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**PROGRAM OF RESEARCH
1988-89**

Ansto

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CONTENTS

FOREWORD

M ADVANCED MATERIALS

MA SYNROC

MB ADVANCED CERAMICS

MC MATERIALS SCIENCE AND TECHNOLOGY

MD PLASMA PROCESSING OF MATERIALS

P APPLICATIONS OF NUCLEAR PHYSICS

PA NUCLEAR TECHNIQUES OF ANALYSIS

— CHARGED PARTICLES ACCELERATOR
MASS SPECTROMETRY

PB NUCLEAR TECHNIQUES OF ANALYSIS

— REACTOR NEUTRONS

PC NUCLEAR TECHNIQUES OF ANALYSIS

— FAST NEUTRONS

PD NEUTRON SCATTERING

PE RADIATION STANDARDS

PF RADIATION DETECTORS

PG SAFEGUARDS RESEARCH AND DEVELOPMENT

PH LASER DEVELOPMENT

AND NUCLEAR APPLICATIONS

PI INSTRUMENT DESIGN

PJ INSTRUMENTATION CONTROL

AND COMPUTER INTERFACE

V ENVIRONMENTAL SCIENCE

VA POLLUTANT GENERATION AND TRANSPORT

VB ORE PROCESSING AND WASTE MANAGEMENT

VC BIOLOGICAL IMPACTS

VD ENVIRONMENTAL CHEMISTRY

VG ENVIRONMENTAL SERVICES

I APPLICATIONS OF RADIOISOTOPES AND RADIATION

IA INDUSTRIAL APPLICATIONS

IB IRRADIATION RESEARCH AND TECHNOLOGY

IC GEOSPHERE APPLICATIONS

ID ALLIGATOR RIVERS ANALOGUE PROJECT

B BIOMEDICINE AND HEALTH

BA NEUTRON DIAGNOSIS AND THERAPY

BBA BIOLOGICAL DOSIMETRY

BBB CLONING OF

RADIORESISTANT GENES

BC RADIOPHARMACEUTICAL RESEARCH
AND DEVELOPMENT

BD MONOCLONAL ANTIBODIES

BF BIOLOGICAL MONITORING

BH ANIMAL HOUSE

N NUCLEAR TECHNOLOGY

NG NEUTRONICS

NH THERMAL ENGINEERING

NI RISK AND RELIABILITY ANALYSIS

LI, MARALINGA REHABILITATION STUDIES

LI PROGRAM MANAGEMENT OF THE
MARALINGA REHABILITATION
STUDIES

DP COMPUTING CENTRE

DA COMPUTING SERVICES

OH OCCUPATIONAL HEALTH AND SAFETY

OE COMMERCIAL DEVELOPMENT OF AMES
MUTAGEN TESTING SERVICE

OH DEVELOPMENT OF
RADIATION MONITORING
SURVEILLANCE SYSTEM

GLOSSARY



FOREWORD

GOVERNMENT RESEARCH ESTABLISHMENTS ARE IN THE PROCESS OF UNDERGOING SIGNIFICANT CHANGE. THIS CHANGE IS MANY-FACETTED: CHANGE IN TERMS OF THE REQUIREMENT FOR INCREASING EXTERNAL SUPPORT AND DECLINING GOVERNMENT APPROPRIATION, CHANGE IN TERMS OF REDEFINITION OF RESEARCH PRIORITIES; AND THE CONSEQUENT REALLOCATION OF RESOURCES. THIS PROCESS OF CHANGE NECESSITATES THE ESTABLISHMENT OF EFFECTIVE COST CONTROL AND ACCOUNTING PROCEDURES, THE DELEGATIONS TO ALLOW PROJECT MANAGERS TO HAVE ACCOUNTABILITY AS WELL AS RESPONSIBILITY AND THE IMPLEMENTATION OF PROJECT MANAGEMENT PRINCIPLES. THE LATTER REQUIRES FORWARD PLANNING, RESOURCE ALLOCATION AND AN AUDIT OF BOTH REALISATION OF THE PROJECT OBJECTIVES AND THE COSTS TO ACHIEVE THOSE OBJECTIVES. SOME MAY QUESTION THE MANAGEMENT OF RESEARCH TO THIS EXTENT AND POINT OUT THE RECORD OF SERENDIPITY AND LESS STRUCTURED MANAGEMENT IN INNOVATION. THIS MAY BE SO, BUT THE ERA OF THIS TYPE OF LESS FORMAL MANAGEMENT IN GOVERNMENT RESEARCH ESTABLISHMENTS HAS GONE.

FROM 1 JULY 1988, THE RESEARCH ACTIVITIES OF ANSTO HAVE REORGANISED INTO FIVE PROGRAMS:

- ADVANCED MATERIALS
- APPLICATIONS OF NUCLEAR PHYSICS
- ENVIRONMENTAL SCIENCE
- APPLICATIONS OF RADIOISOTOPES AND RADIATION
- BIOMEDICINE AND HEALTH

THIS STRUCTURE NOT ONLY GROUPS THE MAIN RESEARCH ACTIVITIES BUT ALSO IDENTIFIES THE UNDERPINNING OF ANSTO'S COMMERCIAL ACTIVITIES. THIS DOCUMENT DESCRIBES THE PROJECTS TO BE UNDERTAKEN IN THE 1988-89 FINANCIAL YEAR. EACH PROJECT IN A PARTICULAR PROGRAM AREA IS DEFINED IN TERMS OF BACKGROUND, OBJECTIVE, RECENT WORK AND ACHIEVEMENTS, WORK PLANNED, RESOURCES AND THE PROJECT MANAGER IS IDENTIFIED. RESEARCH IS ALSO UNDERTAKEN IN AREAS OF THE OPERATIONAL ACTIVITIES OF THE ORGANISATION AND THESE ALSO ARE DETAILED.

ANSTO, THROUGH ITS RESEARCH AND DEVELOPMENT, MUST BE RESPONSIVE TO CHANGING PRIORITIES IN INDUSTRY, GOVERNMENT AND THE COMMUNITY IT SERVES. TO THIS END EXTERNAL ADVISORY COMMITTEES HAVE BEEN FORMED FOR EACH PROGRAM AREA. THESE COMMITTEES WILL MEET TWICE A YEAR TO OVERVIEW AND PROVIDE ADVICE ON RESEARCH PRIORITIES. I WOULD LIKE TO EXPRESS MY GRATITUDE TO THOSE WHO HAVE AGREED TO SERVE ON THESE COMMITTEES AND TO EMPHASISE THE VITAL ROLE THEY PLAY.

ANSTO HAS A RICH RESOURCE OF SKILLS, FACILITIES AND EXPERIENCE THIS 1988-89 PROGRAM OF RESEARCH DEMONSTRATES THE UTILISATION OF THIS RESOURCE. IT CLEARLY ARTICULATES THE ROLE THAT NUCLEAR SCIENCE AND TECHNOLOGY CAN PLAY IN THE ECONOMIC AND SOCIAL DEVELOPMENT OF THE NATION.

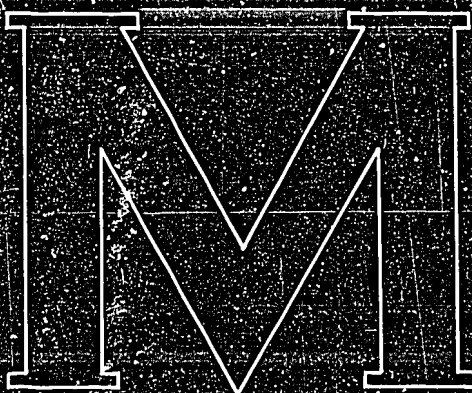
DAVID J COOK
EXECUTIVE DIRECTOR, ANSTO

ANSTO'S ADVANCED MATERIALS PROGRAM IS REQUIRED TO RESEARCH AND DEVELOP A RANGE OF ADVANCED MATERIALS TO ASSIST AUSTRALIAN INDUSTRY IN IMPROVING AUSTRALIA'S COMPETITIVE POSITION IN WORLD MARKETS. THE USE OF NEW MATERIALS IN THE DEVELOPMENT OF NEW PROCESSES AND PRODUCTS IS ESSENTIAL TO THE REVIVAL OF THE MANUFACTURING SECTOR.

ANSTO'S PRESENT NUCLEAR SCIENCE AND TECHNOLOGY PROJECTS IN THE ADVANCED MATERIALS PROGRAM FOCUS

MAINLY ON

- THE DEVELOPMENT OF THE SYNROC CONCEPT AS A SECOND GENERATION TECHNOLOGY FOR HIGH-LEVEL NUCLEAR WASTE IMMOBILISATION IN A CERAMIC MATRIX; AND
- THE DEVELOPMENT OF MATERIALS EVALUATION TECHNIQUES TO SUPPORT REMNANT LIFE ASSESSMENT TO ENSURE SAFE AND ECONOMIC CONTINUED OPERATION OF ANSTO'S NUCLEAR PLANT.



ADVANCED MATERIALS

BACKGROUND

MA SYNROC

OBJECTIVE

To develop the Synroc concept to the maximum possible extent to ensure its commercial exploitation.

RESOURCES

62 person years
Budget: \$3,000,000

PROJECT MANAGER

Dr Keith D Reeve.

The Synroc program commenced at Lucas Heights in 1979 in collaboration with the inventors of the concept, Professor A E Ringwood and colleagues at the Australian National University. The program received a major boost in 1982 with the provision of a \$2.754 M grant by the Government for the design and construction of a Synroc Demonstration Plant at Lucas Heights. This reflected the Government's determination, as a responsible supplier of uranium, to make a positive contribution to international efforts to develop solutions to radioactive waste management. More recently, the Government has approved \$6.5 M for a four-year Phase II Synroc Program to generate an engineering and scientific data base, develop a conceptual design for a radioactive Synroc plant, prepare cost estimates for Synroc fabrication, and develop links with Australian industry for the commercialisation of Synroc.

