue	**14,464**	13,377
Expenses		
Salaries	**3,571**	3,441
Superannuation	**508**	484
Annual leave	**46**	31
Long service leave	**89**	11
Doubtful debts	**48**	39
Other operating expenses	**3,827**	3,950
Depreciation of property, plant and equipment	**212**	222
	8,301	8,178
Internal support	**5,203**	4,633
Total expenses	**13,504**	12,811
Operating surplus	**960**	566

7 PARLIAMENTARY APPROPRIATIONS	1999 $'000	1998 $'000
Appropriation Act No.1 Operating	**57,687**	53,950
Appropriation Act No.3 Operating	**–**	2,334
	57,687	56,284
Appropriation Act No.2 Capital	**20,792**	16,447
	78,479	72,731

8 PROVISIONS AND PAYABLES	1999 $'000	1998 $'000
8A. Liabilities to employees		
Accrued salaries and wages	**1,014**	791
Annual leave	**5,472**	5,108
Long service leave	**11,240**	10,704
Aggregate employee entitlement liability	**17,726**	16,603
8B. Suppliers		
Trade creditors	**8,100**	3,033
	8,100	3,033
8C. Other payables		
Revenue received in advance	**3,327**	2,857
8D. Other provisions		
HIFAR spent fuel rods - (a)	**1,553**	1,553
Waste treatment & disposal - (b)	**965**	2,469
Common law claims	**415**	250
Other	**45**	100
Total other provisions	**2,978**	4,372

(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 1998-99. The residual provision includes a substantial storage cost component covering a 20 year period, and will be reduced over time.

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 1998-99 $1.504 million (1997-98 $1.521 million) has been charged against the provision. Further expenditure of $0.254 million was capitalised.

This provision was reviewed in 1999 and found to be adequate.

9 EQUITY	1999 $'000	1998 $'000
Reserves, including movements		
Asset revaluation reserve		
Balance 1 July	**87,538**	87,538
Net revaluation increases	**11,702**	–
Balance 30 June	**99,240**	87,538
Fuel elements reserve		
Balance 1 July	**513**	2,404
Transferred to accumulated surpluses	**(513)**	(1,891)
Balance 30 June	**–**	513
Instrumentation reserve		
Balance 1 July	**–**	–
Transferred from accumulated surpluses - (a)	**1,400**	–
Balance 30 June	**1,400**	–
Total reserves	**100,640**	88,051
Accumulated surpluses		
Accumulated surpluses 1 July	**97,240**	91,881
Transfers to instrumentation reserve	**(1,400)**	–
Transfer from fuel elements reserve	**513**	1,891
Operating surplus - (b)	**7,777**	3,468
Accumulated surpluses 30 June	**104,130**	97,240
Total equity	**204,770**	185,291

(a) **Instrumentation reserve**
In addition to the 1997 Government decision to fund the construction of a replacement research reactor at Lucas Heights, ANSTO is identifying a planned future capital investment for the development of instrumentation associated with the replacement research reactor.

(b) **Operating surplus**
The operating surplus 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.

10 FINANCIAL ASSETS	1999 $'000	1998 $'000	1999 $'000	1998 $'000
10A. Cash				
Cash at bank and on hand			**9,202**	4,285
Fixed term investment			**14,090**	10,000
			23,292	14,285
10B. Receivables				
Goods and services (trade debtors)			**8,544**	4,894
Less provision for doubtful debts			**176**	236
			8,368	4,658
Advance held by Dept of Industry Science and Resources for overseas payments			**60**	60
Other			**40**	40
			8,468	4,758
Age analysis of trade debtors				
Current	**2,293**	2,685		
Overdue:				
Less than 30 days	**1,195**	624		
30 to 60 days; and	**639**	126		
More than 60 days*	**4,417**	1,459		
	8,544	4,894		

* The largest part of this debt is with two separate entities. Legal proceedings have commenced to recover one debt in respect of which legal advice is that the debt is legally enforceable. The second debt relates to an international design and construction contract, where there are delays in payment. No provision is required for either of these outstanding debts.