EXTERNAL ORGANISATIONS & SUPPORT

Collaboration with ANU (Research School of Earth Sciences) continues under a collaborative R&D agreement. Active international collaboration in research on Synroc is carried out under bilateral agreements between Australia and the UK (Harwell), Japan (JAERI) and between ANSTO and ENEA (Italy). Other local organisations with collaborative links with ANSTO include Griffith University (Qld), the University of Technology, Sydney and the University of New England (NSW).

EXTERNAL SUPPORT

\$3.2 M has been allotted to the Phase II program approved by Federal Cabinet in 1987. Additional support comes from the Department of Primary Industries and Energy through NERDDP as three direct grants and a sub-contract with ANU totalling \$221,000.

MB ADVANCED CERAMICS

OBJECTIVE

To develop a broad portfolio of collaborative projects with external funding to support Australian industry in acquiring a competitive edge in high value added ceramic products.

RESOURCES

4.5 person years.
Budget: \$350,000.

PROJECT MANAGER

Dr Keith D Reeve.

This project will exploit spin-off technologies from the Synroc project by using its expertise, staff and facilities to transfer technology to appropriate industrial partners for further development and commercialisation. The project supports the objectives of the Department of Industry, Technology and Commerce aimed at improving the efficiency and international competitiveness of Australian industry through research and development activities. The choice of suitable technologies is largely market driven and depends fully on external support.

Telectronics Pty Ltd; Metal Manufactures Ltd; Electricity Commission of NSW (ELCOM); CSIRO Division of Applied Physics; School of Materials Science and Engineering of the University of NSW; Ausonics Pty Ltd.

EXTERNAL SUPPORT

Generic Industrial Research and Development (GIRD) grant, \$212,000.

THESE ACTIVITIES HAVE CREATED FACILITIES AND EXPERTISE THAT ARE HIGHLY USEFUL TO THE NATIONAL PRIORITY AREAS IN GENERIC MATERIALS TECHNOLOGY. THE PROGRAM IS ACTIVELY SEEKING COLLABORATIVE RESEARCH AND DEVELOPMENT WITH INDUSTRY AND UNIVERSITIES TO ENABLE THE EXPLOITATION OF THIS TECHNOLOGY FOR THE BENEFIT OF THE COMMUNITY. RECENT EXAMPLES OF THIS INTERACTION ARE THE RECEIPT OF GENERIC INDUSTRIAL RESEARCH AND DEVELOPMENT (GIRD) NEW MATERIALS TECHNOLOGY GRANTS FOR RESEARCH ON BIOMEDICAL CERAMICS AND HIGH TEMPERATURE CERAMIC SUPERCONDUCTORS FOR ELECTRIC POWER TRANSMISSION. THESE PROJECTS UTILISE FACILITIES AND EXPERTISE GAINED FROM THE SYNROC PROJECT. SIMILARLY, THE REMNANT LIFE STUDIES ON NUCLEAR PLANT

HAVE LED TO JOINT PROGRAMS WITH THE ELECTRICITY SUPPLY INDUSTRY TO DETERMINE THE CONTINUED VIABILITY OF COAL-FIRED ELECTRICITY COMPONENTS.

THROUGH THIS PROGRAM, ANSTO MAINTAINS A HIGH REGIONAL AND INTERNATIONAL STANDING IN NUCLEAR MATTERS, WITH COLLABORATIVE R&D PROJECTS ON SYNROC WITH THE UK (HARWELL), JAPAN (JAERI) AND ITALY (ENEA).

THE ADVANCED MATERIALS PROGRAM HAS A MULTIDISCIPLINARY TEAM OF 80 STAFF, PROVIDES SUPPORT TO OTHER ACTIVITIES WITHIN ANSTO, AND PARTICIPATES WITH THE ENVIRONMENTAL SCIENCE PROGRAM AND THE MINING INDUSTRY IN JOINT STUDIES ON THE ENVIRONMENTAL EFFECTS OF RARE EARTHS AND URANIUM EXTRACTION.

PROGRAM DIRECTOR: DR ADAM JOSTSONS.

RECENT WORK & ACHIEVEMENTS

The Synroc Demonstration Plant has been fully commissioned with all modules operating over a 36-hour period. The feed was an advanced, highly surface-active slurry made in-house on a 200 kg scale by the hydrolysis of appropriate metal alkoxides. All modules of the plant operated within or close to design requirements.

WORK PLANNED

- (a) Generate an engineering data base from operation of the Synroc Demonstration Plant.
- (b) Develop and test simplified alternative unit processes for Synroc fabrication.
- (c) Develop an initial conceptual radioactive Synroc fabrication plant design and initiate cost analyses of Synroc in waste disposal scenarios.
- (d) Develop a Synroc property data base and extend the scientific understanding of the fine structure and properties of Synroc.

MA

- (a) A prototype bioceramic for heart pacemakers has been developed.
- (b) Preparation and characterisation of ceramic powders has commenced for high temperature superconductors for power applications.
- (c) A collaborative project has commenced to develop titanate electroceramic components.

Industrial partners are being sought to develop new processes and products for exploitation in electrical and optical ceramics.

MB

MC
**MATERIALS SCIENCE
AND TECHNOLOGY**

OBJECTIVE

To carry out a systematic program of remnant life estimation of HIFAR aluminium structures exposed to a flux of neutrons and to transfer the technology to non-nuclear areas such as coal-fired electricity generating equipment with a view to enhancing the economics and safety of capital intensive plant.

RESOURCES

15 person years
Budget: \$825,000

PROJECT MANAGER

Dr Ken U Snowden.

The project was initiated to develop materials evaluation techniques on engineering structures and components in ANSTO's reactor HIFAR to improve the assessment of remnant life consistent with high standards of engineering safety. Microstructural studies, fracture mechanics, fatigue, creep and stress relaxation and non-destructive testing (NDT) techniques are used to locate and determine the size of structural defects. The results of these studies are then used to determine the continued use of these engineering plant components.

Metal Manufactures Ltd; State Electricity Commission of Victoria (SECV); BHP Co. Ltd (Melbourne Research Laboratories); Department of Transport and Communication; ELCOM; Turbine Components of Australia Pty Ltd; James Hardie Pty Ltd; University of Wollongong.

EXTERNAL SUPPORT

\$30,000.

MD
**PLASMA PROCESSING
OF MATERIALS**

OBJECTIVE

To develop the technique of plasma immersion ion implantation to produce a cost-effective and competitive means of surface modification and thin layer deposition as a means of enhancing the value of industrial products.

RESOURCES

4 person years.
Budget: \$200,000.

PROJECT MANAGER

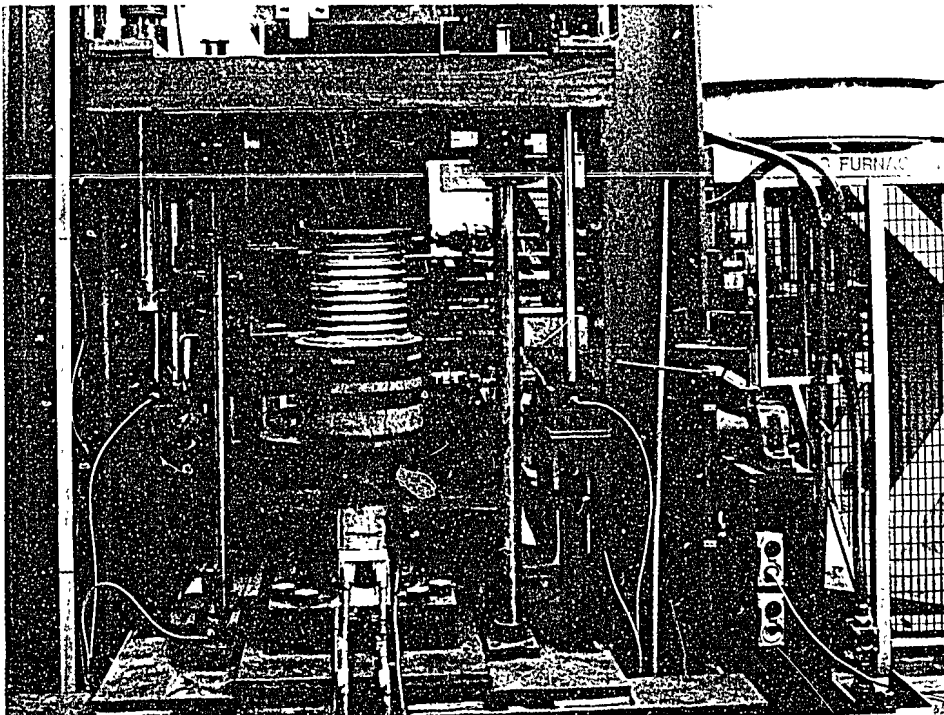
Dr John Tendys.

This project was initiated in 1988 by the recruitment of a small team from a discontinued fusion reactor plasma physics project. The application of plasma techniques to the surface modification of materials will provide components with enhanced in-service performance. This switch from a long-term nuclear project to a high priority field in materials technology identified by the Industry Research and Development Board reflects a new emphasis within ANSTO to facilitate the utilisation of nuclear science and technology in industry.

External participation has not yet been sought.

EXTERNAL SUPPORT

Nil



The hot press: part of the Synroc demonstration plant.

RECENT WORK & ACHIEVEMENTS

- (1) Completion of a review of available data on the effects of thermal and fast neutrons on the mechanical properties of aluminium alloys before commencement of an experimental program for verifying the continued use of engineering components that have been subjected to high levels of radiation.
- (2) Preparation of collaborative programs on remnant life estimation in collaboration with metallurgists from the NSW and Victorian Electricity Commissions.
- (3) Development of two prototype portable ultrasonic imaging instruments in collaboration with the Department of Transport and Communication.
- (4) Completion of a collaborative study of creep/fatigue in aluminium electrical conductor cables.
- (5) Completion of a number of small scoping studies for mechanical and NDT techniques.

WORK PLANNED

- (a) To continue the systematic program of assessment of the remnant life of HIFAR reactor components.
- (b) To expand the scope of the collaborative remnant life programs with the electricity generation/distribution industry.
- (c) To develop the use of neutron radiography for quality control assessment in industry.

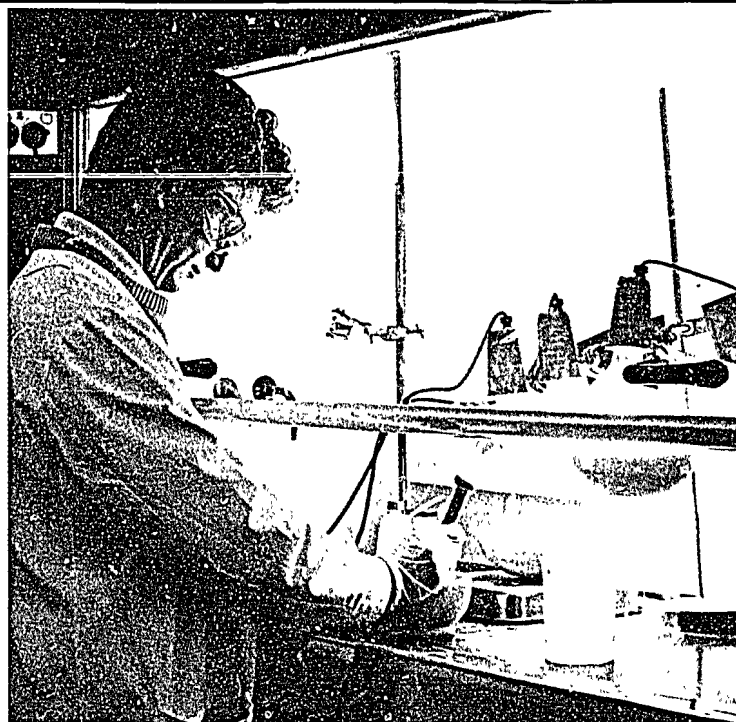
MC

Preliminary studies have shown a factor of 10 enhancement in wear resistance of steel processed using the plasma immersion ion implantation technique. This increase in wear resistance appears to be significantly better than the results achievable with current plasma processing methods.

Initial studies will focus on the optimisation of parameters for surface modification of metals and ceramics and the development of multi-purpose processing unit. Industrial participation in the assessment and development of the method will be sought in 1989.

MD

Ceramics powder preparation



R

APPLICATIONS OF NUCLEAR PHYSICS

THE PRIMARY OBJECTIVE OF THE APPLICATIONS OF NUCLEAR PHYSICS PROGRAM IS TO ENSURE THAT, THROUGH INTERACTION WITH INDUSTRY, THE AUSTRALIAN COMMUNITY BENEFITS FROM RECENT DEVELOPMENTS IN THE APPLICATION OF NUCLEAR SCIENCE AND TECHNOLOGY. THE COMMERCIALISATION OF SPIN-OFF TECHNOLOGIES SHOULD GENERATE INCOME SUFFICIENT TO UNDERWRITE NEW DEVELOPMENTS IN APPLIED NUCLEAR PHYSICS. TO ACHIEVE THIS OBJECTIVE WILL REQUIRE THE RAPID COMPLETION OF

BACKGROUND

PA NUCLEAR TECHNIQUES OF ANALYSIS — CHARGED PARTICLES, ACCELERATOR MASS SPECTROMETRY

OBJECTIVE

To develop new approaches to the total element analysis of any sample and to use ultra-trace analysis for several areas of interest including industrial, environmental and occupational health applications; to improve the precision of the physics data needed for ion beam analysis; to provide a customer service for the utilisation of developed techniques; and to develop a national AMS service initially on the 14 UD tandem at ANU and hopefully on a tandem accelerator at Lucas Heights.

RESOURCES

8.0 person years
Budget: \$388,000

PROJECT MANAGER

Dr J Roger Bird.

In recent years several new ion beam techniques for use in archaeometric, occupational health, scientific and industrial applications have been pioneered in Australia. These include PIXE, Rutherford backscattering, PIGME, channelling and reaction analysis. Effort is being devoted to the establishment of an accelerator mass spectrometer (AMS) facility on the 14 UD accelerator at ANU for the detection of radioactive trace elements such as chlorine-36.

EXTERNAL ORGANISATIONS & SUPPORT

Alcan; Comalco; BHP Coated Products; Joint Coal Board; ELCOM; SPCC; AWRAC; CSIRO; Lawrence Livermore Laboratory; ANU and continued liaison with AINSE.

EXTERNAL SUPPORT

\$44,500. ANU commitment of time and equipment on the 14 UD accelerator.

PB NUCLEAR TECHNIQUES OF ANALYSIS — REACTOR NEUTRONS

OBJECTIVE

To commercialise these techniques further and to develop other techniques to meet the needs of agriculture, medicine, high technology and other industries.

RESOURCES

8.5 person years
Budget: \$378,000

PROJECT MANAGER

Dr David J Wilson.

Several nuclear techniques have been developed to commercial standard on the low power reactor Moata. The principal methods include fission track analysis of geological and biological materials; soil cross-section measurements for neutron moisture probes; neutron radiography on aircraft components, diesel pistons, etc.; uranium ore analyses by delayed neutron detection; and irradiation services for industry in other program areas.

Turbine Components of Australia Ltd, Perth; NSW State Rail Authority; various analytical and mining research laboratories; Alcoa Ltd; Invetech Developments Ltd; Boral Ltd; Shell Co. of Australia Ltd; Esso Australia Ltd; CSIRO; AINSE; IAEA; Puspati (Malaysia).

EXTERNAL SUPPORT

Approximately \$42,000

A NUMBER OF DEVELOPMENTAL GOALS.

THESE INCLUDE

- THE DEVELOPMENT OF AN EXTENSIVE NEUTRON RADIOGRAPHY SERVICE USING THE MOATA RESEARCH REACTOR;
- THE DEVELOPMENT OF NUCLEAR-BASED AND LASER-BASED INSTRUMENTS FOR PROCESS CONTROL;
- THE ESTABLISHMENT OF A NATIONAL RADIATION DETECTOR INDUSTRY AND A NATIONAL NUCLEAR ELECTRONICS INDUSTRY WITH THE POTENTIAL TO ENTER THE INTERNATIONAL MARKET; AND
- THE VIGOROUS EXPLOITATION IN AUSTRALIA AND OTHER MARKETS OF A RANGE OF ANALYTICAL TECHNIQUES BASED ON CHARGED PARTICLE BEAMS, FAST NEUTRONS AND THERMAL NEUTRONS.

THESE SHORT-TERM GOALS ARE ATTAINABLE WITH EXISTING STAFF AND EQUIPMENT.

HOWEVER, TO DEVELOP OTHER NEW TECHNOLOGIES WILL REQUIRE CAPITAL INVESTMENT IN A NUMBER OF MAJOR RESEARCH INSTALLATIONS, INCLUDING A 4 MV TANDEM ACCELERATOR AND A SMALL ANGLE NEUTRON SCATTERING INSTRUMENT, TOGETHER WITH THE ESTABLISHMENT OF AN ACCELERATOR MASS SPECTROMETRY SERVICE ON THE TANDEM ACCELERATOR.

APPROXIMATELY 60 STAFF ARE ASSIGNED TO THE PROGRAM AND 10 PROVIDE SUPPORT FOR OTHER ANSTO PROGRAMS. IN ADDITION, ASSISTANCE IS PROVIDED BY 15 SUPPORT STAFF FUNDED THROUGH THE AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING (AINSE).

PROGRAM DIRECTOR: DR JOHN W BOLDEMAN.

RECENT WORK & ACHIEVEMENTS

- (a) Marketing internationally ANSTO's PIXE analysis (PIXAN) program.
- (b) Preparation and editing of a reference text on 'Ion Beams for Materials Analysis' for international distribution.
- (c) Specialised analyses for a number of industrial and government organisations and numerous university and museum laboratories.
- (d) Establishment of an AMS service at ANU with a sensitivity of ≈ 1 in 10^{15} for chlorine-36.

WORK PLANNED

- (a) Measurements of ion-beam induced gamma-ray yields.
- (b) Improvement in beam alignment and accelerator stability for all analysis techniques.
- (c) Development of a heavy ion analysis facility on the existing Van de Graaff particle accelerator.
- (d) Development of a specialised surface analysis rig to cater for the requirements of the Advanced Materials Program.
- (e) Extension of the AMS technique to other radioisotopes.
- (f) Measurements for industry as required.

PA

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- (a) Soils moisture measurements for mining area rehabilitation.
 - (b) Uranium analysis service for the mining industry.
 - (c) Installation of a commercial standard neutron radiography unit on the north beam cavity of Moata for the expansion of radiography services to industry.

- (a) Creditation of ANSTO as a provider of neutron radiography services.
- (b) Establishment of neutron radiography for diesel pistons for the New South Wales State Rail Authority.
- (c) Expansion of moisture measurement work to a number of industrial applications.
- (d) Continuation and development of general radiation services.