11 NON-FINANCIAL ASSETS	1999 $'000	1998 $'000
11A. Land and buildings		
Land - at independent valuation	**33,223**	33,223
Buildings - at cost	**8,714**	3,725
Less accumulated depreciation	**668**	272
	8,046	3,453
Buildings - at independent valuation	**90,774**	90,774
Less accumulated depreciation	**7,681**	3,840
	83,093	86,934
Total buildings	**91,139**	90,387
Total land and buildings	**124,362**	123,610
11B. Infrastructure, plant, equipment and major facilities		
11B (i) Plant and equipment		
Plant and equipment - at cost	**12,525**	60,595
Less accumulated depreciation	**11,250**	32,086
	1,275	28,509
Additions - at cost	**7,667**	–
Less accumulated depreciation	**718**	–
	6,949	–
Plant and equipment - at independent valuation	**30,452**	–
Less accumulated depreciation	**–**	–
	30,452	–
Plant and equipment under construction	**1,974**	1,057
Total plant and equipment	**40,650**	29,566
11B (ii) Infrastructure		
Electrical/site services		
Electrical/site services facilities - at cost	**2,166**	1,364
Less accumulated depreciation	**403**	152
	1,763	1,212
Electrical/site services facilities - at independent valuation	**16,765**	16,765
Less accumulated depreciation	**3,726**	1,863
	13,039	14,902
Total infrastructure	**14,802**	16,114
11B (iii) Major facilities		
Major research facilities - at cost	**12,373**	27,286
Less accumulated depreciation	**11,866**	18,610
	507	8,676
Major research facilities - at independent valuation	**6,456**	–
Less accumulated depreciation	**–**	–
	6,456	–
Research facility under construction - at cost	**1,068**	2,336
Research facility under construction - at independent valuation	**3,333**	–
Replacement Research Reactor capitalised cost	**5,390**	1,663
Total major facilities	**16,754**	12,675
Total infrastructure, plant, equipment and major facilities	**72,206**	58,355
Total land, buildings, infrastructure, plant, equipment and major facilities	**196,568**	181,965

11 Non-financial assets (continued)

Movement summary 1998-99 for all assets irrespective of valuation basis

	Land	Building	Total land and building	Infrastructure, plant, equipment and major facilities	Total
	$'000	$'000	$'000	$'000	$'000
Net book value as at 1 July 1998	**33,223**	**90,387**	**123,610**	**58,355**	**181,965**
Gross value as at 1 July 1998	**33,223**	**94,500**	**127,723**	**111,066**	**238,789**
Additions	–	4,988	4,988	13,783	18,771
Revaluations	–	–	–	11,580	11,580
Disposals	–	–	–	(5,016)	(5,016)
Other movements	–	–	–	(31,242)	(31,242)
Gross value as at 30 June 1999	**33,223**	**99,488**	**132,711**	**100,171**	**232,882**
Accumulated depreciation/ amortisation 1 July 98	–	4,113	4,113	52,711	56,824
Depreciation/amortisation for assets held 1 July 98	–	4,113	4,113	9,884	13,997
Depreciation/amortisation charge for additions	–	123	123	836	959
Adjustments for other movements	–	–	–	(31,553)	(31,553)
Adjustments for disposals	–	–	–	(3,913)	(3,913)
Accumulated depreciation/ amortisation 30 June 99	**–**	**8,349**	**8,349**	**27,965**	**36,314**
Net book value as at 30 June 99	**33,223**	**91,139**	**124,362**	**72,206**	**196,568**

Summary of balance of assets at valuation as at 30 June, 1999

Item	Land	Building	Total land and building	Infrastructure, plant, equipment and major facilities	Total
	$'000	$'000	$'000	$'000	$'000
As at 30 June, 1998					
Gross value	33,223	90,774	123,997	16,765	140,762
Accumulated depreciation/amortisation	–	3,840	3,840	1,863	5,703
Net value	**33,223**	**86,934**	**120,157**	**14,902**	**135,059**
As at 30 June, 1999					
Gross value	33,223	90,774	123,997	57,006	181,003
Accumulated depreciation/amortisation	–	7,681	7,681	3,726	11,407
Net value	**33,223**	**83,093**	**116,316**	**53,280**	**169,596**