PB

PC**NUCLEAR TECHNIQUES OF
ANALYSIS —
FAST NEUTRONS****OBJECTIVE**

To develop new techniques and expand existing techniques for the non-destructive testing of bulk materials in industry and medicine.

RESOURCES

6 person years
Budget: \$267,000

PROJECT MANAGER

Dr Robin L Walsh.

Fast neutron beams provide an excellent tool for the non-destructive analysis of bulk materials. Neutrons have no charge and as a consequence they can penetrate deep into a medium with little attenuation. Charged particle beams on the contrary rapidly lose energy via ionisation processes and can be applied to surface analyses only.

AINSE; University of Queensland; ANU; Universities of Sydney, Wollongong and Western Australia; Aust. Meat and Livestock Research and Development (Sydney); Invetech Developments Ltd (Melbourne); IAEA; Lawrence Livermore Laboratory (USA); Commissariat a l'Energie Atomique; DSIR (New Zealand).

EXTERNAL SUPPORT

\$21,500

PD**NEUTRON SCATTERING****OBJECTIVE**

To continue operating neutron scattering equipment for ANSTO and external users; to maintain and upgrade existing equipment and build and install new equipment; to investigate and extend neutron scattering techniques to commercially useful applications; and to continue collaborative research with industry, medicine, CSIRO and tertiary institutions.

RESOURCES

9 person years
Budget: \$619,000

PROJECT MANAGER

Dr Margaret M Elcombe.

Neutrons have special properties which allow them to be used for material investigations in ways which are complementary to other techniques, and in some cases unique. HIFAR is the only high flux reactor in Australia, and is the source of neutron beams suitable for such investigations. A range of neutron scattering instruments is installed on these beams. ANSTO, in collaboration with AINSE, makes these instruments available to outside users for a variety of studies on a wide range of materials.

AINSE; tertiary institutions; CSIRO — Divisions of Materials Science and Chemical Physics, Mineral Physics, Coal Technology, Energy Chemistry, Applied Physics, Food Processing; Federal Government; UTN Malaysia; Indonesian Atomic Energy; IAEA; Brookhaven National Laboratory (USA).

EXTERNAL SUPPORT

Federal Government — National Research Fellow \$28,000 per year, IAEA funds for Fellow to train at Lucas Heights, Brookhaven (\$200,000 of equipment on renewable loan).

PE**RADIATION STANDARDS****OBJECTIVE**

To maintain standards of measurement for radioactivity which allow the legal sale of radioisotopes in Australia; and to extend the standard of absorbed dose to allow calibration of beam intensities for high energy linear particle accelerators being introduced into hospital radiotherapy units.

RESOURCES

4.5 person years
Budget: \$206,000

PROJECT MANAGER

Mr Stuart L Sherlock.

ANSTO has legal responsibility for the technical aspects of maintaining national standards of radioactivity and absorbed dose.

CSIRO; Australian Radiation Laboratory; ARI; Westmead; Prince of Wales and Royal North Shore Hospitals.

EXTERNAL SUPPORT

Grant from National Institute of Health for equipment; Westmead Hospital for use of facilities; Royal North Shore and Prince of Wales Hospitals — total of \$4000.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

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| <ul style="list-style-type: none">(a) Provision of calibrated fast neutron beams from the standard neutron irradiation facility (SNIF) to study DNA damage in tissue.(b) Detection of protein in meat through the technique of resonance absorption of neutrons at 432 keV energy, developed at ANSTO. | <ul style="list-style-type: none">(a) To adapt to Australian needs a fast, accurate method of measuring the fat and moisture content of meat.(b) To develop a technique which can monitor and therefore control on line the composition of concrete.(c) To develop techniques based on inelastic neutron scatter from portable fast neutron generators to determine trace elements in bulk samples.(d) To seek further uses for the SNIF facility.(e) To develop new methods of body composition studies based on kinematically focussed neutrons. |
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PC

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- | | |
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| <ul style="list-style-type: none">(a) Upgrading of a number of neutron scattering instruments on HIFAR.(b) Determination of the crystal structure of cyclosporin (an immuno-suppressant drug used in organ transplants) by neutron diffraction; development of a method of quantitative phase analysis by neutron diffraction (with CSIRO); and determination of crystal structures of several newly developed superconducting oxides. | <ul style="list-style-type: none">(a) Development, relocation or replacement of neutron scattering instruments on HIFAR, and the planning and design of a small angle neutron scattering instrument.(b) Develop further the conditions for the experimental observation of the neutron Kikuchi effect; continue high resolution powder diffraction (HRPD) studies on materials of practical importance, such as battery-related lead oxides, partially stabilised zirconia, residual stress analysis of bulk materials, and Synroc-related hollandites; and determine how cyclosporin binds to its receptor.(c) Investigate the commercial potential of quantitative phase analysis by neutron diffraction. |
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PD

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- | | |
|---|--|
| <ul style="list-style-type: none">(a) Standardisation of radioisotope sources.(b) The solution of the $4\pi \beta - \gamma$ coincidence counting, extending dead-time and statistical analysis problems.(c) Establishment of new primary standards for absorbed dose for 6, 18 and 25 MeV photon beams.(d) Establishment of a cobalt-60 exposure calibration service.(e) Establishment of a thermoluminescent dosimetry (TLD) service for calibration checks, hospital intercomparisons and patient dose measurement in clinical trials. | <ul style="list-style-type: none">(a) Documentation of newly developed procedures.(b) Re-standardisation of commonly used isotopes.(c) Application of the extending dead-time solution to $\pi \beta - \gamma$ coincidence counting.(d) International intercomparison of high-energy photon absorbed dose primary standards.(e) Establishment of secondary standards for exposure 100 keV to 1.25 MeV, and high energy photon water absorbed dose.(f) Perform national TLD survey of hospital gray (SI unit of absorbed dose) for high energy photons. |
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PE

PF**RADIATION DETECTORS****OBJECTIVE**

To develop, supply and maintain germanium and silicon spectrometers for γ -ray and X-ray spectrometers essential for accurate measurements of radiations on site and to establish production on a commercial scale; to provide expert advice to detector users and technical training through AINSE and ANSTO's Education & Training Centre; to provide essential HIFAR calibration services for the Japanese commercial neutron transmutation doping of silicon (NTD-Si) project; and to research semiconductors, especially high atomic number materials, for use in medi-probes.

RESOURCES

7 person years
Budget: \$362,000

PROJECT MANAGER

Dr Alister J Tavendale.

Radiation detectors are essential to the activities of any nuclear research establishment, particularly high-performance semiconductor radiation detectors such as germanium γ -ray and silicon X-ray cryogenically cooled systems. These are used in such applications as neutron activation analysis (NAA), health and safety, waste management, isotope production quality control, PIXE spectroscopy, hydrology studies and X-ray fluorescence analysis applications.

AINSE; AMDEL; Universities of New South Wales, Wollongong, Griffith and Tasmania; Medical Engineering Research Association; Bell Laboratories; Komatsu, Japan.

EXTERNAL SUPPORT

NTD-Si \$39,000; Repair Services \$5,000.

PG**SAFEGUARDS RESEARCH
AND DEVELOPMENT****OBJECTIVE**

To develop instrumentation and methods for the measurement and monitoring of sensitive nuclear materials, such as enriched uranium and plutonium during IAEA inspection programs; and to measure basic nuclear data required for safeguards where the present precision is inadequate.

RESOURCES

6 person years
Budget: \$252,000

PROJECT MANAGER

Dr John W Boldeman.

The Federal Government, as part of its support for the Treaty for the Non-Proliferation of Nuclear Weapons, agreed to assist the IAEA in the implementation of international safeguards through a series of bilateral assistance programs. These programs were coordinated and partly financed through the Department of Foreign Affairs (DFA) with ANSTO (then the AAEC) being responsible for the R&D aspects. Funding by DFA ceased in June 1986 and ANSTO has been supporting an R&D program since that date.

Los Alamos National Laboratory; IAEA; Australian Safeguards Office (ASO); DFA.

EXTERNAL SUPPORT

Los Alamos National Laboratory – \$25,000 (staff support).
Dept of Foreign Affairs – \$40,000 (requested).

PH**LASER DEVELOPMENT AND
NUCLEAR APPLICATIONS****OBJECTIVE**

To develop a commercial desk-top CO₂ laser (500/1000 W), a small-scale commercial CO₂ laser isotope separation process, and the low cost CO₂ laser synthesis of refractory composite materials.

RESOURCES

5.5 person years.
Budget: \$254,000.

PROJECT MANAGER

Dr Horst Struve.

Considerable expertise in the development of lasers and their application to isotope separation has been built up as a consequence of recent research activities at ANSTO. This expertise could be exploited commercially. There is a large national market for medium power CO₂ lasers. Furthermore, the increasing usage of separated isotopes suggests that there is a reasonable market for their production in Australia.

Laser Electronics Pty Ltd.