11 Non-financial assets (continued)

	1999 $'000	1998 $'000
11C. Inventories		
Raw materials and stores - not held for resale		
Stores - at cost	**774**	738
Cobalt-60 sources - at net realisable value	**551**	548
Reactor fuel and heavy water - at average purchase price	**5,815**	6,811
Nuclear materials - at net realisable value	**592**	605
Nuclear materials - at cost	**20**	20
	7,752	8,722
Work in progress - held for sale		
Work in progress - at cost	**97**	97
	7,849	8,819
11D. Intangibles		
Licences - at valuation	**309**	431
Less accumulated amortisation	**–**	154
	309	277

Movement summary 1998-99 for intangibles irrespective of valuation basis

Intangibles	Total $'000
Net book value as at 1 July, 1998	**277**
Gross value as at 1 July, 1998	**431**
Additions	21
Revaluation	122
Other movements	(265)
Gross value as at 30 June, 1999	**309**
Accumulated amortisation 1 July, 1998	**154**
Amortisation for assets held 1 July, 1998	106
Amortisation charge for additions	5
Adjustments for other movements	(265)
Accumulated amortisation 30 June, 1999	**–**
Net book value as at 30 June, 1999	**309**

11E. Other		
Prepayments	**118**	1,597
Interest accrued	**297**	202
Other	**–**	253
	415	2,052
Total non-financial assets	**205,141**	193,113

12 CASH FLOW RECONCILIATION

Reconciliation of net cash flows from operating activities to Net Cost of Services

	1999 $'000	1998 $'000
Net Cost of Services	**71,023**	69,263
Revenue from Government	**78,479**	72,731
Operating surplus	**7,456**	3,468
Decrease/(increase) in prepayments	**1,479**	(1,118)
Decrease/(increase) in inventories	**980**	185
(Decrease)/increase in other accruals	**5,821**	(531)
(Decrease) in other creditors	**(139)**	(557)
(Decrease) in provision for HIFAR spent fuel rods	**–**	(504)
(Decrease) in provision for waste treatment and disposal	**(1,504)**	(1,521)
Increase in creditors	**(681)**	478
Increase in employee entitlements.	**899**	780
Increase in provision for common law claims	**165**	250
Increase/(decrease) in other provisions	**(55)**	65
(Increase) in accrued interest	**(95)**	(142)
(Increase) in assets under construction	**(628)**	(111)
(Increase) in receivables	**(3,650)**	(1,348)
Foreign exchange loss/(gain)	**856**	(214)
Nuclear materials (devaluation)/revaluation	**(9)**	139
Assets received free of charge	**–**	(37)
Depreciation/amortisation	**15,069**	14,282
Gain on disposal of assets	**(635)**	(470)
Loss on disposal of assets	**336**	139
Replacement research reactor - capitalised cost	**(3,757)**	(1,633)
Other	**73**	(1,451)
Extraordinary items (refer to note 13)	**321**	–
Net cash provided by operating activities	**22,302**	10,149

13 EXTRAORDINARY ITEMS

The extraordinary gain results 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 4) are:

	1999 $	1998 $
Aggregate amounts of superannuation payments in connection with the retirement of members of the Board	**27,819**	25,048
Other remuneration received, or due and receivable by the members of the Board	**274,809**	262,449
	302,628	287,497

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**	–
$10,000 and $19,999	**2**	2
$20,000 and $29,999	**1**	1
$30,000 and $39,999	**1**	1
$170,000 and $179,999	**–**	–
$180,000 and $189,999	**–**	–
$190,000 and $199,999	**1**	1
	6	5

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 4) 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.

	1999 $	1998 $
	1,517,062	1,996,881

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	**3**	4
$110,000 and $119,999	**1**	1
$120,000 and $129,999	**2**	5
$130,000 and $139,999	**4**	2
$140,000 and $149,999	**1**	–
$150,000 and $159,999	**–**	1
$160,000 and $169,999	**1**	1
$210,000 and $219,999	**–**	1
	12	15

16 INSURANCE

Comcover, the Commonwealth's managed fund for insurable risk, began operations on 1 July 1998. For ANSTO, all risk previously covered by commercial insurance, including professional indemnity, general liability, industrial special risk for a property used substantially for commercial purposes, directors and officers, and travel, were reinsured under Comcover on 1 October 1998. The terms and conditions for these policies were substantially unchanged from those of the previous commercial policies.
Workers compensation is covered by statute under the Safety Rehabilitation and Compensation Act 1988.

A Deed of Indemnity was signed 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.

17 REMUNERATION OF AUDITORS

	1999 $	1998 $
Remuneration to the Auditor-General for auditing the financial statements for the reporting period	**92,000**	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		10 May 2000
M H Codd AC	5 July 1996	30 June 1999	
	21 July 1999		31 December 2001
S M Richards	5 July 1996		30 June 2001
F A Khafagi	14 May 1997		31 December 1999
J M Craker	2 June 1998		31 December 2002
A K Gregson	5 July 1996	31 December 1998	
P W Wellings	2 June 1998	7 May 1999	
C Hillyard	21 July 1999		21 July 2004
J Spasojevic	21 July 1999		21 July 2004

For the 1998-99 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 $27,819 (1997-98 $25,048).

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.

20 TRUST MONEY	1999 $'000	1998 $'000
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	**1,780**	583
Add: receipts	**1,927**	2,036
interest received	**68**	36
Deduct: payments	**1,340**	875
Balance 30 June	**2,435**	1,780
Represented by the following:		
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	**9**	9
Add: receipts	**11**	–
interest received	**–**	–
Deduct: payments	**–**	–
Balance 30 June	**20**	9
MNRF synchrotron		
The Australian Synchrotron Research Program Incorporated was established under the Major National Research (MNRF) Program.		
Balance 1 July	**1,752**	554
Add: receipts	**1,916**	2,033
interest received	**67**	35
Deduct: payments	**1,340**	870
Balance 30 June	**2,395**	1,752
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 1995 to fund the operations of the project.		
Balance 1 July	**3**	3
Add: receipts	**–**	–
interest received	**–**	–
Deduct: payments	**–**	–
Balance 30 June	**3**	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	**16**	17
Add: receipts	**–**	3
interest received	**1**	1
Deduct: payments	**–**	5
Balance 30 June	**17**	16

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.	
Fixed Term Investment	10A	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 4.81% payable monthly.
Foreign exchange holdings	10A	Transactions denominated in a foreign currency are converted at a rate of exchange prevailing at the date of each transaction.	The deposits are with the Commonwealth Bank of Australia, the Westpac Banking Corporation, and the Bank of America, and earn an effective rate of interest of 2.58% payable on maturity.
Receivables for goods & services	10B	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 (1997-98: 30 days)
Loans	10B	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 Common-wealth agency provides the basis for reimbursement of the advance to the operating limit.
Other debtors	10B	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	8B	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	8C	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	8D	Liabilities have been recognised for transport and reprocessing of spent fuel elements, management of residual waste from past operations, and pending common law claims.	Provision for spent fuel disposition will be drawn as and when required and management of residual waste will be drawn down by 2001 in accordance with the schedule set out in a Waste Management Action Plan. Other provisions for common law claims are contingent upon completion and outcome of legal proceedings and may be expected to be used within 1 to 2 years.