EXTERNAL SUPPORT

\$2500 Consultant fee.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

- | | |
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| <ul style="list-style-type: none">(a) Maintenance/servicing of silicon X-ray and germanium γ-ray detector systems.(b) Provision of HIFAR calibration services for the NTD-Si project including development, demonstration and application of new rapid thermal annealing techniques in this work.(c) Design of vertical-mount silicon (lithium) X-ray spectrometers, together with a multi-detector drift system for the production of detectors.(d) A prototype furnace for liquid-phase epitaxial growth of gallium arsenide to be used in γ-medi-probes has been manufactured and layer growth to 300 μm demonstrated.(e) Accrual of more basic data on hydrogen injection into chemically etched semiconductors. | <ul style="list-style-type: none">(a) To continue to provide maintenance/servicing requirements on demand, and at commercial rates to external detector users.(b) To continue provision of NTD-Si calibration services.(c) To move into the construction/demonstration phase of an silicon (lithium) X-ray cryostat system.(d) To grow high-purity epitaxial gallium arsenide as the next phase of this materials project.(e) To undertake collaborative research with universities on semiconductors. |
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PF

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| <ul style="list-style-type: none">(a) An on-line instrument for measuring uranium enrichment in gas centrifuge plants has been accepted by the IAEA and installed in Vienna. The first instrument is expected to go into service at Capenhurst in England.(b) Development of a non-intrusive device which will be used to verify that low enriched uranium is flowing through the pipework in gas centrifuge enrichment plants.(c) The principle of a plutonium assay method was established, a prototype instrument has been assembled and a testing program initiated.(d) Safeguards R&D has revealed a number of deficiencies in existing nuclear data; a measurement and evaluation program has been initiated and some results have been published. | <ul style="list-style-type: none">(a) Complete studies of the liquid scintillator neutron coincidence counter (LSNCC) and hybrid systems.(b) Design and construct a hybrid LSNCC.(c) Assess the performance of the prototype plutonium detector and carry out field trials.(d) Develop a prototype 'Go-No Go' detector for nuclear materials surveillance.(e) Complete nuclear data measurements on plutonium-240. |
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PG

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| <ul style="list-style-type: none">(a) Construction and operation of a compact design, high power CO₂ laser (200 W).(b) Completion of a supersonic molecular beam laser target facility.(c) Conceptual design of a special turbo-compressor for fast axial-flow laser use.(d) Operation of a sub-atmosphere, 100,000 rev/min turbo-compressor test loop.(e) Generation of extensive turbo-compressor performance data on low pressure, laser gas mixtures.(f) Design of an ultra-fast mechanical laser Q-switch. | <ul style="list-style-type: none">(a) High power level CO₂ laser demonstration (400 W).(b) Design/commissioning/demonstration of a laser turbo-compressor.(c) Commissioning of a mechanical Q-switch.(d) Demonstration of new Q-switched intra-cavity isotope separation technique.(e) Transverse excited atmospheric (TEA) laser dissociation of volatile aluminium and zirconium complexes. |
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PH

PI
INSTRUMENT DESIGN**OBJECTIVE**

To design, develop and commercialise instruments; to develop electronic systems; and to act as consultants on electronic applications to other ANSTO programs.

RESOURCES

5.5 person years.
Budget: \$215,000.

PROJECT MANAGER

Mr Geoff Watt.

This project involves the design and development of electronic units and instruments in support of ANSTO program areas. These services are essential because of the specialised nature of many of ANSTO's activities and the absence of a broad industrial base for this field in Australia.

AMDEL; ETP; Chua Electronics; Scientific Industrial Automation.

EXTERNAL SUPPORT

Chua Electronics \$12,000.

PJ
**INSTRUMENTATION
CONTROL AND COMPUTER
INTERFACE****OBJECTIVE**

To maintain a group of experts in the field of digital electronics and instrumentation; and to evaluate the use of new generations of computers as time-saving tools to enable automatic operation of various projects, experiments and plant.

RESOURCES

3 person years.
Budget: \$148,000.

PROJECT MANAGER

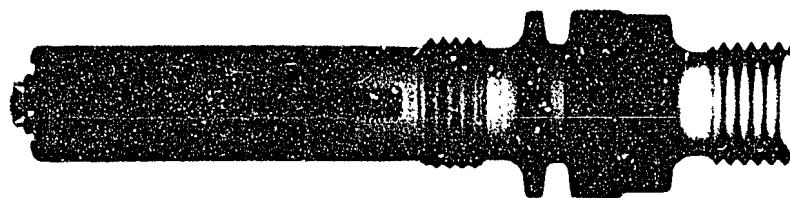
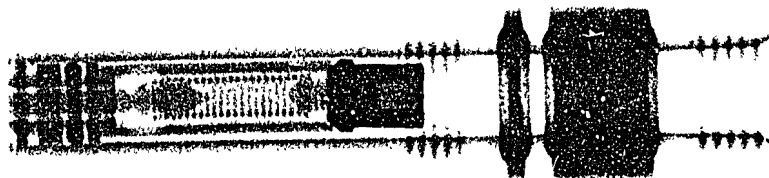
Mr Peter J Ellis.

This project involves the design, development and calibration of electronic, digital and plant instrumentation. Services are provided to most scientific programs at Lucas Heights, thus enabling ease of control and data collection and subsequent transmission to the larger computers.

CSIRO; AINSE.

EXTERNAL SUPPORT

8 person years to be funded from other Program areas.



Neutron radiograph (top)
and X-radiograph of a car fuel injector.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

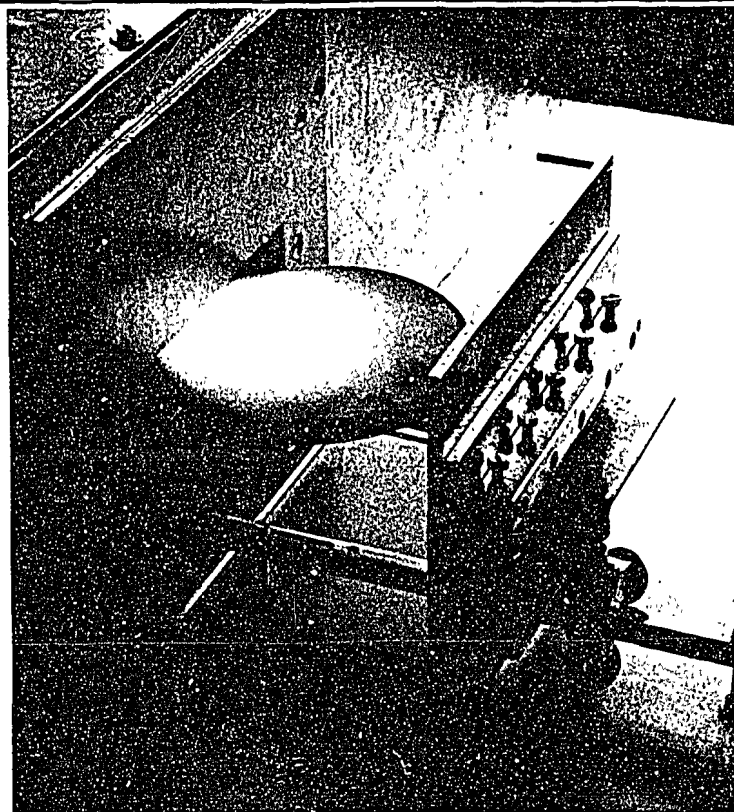
- (a) Major assistance with the writing of neutronic specifications and the development of fault-finding instruments for HIFAR.
 - (b) Design and installation of a low noise field-effect transistor (FET) characterisation rig.
 - (c) Re-design of a field ratemeter.
 - (d) Production of field multi-channel analyser (MCA) prototype.
 - (e) Advice, equipment modifications and testing for the Maralinga rehabilitation project.
 - (f) Lease of a custom-built miniature prototype low noise amplifier.
- (a) Development of the prototype MCA for potential commercialisation.
 - (b) Continuation of the junction FET noise evaluation project.
 - (c) Development and sale of extra high tension voltage supplies.
 - (d) Further development of the field ratemeter.
 - (e) Provide advice and support to other program areas.

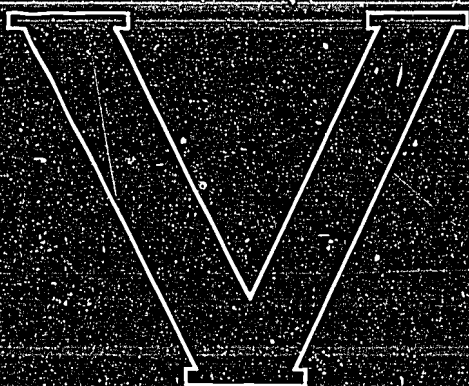
PJ

- (a) Ongoing development of the Synroc plant control systems during trials and modifications.
 - (b) Modernisation of several instrumentation systems for HIFAR experiments particularly for neutron scattering studies.
 - (c) Automation of several labour-intensive tasks such as the film badge service and counting experiments.
 - (d) Rewiring of the control systems for the research reactor Moata.
 - (e) Maintenance of the site computer networks.
 - (f) Repair of faulty electronic units and computer systems.
- (a) Further development of Synroc plant instrumentation.
 - (b) Upgrading of Moata reactor control system.
 - (c) Expansion of site computing network.
 - (d) Increased automation of experiments.

PJ

Silicon wafer being annealed after irradiation.