21 Financial Instruments (continued)

(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							
		98-99 $'000	97-98 $'000	**98-99 $'000**	97-98 $'000	**98-99 $'000**	97-98 $'000	**98-99 $'000**	97-98 $'000	**98-99 $'000**	97-98 $'000	**98-99 $'000**	97-98 $'000
Financial Assets (Recognised)													
Cash at Bank	10A	**2,451**	2,627	–	–	–	–	–	–	**2,451**	2,627	**3.79%**	3.16%
Cash on Hand	10A	–	–	–	–	–	–	**17**	17	**17**	17	**n/a**	n/a
Fixed term investment	10A	–	–	**14,090**	10,000	–	–	–	–	**14,090**	10,000	**4.81%**	4.91%
Foreign exchange holdings	10A	**6,734**	1,641	–	–	–	–	–	–	**6,734**	1,641	**2.58%**	5.66%
Receivables for Goods and Services	10B	–	–	–	–	–	–	**8,368**	4,658	**8,368**	4,658	**n/a**	n/a
Loans	10B	–	–	–	–	–	–	**60**	60	**60**	60	**n/a**	n/a
Other debtors	10B	–	–	–	–	–	–	**40**	40	**40**	40	**n/a**	n/a
Total Financial Assets (Recognised)		**9,185**	4,268	**14,090**	10,000	–	–	**8,485**	4,775	**31,760**	19,043		
Total Assets										**236,901**	212,156		
Financial Liabilities (Recognised)													
Trade Creditors	8B	–	–	–	–	–	–	**8,100**	3,033	**8,100**	3,033	**n/a**	n/a
Revenue received in advance	8C	–	–	–	–	–	–	**3,327**	2,857	**3,327**	2,857	**n/a**	n/a
Other provisions	8D	–	–	–	–	–	–	**2,978**	4,372	**2,978**	4,372	**n/a**	n/a
Total Financial Liabilities (Recognised)		–	–	–	–	–	–	**14,405**	10,262	**14,405**	10,262		
Total Liabilities										**32,131**	26,865		

21 Financial Instruments (continued)
(c) Net Fair Values of Financial Assets and Liabilities

	Note	1998-99 Total carrying amount $'000	1998-99 Aggregate net fair value $'000	1997-98 Total carrying amount $'000	1997-98 Aggregate net fair value $'000
Financial Assets					
Cash at Bank	10A	2,451	2,451	2,627	2,627
Cash on Hand	10A	17	17	17	17
Term investments	10A	14,090	14,090	10,000	10,000
Foreign exchange holdings	10A	6,734	6,734	1,641	1,641
Receivables for Goods and Services	10B	8,368	8,368	4,658	4,658
Loans	10B	60	60	60	60
Other debtors	10B	40	40	40	40
Total Financial Assets		**31,760**	**31,760**	19,043	19,043
Financial Liabilities (Recognised)					
Trade creditors	8B	8,100	8,100	3,033	3,033
Revenue received in advance	8C	3,327	3,327	2,857	2,857
Other provisions	8D	2,978	2,978	4,372	4,372
Total Financial Liabilities (Recognised)		**14,405**	**14,405**	10,262	10,262

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 10.

Australian National
Audit Office

INDEPENDENT AUDIT REPORT

To the Minister for Industry, Science and Resources

Scope

I have audited the financial statements of Australian Nuclear Science and Technology Organisation for the year ended 30 June 1999. The financial statements comprise:

- Statement by Directors
- Operating Statement
- Statement of Assets and Liabilities
- 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 Minister for Industry, Science and Resources.

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 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

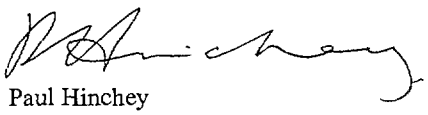
Audit Opinion

In my opinion,

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

(ii) the financial statements give a true and fair view, in accordance with applicable Accountin Standards, other mandatory professional reporting requirements and Schedule 2 of the Financ Minister's Orders, of the financial position of the Australian Nuclear Science and Technolog Organisation as at 30 June 1999 and the results of its operations and its cash flows for the yea then ended.

Australian National Audit Office



Paul Hinchey
Senior Director

Delegate of the Auditor General

Sydney
18 August 1999

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 the social justice needs of the 1990s.

ACTIVITIES AND OUTPUTS

The review of people management policies and procedures, begun last year, continued. The review is being carried out to ensure all policies and procedures meet best practice requirements and recognise the value of diversity.

Staff and their families continued to be provided with access to the services of counsellors from Citipsych. A survey to assess the workforce response to the provider demonstrated satisfaction with the service.

Terms of reference for the workplace Equal Employment Opportunity and Diversity Committee on EEO and harassment issues were reviewed and updated. A refresher course for harassment officers was conducted.

Staff employed at corporate executive level as at 30 June 1999

Band 3 Corporate Executive	1 Male	
Band 2 Corporate Executive	11 Male	1 Female
Band 1 Corporate Executive	2 Male	1 Female

Staff numbers as at 30 June 1999

	Full time		Part time	
	Male	Female	Male	Female
Executive Director		1		
Corporate Executives	13	2	1	
Professional Officers	165	48		6
Research Scientists	88	17	2	
Technical Officers	250	24		4
Administrative Services Officers	38	71		13
Craftsperson	63	4	1	4
Total	617	167	4	27

Total Staff 786

Summary of EEO statistics as at 30 June 1999

Total staff = 815	Number employed	Percentage of total staff	Average salary
Female	194	24	$53,048
Male	621	76	$43,442

Staff in specific employment categories (based on specific data voluntarily provided by 360 staff)

People with disabilities	24	$48,403
Aboriginal and Torres Strait Islanders	2	$45,552
Non-English speaking background	154	$51,389

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

Australian Radiation Protection and Nuclear Safety Agency

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) was established on 5 February 1999 to implement the requirements of the Australian Radiation Protection and Nuclear Safety Act and Regulations. It was formed by the amalgamation of the Nuclear Safety Bureau and the Australian Radiation Laboratory of the Commonwealth Department of Health and is responsible to the Minister for Health and Aged Care. Its main task is to regulate all Commonwealth entities involved in radiation or nuclear activities or dealings.

The roles previously exercised by the Nuclear Safety Bureau and the Safety Review Committee are subsumed by ARPANSA.

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.

Meetings are held every two months between local community groups and ANSTO with an independent facilitator to ensure exchange of information.

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 the Annual Report, Lucas Heights News, Program of Research, Strategic 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, employment, delegations, security, finance and accounting handbooks and manuals.

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 and 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 rmh@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.

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 Employee's) Act 1976*
- *Superannuation Act 1976*
- *Superannuation Act 1990*
- *Superannuation (Productivity Benefit) Act 1988*
- *Superannuation Guarantee (Administration) Act 1992*
- *Maternity Leave (Commonwealth Employees) Act 1987*
- *Australian Radiation Protection and Nuclear Safety Act 1998 (applicable from February 1999)*
- *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.

With respect to the Commonwealth Authorities and Companies Act 1997, ANSTO arranged for all senior managers to be briefed during the financial year on the key provisions of the Act and their duties and responsibilities under that Act.

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

For most of the year, the Board comprised five non-executive members, drawn from the broader community, and the Executive Director. The Executive Director, who is appointed by the Board, cannot be the Chairman. A retirement in May reduced the non-executive membership to four. 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 1998-99 financial year had experience in areas that included industry, scientific research, medicine and primary production.

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.

Eight Board meetings were held during the financial year. The number of Board meetings during the period in which each member held office during the financial year, and the number of meetings attended by each member, are provided below.

MEETINGS

Member	Held	Attended
S M Richards (Chairman)	8	8
M H Codd AC	8	8
A K Gregson (Retired 31/12/98)	4	4
F A Khafagi * Meeting date rescheduled at short notice	8	7*
P W Wellings (Retired 7/5/99)	6	4
J M Craker	8	8
H M Garnett (Executive Director)	8	8

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 1998-99 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 Operating Statement 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. The major project for the design, construction and commissioning of a new research reactor to replace HIFAR continues in accordance with the approved project plan and required government approval processes, and
- there have been no significant developments since the conclusion of the 1998-99 financial year which impact on any matter included in the report.

In the opinion of management and the Board, adequate cash resources will be available to cover the entity's requirement for working capital, to pay existing debts, and to pay potential future debts to the extent that they will compete with existing debts.

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. To demonstrate its commitment to safety and environmental responsibility, the organisation issued a new ANSTO Health, Safety and Environment Policy during the year. This policy, which replaced the previous Safety 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 two independent external bodies, the Nuclear Safety Bureau (NSB) and the Safety Review Committee (SRC). The Australian Radiation Protection and Nuclear Safety Act, which established the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), was passed in December 1998, and with it the sections of the ANSTO Act establishing the SRC and the NSB were repealed.