ENVIRONMENTAL SCIENCE

THE PRIMARY OBJECTIVE FOR THE ENVIRONMENTAL SCIENCE PROGRAM IS TO USE SPIN-OFF TECHNOLOGIES ARISING OUT OF NUCLEAR SCIENCE AND TECHNOLOGY TO MINIMISE THE ENVIRONMENTAL IMPACT FROM MINING AND OTHER INDUSTRIES IN AUSTRALIA. THE MINIMISATION PROCESS CAN TAKE MANY FORMS AND COULD INCLUDE THE FOLLOWING:

- DERIVATION OF THE APPROPRIATE DISCHARGE AUTHORISATIONS BASED ON PHYSICAL DISPERSION MECHANISMS, GEOCHEMICAL INTERACTIONS, META-

BOLIC PROCESSES, OCCURRING IN THE LOCAL FAUNA AND FLORA, RADIOLOGICAL DOSIMETRY AND ECOTOXICOLOGY;

- ADVICE ON MANAGEMENT PRACTICES FOR SOLID AND LIQUID WASTE ENCOMPASSING LIQUID WASTE TREATMENT, PLACEMENT ARRAYS FOR SOLIDS WITH OR WITHOUT PRIOR CONDITIONING, CHARACTERISATION OF LEACHATE FROM A RANGE OF WASTE STORAGE FACILITIES AND THEIR GEOCHEMICAL TRANSPORT; AND
- MODIFICATION OF PROCESSES AND

BACKGROUND

EXTERNAL ORGANISATIONS & SUPPORT

VA POLLUTANT GENERATION AND TRANSPORT

OBJECTIVE

To maintain state-of-the-art expertise in environmental radon measurements; develop and apply atmospheric pollutant transport and dispersion models; develop and apply water-borne pollutant transport models; and develop and deploy equipment to measure pollutant generation rates and transport rates.

RESOURCES

19 person years.
Budget: \$1,003,000.

PROJECT MANAGER

Dr A Ian M Ritchie.

Assessment of the environmental impact of an operation requires quantification of both the strength of the pollutant sources and the transport and dispersion of pollutants away from them. Two dominant transport processes are water-borne through porous media and air-borne. Research on these processes allows a wide variety of problems in radioactive waste repositories, the safe operation of nuclear facilities and the environmental impact of the mining and processing of radioactive minerals to be addressed.

Office of the Supervising Scientist (OSS); Bureau of Meteorology; Total Mining; CSIRO Division of Atmospheric Research; CSIRO Antarctic Division; Boral Research; Alcoa Ltd; Bourgainville Copper; CRA/ATD; Northern Territory Power and Water Authority; CSIRO Division of Soils; Canadian RATS Program.

EXTERNAL SUPPORT

\$100,000.

VB ORE PROCESSING AND WASTE MANAGEMENT

OBJECTIVE

In collaboration with industry and environmental authorities, to develop more efficient chemical engineering/metallurgical methods for the processing of uranium and other ores, and for the treatment and management of waste generated by hydrometallurgical processes. Ultimately, the aim is to establish a consultancy with sufficient breadth of experience to provide specialised services to the mining/ore processing industries.

RESOURCES

7.5 person years.
Budget: \$428,000.

PROJECT MANAGER

Dr Des M Levins.

From research into problems faced by the uranium mining/milling industry ANSTO has gained expertise in hydrometallurgy, particularly in relation to the extraction of uranium from ores, fate of radionuclides in metallurgical processes, treatment of waste waters, pollutant source terms and tailings management. Similar work is being undertaken in other areas such as mineral sands and gold processing.

Roxby Management Services (RMS); Queensland Mines Ltd (QML); Coal Corporation of Victoria (CCV); Pyrotech Resources; Wimmera Industrial Minerals; BP Minerals (Aust.); Interlox Chemicals; Office of the Supervising Scientist (OSS); Canning Resources Pty Ltd; PNC Exploration; Deckhand Pty Ltd; Universities of Sydney and NSW.

EXTERNAL SUPPORT

\$21,000 for work in progress; other projects funded to \$56,000 yet to commence.

OPTIMISATION OF CONDITIONS WHERE, FOR EXAMPLE, USE OF ALTERNATIVE CHEMICALS AND FLOW-SHEETS CAN IMPROVE WASTE TREATMENT OPERATIONS AND MINIMISE DISCHARGE OF CONTAMINANTS.

TO ACHIEVE THESE OBJECTIVES RESEARCH MUST CONCENTRATE ON THE UNDERLYING MECHANISMS; THE CONTINUUM IMPLIED BY THE GENERIC TITLES AND OBJECTIVES OF EACH PROJECT REFLECT THIS REQUIREMENT. IDEALLY A QUARTER OF THE RESEARCH EFFORT WOULD BE EXTERNALLY SUPPORTED THROUGH GOVERNMENT GRANTS AND A QUARTER SUPPORTED BY CLIENT COMPANIES WITH A SYNERGY BETWEEN THE RESPECTIVE GENERAL AND SPECIFIC OBJECTIVES. WITHIN ANY REVIEW PERIOD IT IS EXPECTED THAT A NUMBER OF THE INDUSTRY-BASED UNDERTAKINGS WILL

HAVE ROLLED THROUGH THE PROJECT, EACH WITH OBJECTIVES AND TO A TIME TABLE DETERMINED BY THE CUSTOMER. THIS IS AN EFFECTIVE METHOD FOR TRANSFERRING TECHNOLOGY TO AUSTRALIAN INDUSTRY.

TECHNICAL CONTACT AT SCIENTIFIC MEETINGS AND LABORATORY/PLANT VISITS HAVE BEEN AND WILL REMAIN AN IMPORTANT MEANS OF INITIATING RESEARCH CONTRACTS WITH INDUSTRY, CONSEQUENTLY ENSURING THE RELEVANCE OF THE ENVIRONMENTAL SCIENCE PROGRAM TO PROBLEMS IN INDUSTRY. RECENTLY, SOME OF THE LARGER MINING COMPANIES HAVE CALLED TENDERS FOR RESEARCH. THIS MERITS ENCOURAGEMENT SINCE IT IS AN EFFECTIVE METHOD FOR TECHNOLOGY TRANSFER AND CAN FOCUS DISPARATE RESEARCH GROUPS ON THE SAME SPECIFIC OBJECTIVES.

PROGRAM DIRECTOR: MR DES R DAVY.

RECENT WORK & ACHIEVEMENTS

- (a) Developed and commissioned sensitive continuous radon monitors for baseline measurements of airborne radon.
- (b) Initiated a study of radon transport.
- (c) Developed mathematical models of saturated and unsaturated flow in thin extended aquifers.
- (d) Interpreted neutron/gamma soil moisture/density field measurements.
- (e) Quantified effectiveness of the rehabilitation of pyritic waste dumps at Rum Jungle.
- (f) Developed an in situ method of measuring gas permeability in mine waste.
- (g) Completed a meteorological study at a mine site.

WORK PLANNED

- (a) Deploy new automated radon detectors for extension of the radon transport study.
- (b) Deploy a radon station at another World Meteorological Organisation (WMO) baseline station.
- (c) Develop radon/thoron emanometers.
- (d) Evaluation of selected codes for the calculation of water flow in porous media.
- (e) Further development of models of saturated/unsaturated flow.
- (f) Investigate leaching copper from mine waste.
- (g) Investigate leaching of auriferous pyrite.
- (h) Use of radioactive tracers to measure diffusion coefficients of soils.
- (i) Upgrade meteorological monitoring at Lucas Heights.

VA

- (a) Report on radiological and environmental aspects of processing copper concentrates.
- (b) Report on radioactive contamination of properties at Hunters Hill, NSW.
- (c) Research on (i) volatilisation of radionuclides during smelting and refining of ore, and (ii) development of techniques for analysis of radionuclides in metallurgical samples.
- (d) Research on the processing of bogum slimes and primary ore.
- (e) Report on the removal of heavy metals from liquid mining waste using modified brown coal.
- (f) Research into the processing of monazite and management of thoria waste.
- (g) Minor research on the distribution of radioactivity in Doré metal, and on the use of Caro's acid as an oxidant for gold ores.

- (a) Recovery of rare earths from ores.
- (b) Stabilisation of thoria waste from the processing of monazite.
- (c) Continued support for uranium producers on ore processing, department of radionuclides, waste treatment and tailings management.
- (d) Use of peroxygen compounds in gold industry for heap leaching, leaching of refractory ores and destruction of cyanide waste.
- (e) Separation of rare earth elements by solvent extraction and/or ion exchange.
- (f) Collaborative research on disposal of tailings, especially sub-aerial deposition, disposal into open cuts and radon emanation.

VB

VC

BIOLOGICAL IMPACTS**OBJECTIVES**

To assess the uptake and transfer of radium and some man-made radionuclides, including plutonium-239, americium-241, caesium-137 and strontium-90 into human food chains, define the dose which may be received by humans from consuming these radioisotopes, and set discharge limits for uranium mines and clean-up options for Maralinga. Also to assess the impact of non-radioactive pollutants such as heavy metals on biota in order to formulate discharge standards for mining operations.

RESOURCES

8.5 person years.
Budget: \$388,000.

PROJECT MANAGER

Mr Max S Giles.

This project principally involves the uptake and kinetics of radionuclides into human food chains in the wetlands adjacent to the Northern Territory uranium mines and the arid lands of the former nuclear weapons testing site at Maralinga, South Australia. Associated studies consider the radioecology of these regions and the effects of mining pollutants on marine and freshwater biota.

OSS, Dept of Primary Industry and Energy (DPIE), OK Tedi Mines Ltd, SPCC.

EXTERNAL SUPPORT

\$61,000.

VD

**ENVIRONMENTAL
CHEMISTRY****OBJECTIVE**

To define and quantify chemical processes which control the movement of pollutants into the environment from mining and industrial operations, and to develop methods for the management of solid and liquid waste to minimise impact on water quality.

RESOURCES

15 person years.
Budget: \$702,000.

PROJECT MANAGER

Dr John V Evans.

The important processes governing both release and transport of pollutants (oxidation-reduction, adsorption-desorption, dissolution-precipitation and complexation) are being characterised and quantified. The approach was developed for problems associated with the safe disposal of radioactive waste from uranium mining, milling, and the nuclear fuel cycle, and can be used on similar management problems in non-nuclear mining and heavy industrial operations.