By agreement between ANSTO and ARPANSA, the powers previously exercised by the NSB in relation to nuclear plant were extended, during the transition period, to cover all new and spent fuel activities, airborne and liquid effluent releases, waste operations and radiopharmaceutical production. The transition period extended until 5 August 1999, at which time all formal licence applications were required to be submitted by ANSTO to ARPANSA.

The ARPANS Regulations 1999 required the submission of licence applications for all ANSTO facilities and radioactive sources by 5 August 1999.

The Safety Review Committee met following the passage of the ARPANS Act and provided a final statement of position to the Executive Director. Future reporting will be done through ARPANSA, which has taken over the role of providing quarterly and annual reports relating to ANSTO safety to Parliament.

The Board receives regular reports on occupational health and safety issues.

Audit Committee

The Audit Committee, a formal sub-committee of the Board, comprised Mr M. H. Codd (Chairman), Dr A. K. Gregson (Retired 31/12/98), 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 financial and commercial activities, legislative and regulatory conformance, and asset protection. The Committee also reviews the internal and external audit work programs 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. 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.

MEETINGS

Member	Held	Attended
M H Codd AC (Chairman)	4	4
A K Gregson (Retired 31/12/98)	2	2
J M Craker	4	4
J Bergman (External Member)	4	4

The Committee generally meets quarterly and 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 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 copies of all risk assessment reports.

The Board approved a new risk management policy in August 1998. It is the responsibility of the operational management of ANSTO to develop and implement risk mitigation strategies. 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.

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 fraud risk assessment of the organisation, commissioned last year in accordance with the Government's fraud control policy, gave rise to a fraud control policy and plan. This was adopted by the Board in August 1998 and subsequently implemented by management.

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 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.

An internal control policy framework document and related policies were developed by management and approved by the Board in August 1998.

Compliance and review are monitored through the Audit Committee and the Internal Audit function.

Year 2000 compliance

ANSTO has had a Year 2000 compliance project running since July 1997. Through this project, mission critical systems have been identified and, from 30 June 1999, made compliant in terms of the Year 2000 computer date problem. Currently effort is focussed on refinement of contingency plans.

ANSTO received seed funding from the Commonwealth Government for its compliance work, and has reported regularly on its progress through the Office of Government Online.

External consultants have twice audited the Year 2000 Compliance project. This has resulted in improved process and performance benchmarking. Status reports on the project are given regularly to senior management, the Audit Committee, and the Board.

FUNCTIONS OF THE ORGANISATION UNDER THE ANSTO ACT

Functions of the Organisation under the *Australian Nuclear Science and Technology Organisation Act 1987* (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.

(3) In undertaking its functions, the Organisation is to have regard to:

- the Commonwealth Government's national science, technology and energy policy objectives; and
- the Commonwealth Government's commercialisation objectives for public research institutions.

Subsection 4 (2) of the Australian Nuclear Science and Technology Organisation Amendment Act 1992 (the ANSTO Amendment Act) provides that subject to subsection 4 (3), for the purposes of paragraph 5 (1) (ba) of the ANSTO Act, any radioactive material or radioactive waste that is stored on the Organisation's premises is taken to be radioactive material and radioactive waste arising from the Organisation's activities.

Section 4 (3) of the ANSTO Amendment Act provides that on and after 5 February 1995, the above provision does not apply to any radioactive material or radioactive waste that is the subject of order 3 of the orders made in the Land and Environment Court of New South Wales on 5 February 1992 in the matter of the Council of the Shire of Sutherland v. the Australian Nuclear Science and Technology Organisation.

General powers of the Organisation under the ANSTO Act

Section 6 of the ANSTO Act provides that:

(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:

- to enter into contracts;
- to acquire, hold and dispose of real or personal property;
- 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;
- to erect buildings and structures and carry out works;
- to form, or participate in the formation of, a company or partnership;
- to appoint agents and attorneys, and to act as an agent for other persons;
- to engage persons to perform services for the Organisation;
- to design, produce, construct and operate equipment and facilities; and
- to do anything incidental to any of its powers.

(2) The powers of the Organisation may be exercised within or outside Australia.