Universities of Sydney, NSW, Wollongong, James Cook and Tasmania; Ranger Uranium Mining; EZ Comp.; Total Mining; CRA; Bougainville Copper; FIRTA; SPCC; NSW Dept of Water Resources; Wyong Shire Council; CSIRO; AINSE; AMSTAC; AWRAC; ARGS; US Geological Survey; US Office of Naval Research.

EXTERNAL SUPPORT

~ \$100,000 (excluding fellowships \$22,000).

VG

**ENVIRONMENTAL
SERVICES****OBJECTIVE**

To demonstrate that radioactive discharges from the Lucas Heights Research Laboratories and the nearby radioactive burial ground do not represent a hazard to the environment and to extend expertise in the field to the needs of industry.

RESOURCES

3.5 person years.
Budget: \$170,000.

PROJECT MANAGER

Mr Max S Giles.

Since discharges of radioactivity into the environment began at Lucas Heights in 1960, it has been necessary to monitor radioactivity in air, water, soil and vegetation to demonstrate compliance with the Regulations of the NSW Radioactive Substances Act and Clean Waters Act. This project carries on that requirement. Expertise gained in this field is being used to gain some contract work in industry.

NSW Health Commission; SPCC; Australian Wheat Board, West Australian Analabs; BHP; Deckhand Pty Ltd.

EXTERNAL SUPPORT

Nil.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

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| <ul style="list-style-type: none">(a) Determination of the pathways and mechanisms of uptake of radium into freshwater mussels and water lilies from water and sediment together with estimates of concentration factors. This information was used to formulate suitable discharge standards for radium from Northern Territory uranium mines.(b) Some 250 samples of biota (kangaroo, rabbit, witchetty grubs, goanna and native fruits) and soils have been collected at Maralinga and are awaiting analysis in the UK. These results will be used to calculate possible doses to humans deriving food from, and/or living in, the contaminated areas of Maralinga and thus establish rehabilitation measures necessary before restrictions on entry are lifted.(c) Demonstration that tailings muds are not toxic to freshwater prawns and catfish. | <ul style="list-style-type: none">(a) Extension of the radium work to fresh water turtles and water lilies to marine prawns.(b) Further sampling of Maralinga rabbit populations.(c) Negotiations to undertake collaborative work with the NSW State Pollution Control Commission (SPCC) on organotin toxicity. |
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VC

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| <ul style="list-style-type: none">(a) Completion of a groundwater study of a uranium deposit and an investigation of the role of redox chemistry in controlling the geochemical behaviour of uranium.(b) Completion of a geochemical study of migration in and from an abandoned uranium mill tailings dam and laboratory measurements of the physical characteristics of solute movement.(c) Completion of a study of the role of iron oxides in the transport of uranium and thorium in soils.(d) Development of a fully instrumented leach column to study the mechanism of pyritic oxidation in overburden.(e) Extension of an AMSTAC grant for the study of oxidation-reduction photochemistry in marine systems to studies into US waters.(f) Successful research on iron and manganese oxide solution/precipitation reactions in potable water.(g) A study of the feasibility of chemically recycling aluminium extracted from water treatment sludges.(h) Acceptance of a predictive model of solution equilibria into the NEA geochemical thermodata bank. | <ul style="list-style-type: none">(a) Field evaluation of selected geochemical transport codes and the application of improved codes to specific waste management problems.(b) Continue work on the chemistry of uranium mine waste, arsenic waste and cyanide gold extraction tailings.(c) Continue the study of chemistry of pyrite oxidation in waste heaps.(d) Model release of pollutants from mine waste and their impact on quality of receiving surface waters.(e) Commence major project on marine sedimentation.(f) Use drill cores to extend investigation of geochemical factors controlling uranium migration.(g) Commence a collaborative study of solute concentration and flow processes in ground waters.(h) Expand water treatment activities to include aspects of sewage treatment and disposal.(i) Extend work on the hydrolysis and precipitation from solution of iron oxides to the study of the effect on solids thickening/filtration processes.(j) Investigate processes controlling gold migration in the environment.(k) Investigate the kinetics of aggregation of simple and mixed oxides in natural and industrial aqueous environments. |
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VD

- | | |
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| <ul style="list-style-type: none">(a) Routine environmental surveys have continued and the results reported.(b) Small contracts for a proposed mineral sands processing plant have been finalised. | <ul style="list-style-type: none">(a) To fulfil routine environmental monitoring schedules at Lucas Heights.(b) Measurement of gross β radioactivity in Australian Standard White Wheat.(c) Analysis of ground water samples for gross α and β radioactivity. |
|---|---|

VG

WORLDWIDE RADIOISOTOPE AND RADIATION TECHNOLOGY HAS CONTRIBUTED SIGNIFICANTLY TO INDUSTRY, LEADING TO SUBSTANTIAL ECONOMIC AND SOCIAL BENEFITS. THESE HAVE BEEN ACHIEVED THROUGH:

- IMPROVED COMPETITIVENESS BY BETTER QUALITY CONTROL, HIGHER PRODUCTIVITY, LOWER MANUFACTURING COSTS AND INCREASED EFFICIENCY;
- SAVINGS IN RAW MATERIAL COSTS FOR HIGHER CONSUMPTION INDUSTRIES; AND
- SAVINGS IN ELECTRICITY USAGE.

APPLICATIONS OF RADIOISOTOPES AND RADIATION

BACKGROUND

EXTERNAL ORGANISATIONS & SUPPORT

IA INDUSTRIAL APPLICATIONS

OBJECTIVE

To develop and apply a wide range of industrial radioisotopes to a number of industries through collaboration and consultation, and to support international agencies in the transfer of radioactive tracer technology to the Asian-Pacific region.

RESOURCES

12 person years.
Budget: \$750,000.

PROJECT MANAGER

Dr John F Easey.

The use of radioisotope techniques for industrial applications has provided solutions hitherto unanswered by more conventional technologies. In collaboration with industry and governmental organisations, ANSTO has successfully used these techniques in Australia and several countries of South East Asia. In addition, expertise has been provided to the IAEA UNDP Regional Cooperative Agreement (RCA) and the Australian International Development Aid Bureau (AIDAB) for technology transfer and for the training of visiting scientists.

AIDAB; IAEA; BHP; Sulphide Corporation; NSW Dept of Public Works; Comalco Ltd; Santos Ltd; Metropolitan Water, Sewerage and Drainage Board (MWS&BD); OSS; several Shire Councils.

EXTERNAL SUPPORT

\$200,000 in contracts for collaborative research projects.

IB IRRADIATION RESEARCH AND TECHNOLOGY

OBJECTIVE

To develop and assess the use of irradiation techniques for the sterilisation, disinfestation and preservation of a variety of materials in collaboration with organisations in the private and public sectors. Materials include foodstuffs, and medical, agricultural, horticultural and industrial products.

RESOURCES

6 person years.
Budget: \$327,000.

PROJECT MANAGER

Dr Kerrie Hammerton.

ANSTO is required by the Australian Government to investigate and advise on the use of irradiation techniques for the protection or improvement of industrial, agricultural and food products and processes. It also provides to national and international regulatory organisations expert knowledge on the benefits and limitations of this technology.

CSIRO; IAEA; Ansell-Steritech Ltd, Gosford Post-harvest Laboratory, NSW; Queensland Dept of Primary Industry (QDPI); Fisheries Industry Research Council (FIRC); horticultural companies; dosimetry service for the pharmaceutical industry.

EXTERNAL SUPPORT

Fishing Industry Research Trust Account (FIRTA) Grant \$12,000, dosimetry service \$7000, Ansell-Steritech Ltd \$21,000, Total \$40,000. QDPI, \$500 per day as a service charge, similar charge to be negotiated with CSIRO Meat Research Laboratories.

ANSTO HAS CONSIDERABLE EXPERIENCE IN A NUMBER OF FACETS OF RADIOISOTOPE AND RADIATION TECHNOLOGY, AND HAS GAINED AN INTERNATIONAL REPUTATION IN THESE FIELDS. THIS CAPABILITY IS BEING FURTHER DEVELOPED IN THE CURRENT SERIES OF PROJECTS, AND ADDITIONAL BENEFITS SHOULD ACCRUE FROM INTERACTION BETWEEN ANSTO AND ITS CLIENTS. THE BROAD AIMS OF THE SIX PROJECTS ARE

- TO DEVELOP RADIOISOTOPE AND RADIATION TECHNIQUES FOR USE IN INDUSTRY AND OTHER ECONOMICALLY IMPORTANT SECTORS OF THE ECONOMY;
- TO TRANSFER THIS TECHNOLOGY TO INDUSTRY VIA COLLABORATIVE AGREEMENTS, CONSULTANCIES OR THE ESTABLISHMENT OF JOINT VENTURE ARRANGEMENTS;

- TO INVESTIGATE AND DEVELOP THE USES OF RADIATION FOR THE STERILISATION, DISINFESTATION OR PRODUCT IMPROVEMENT OF AGRICULTURAL AND HORTICULTURAL MATERIALS;
- TO DEVELOP AND APPLY ISOTOPE TECHNIQUES TO THE STUDY OF SOIL AND WATER PROBLEMS; AND
- TO STUDY THE MIGRATION OF RADIONUCLIDES IN GROUND-WATER AND SO IMPROVE THE UNDERSTANDING OF THE BEHAVIOUR OF BURIED NUCLEAR WASTE FORMS.

PROGRAM DIRECTOR: DR CLARENCE J HARDY.

RECENT WORK & ACHIEVEMENTS

- (a) Continuation of studies to improve blast furnace performance.
- (b) Continuation of coastal engineering studies at the Port of Brisbane, Port Adelaide and Port Hacking.
- (c) Extension of metallurgical investigations to the aluminium industry.
- (d) Continuation of industrial pollution and sewage studies.
- (e) Development of tracer studies on termites in natural and urban environments.