INDEX OF COMPLIANCE WITH REPORTING GUIDELINES

GLOSSARY

AAD	Australian Antarctic Division
AHSEC	ANSTO Health, Safety and Environment Committee
AINSE	Australian Institute of Nuclear Science and Engineering
AMS	accelerator mass spectrometry
ANBF	Australian National Beamline Facility
ANTARES	Australian National Tandem Accelerator for Applied Research
ANU	Australian National University
ASNPO	Australian Safeguards and Non-proliferation Office (previously the Australian Nuclear Safeguards Office)
APS	Advanced Photon Source
ARC	Australian Research Council
ARPANSA	Australian Radiation Protection and Nuclear Safety Agency
ASRP	Australian Synchrotron Research Program
BFCG	Beam Facilities Consultative Group
BFTG	Beam Facilities Technical Groups
CAT	Collaborative Access Team
CRC	Cooperative Research Centre
ESR	Electron Spin Resonance
FDG	fluorine-18 fluorodeoxyglucose
FIMS	financial information management system
GATRI	Gamma Technology Research Irradiator
IAEA	International Atomic Energy Agency
INIS	International Nuclear Information System
NEDO	(the Japanese) New Energy and Industrial Technology Development Organisation
NIST	US National Institute of Standards and Technology
NPWEWS	Nuclear Powered Warships Early Warning System
NMC	National Medical Cyclotron
NPL	(UK) National Physical Laboratory
OECD	Organisation of Economic Cooperation and Development
PAEC	Pakistan Atomic Energy Commission
PIGME	Proton-Induced Gamma-ray Emission
PIXE	Particle-induced x-ray emission
REIF	Research Infrastructure Equipment and Facilities Scheme
RNCA	Regional Nuclear Cooperation in Asia
SANS	Small Angle neutron scattering
SRI-CAT	Synchrotron Radiation Instrumentation Collaborative Access Team
SPECT	Single Photon Emission Computed Tomography
TROPICS	Tropical River-Ocean Processes in Coastal Settings (Project)
QUATERNARY	The geological era that includes the Pleistocene and Recent Periods
RRRP	Replacement Research Reactor Project
UNDP	United Nations Development Program

ANSTO REPRESNTATIVES

CANBERRA

ANSTO Representative
Department of Industry, Science and Resources
20 Allara Street
Canberra City
ACT 2601
Australia

LONDON

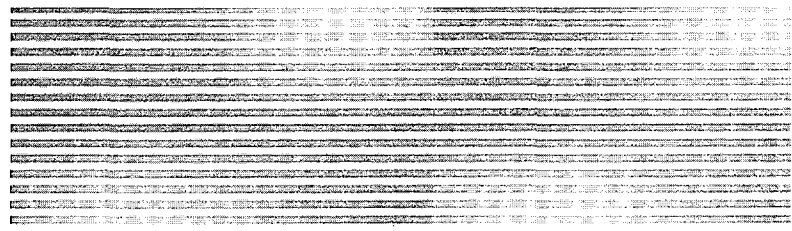
Counsellor (Nuclear)
Australian High Commission
Australia House
The Strand
London WC2B 4LA
United Kingdom

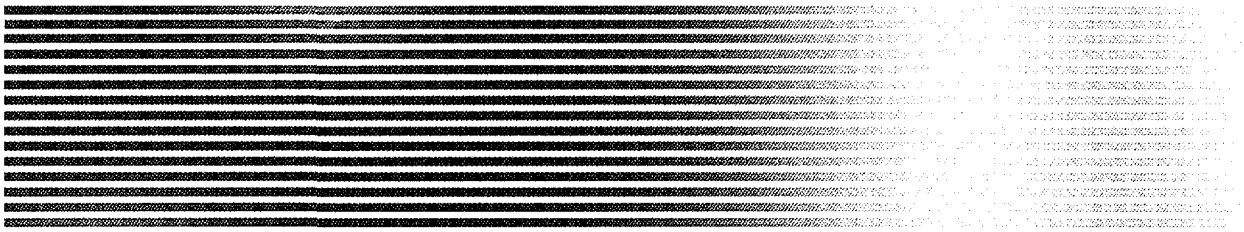
VIENNA

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





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