WORK PLANNED

- (a) Contribute to the transfer of industrial tracer technology to the Asian/Pacific Region through the UNDP/RCA Industrial Project and termite tracer technology through the RCA program.
- (b) To develop and market activateable tracer technology to complement the work normally done with radioactive tracers. In this technique the material for analysis is spiked with a non-radioactive substance then submitted for neutron activation analysis at the reactor HIFAR.
- (c) To develop technology that can be commercially exploited through the ANSTO/ICI joint venture company.
- (d) Negotiation of collaborative research and development with other Australian and overseas organisations.

IA

- (a) Provision of a routine ceric/cerous and ferric/ferrous (low dose) dosimetry service to industry for independent analysis of radiation doses to materials.
 - (b) Provision of major evidence and advice to the House of Representatives Standing Committee on Irradiation.
 - (c) Collaborative research on the qualitative improvement of tropical fruits.
 - (d) Improvement of quality of shelf life of fish.
 - (e) Consultancy with Ansell-Steritech Ltd on the application of irradiation techniques at the company's irradiation plant.
 - (f) Participation in the IAEA RCA for South East Asia.
- (a) Continue provision of a routine radiation dosimetry service.
 - (b) Completion of projects supported by grants.
 - (c) Expansion of studies on tropical fruits.
 - (d) Completion of meat research in association with processing companies and CSIRO Meat Research Laboratories.
 - (e) Explore commercial opportunities in the horticulture industry, including the disinfestation of fruit fly, and of cut flowers for export.

IB

IC
GEOSPHERE APPLICATIONS

OBJECTIVE

To develop and apply techniques based on the measurement of naturally occurring radioisotopes such as tritium, carbon-14, chlorine-36 and caesium-137 to problems of groundwater and soil management in Australia and South East Asia.

RESOURCES

9 person years.
Budget: \$545,000.

PROJECT MANAGER

Dr Graeme E Calf.

Because of Australia's dwindling land and water resources, ANSTO has been monitoring the distribution of naturally occurring radioisotopes to enable the better management of these resources. Work has been carried out in collaboration with the Bureau of Mineral Resources and Geophysics (BMR) together with government agencies from several States, and with a number of industries. The expertise acquired during these studies has been applied to the IAEA's five-year RCA on Hydrology for South East Asia.

ANU; University of Newcastle, NSW; CSIRO; BMR; soil conservation and water resources agencies in all Australian States; National Soil Conservation Project; IAEA; AIDAB; Malaysian Government; Australian Water Resources Advisory Council (AWRAC).

EXTERNAL SUPPORT

\$40,000 extension to AWRAC grant; \$10,000 from several States and Shire Councils.

ID
**ALLIGATOR RIVERS
ANALOGUE PROJECT
(ARAP)**

OBJECTIVE

First, to develop models of the migration of radionuclides in the geosphere in porous and fractured media and ascertain the factors which control this migration, then to validate the models with field and laboratory data on uranium/thorium series nuclides and selected fission products and transuranic nuclides.

RESOURCES

3 person years.
Budget: \$192,000.

PROJECT MANAGER

Mr Peter Duerden.

Uranium deposits in the Alligator Rivers region of the Northern Territory are being studied as natural analogues of radioactive waste repositories.

Initial support was from the US Nuclear Regulatory Commission (USNRC) and UK Department of Environment (UKDOE). In 1987, international support was received from six organisations from five countries (see below).

USNRC; UKDOE; JAERI (Japan); PNC (Japan); SKI (Sweden); University of Sydney; University of Arizona; Johns Hopkins University; UKAEA; AERE, Harwell; Los Alamos National Laboratory.

EXTERNAL SUPPORT

Contributions in (a) cash — USNRC (\$210,000), UKDOE (\$168,000), JAERI (\$70,000), PNC (\$21,000), SKI (\$70,000) = \$529,000; and (b) kind — JAERI (\$98,000), PNC (\$21,000) = \$119,000.



Irradiation can improve the quality and extend the shelf-life of fish.

RECENT WORK & ACHIEVEMENTS

- (a) Application to salinity problems in the Murray Basin, in collaboration with BMR, CSIRO and the Australian National University (ANU), of chlorine-36 sampling techniques using facilities supplied by ANU.
- (b) Quantitative measurements of soil and productivity loss in agricultural regions in collaboration with state agencies and universities, utilising caesium-137 deposited from weapons test fallout.
- (c) Establishment of tritium and carbon-14 measurement laboratories in South East Asia as required by the RCA and an Australian-Malaysian Agreement.

WORK PLANNED

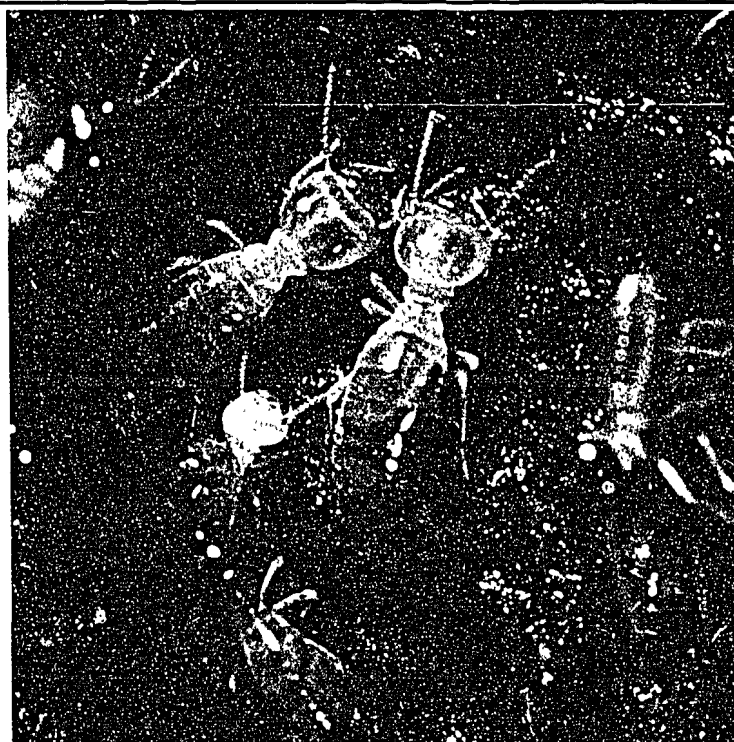
- (a) Continue research on Murray Basin salinity.
- (b) Utilise the ANU's accelerator mass spectrometer for the measurement of beryllium-10 and aluminium-26 in soils.
- (c) Continue to collaborate with state agencies on the National Soil Conservation Project's soil erosion study.
- (d) Seek contracts and grants to extend the above methods to soil management problems in the pastoral industry.

IC

- (a) Extension of ARAP as an international project.
- (b) Completion of outstanding contracts with USNRC and UKDOE.
- (c) Presentation of results at major international scientific conferences in USA, Europe and China.
- (d) Agreement to participate in the complementary Intraval model validation project organised by SKI (Sweden).

- (a) Evaluate data accrued from the 1988 field trip to the Koongarra uranium ore deposit.
- (b) Coordinate modelling studies in ARAP with complementary studies undertaken for the Intraval project.
- (c) Continue laboratory and field studies on samples from Koongarra to accrue more data for modelling.

ID



Termite colonies can be mapped by labelling their food with a radioisotope.



BIOMEDICINE AND HEALTH

THE PRINCIPAL OBJECTIVES OF THE BIOMEDICINE AND HEALTH PROGRAM ARE THE APPLICATION OF NUCLEAR SCIENCE AND ENGINEERING TECHNOLOGIES IN DIAGNOSTIC AND THERAPEUTIC NUCLEAR MEDICINE AND THE PROVISION OF R&D SUPPORT TO AUSTRALIA'S SOLE PRODUCER OF RADIOISOTOPES AND RADIOPHARMACEUTICALS.

PRESENT PROJECTS IN THE BIOMEDICINE AND HEALTH PROGRAM INCLUDE

- APPLICATION OF NEUTRON-BASED TECHNIQUES TO THE IN - VIVO MEASUREMENT OF BODY COMPOSITION

BACKGROUND

EXTERNAL ORGANISATIONS & SUPPORT

BA NEUTRON DIAGNOSIS AND THERAPY

OBJECTIVES

To apply IVBC measurements to the treatment of malnutrition in medical practice; and to develop new cancer therapy methods for melanoma, leukaemia, breast cancer and glioblastoma.

RESOURCES

4.5 person years.
Budget: \$266,000.

PROJECT MANAGER

Dr Barry J Allen.

This project involves the development of diagnostic techniques in malnutrition studies and the application of neutron capture therapy (NCT) to the treatment of some forms of cancer. In-vivo body composition (IVBC) studies provide accurate determinations of total body protein, a basic parameter in disease-induced malnutrition. Total body water and intracellular water provide further insights into patient condition. Because NCT combines elements of radiotherapy and chemotherapy, it has the potential to treat cancers which are insensitive to current methods.

Royal Alexandra Hospital for Children; Royal Prince Alfred Hospital; Mount St Margaret's Hospital; Royal North Shore Hospital; Westmead Hospital; Albion Street Centre; Bread Research Institute; Australian Meat and Livestock Corporation; Monash University; Peter MacCallum Cancer Institute; Queensland Institute Medical Research; Sydney University; Royal Newcastle Hospital; Melbourne University; Kobe Medical School, Japan; University of California, San Francisco; University of Bremen, Federal Republic of West Germany.

EXTERNAL SUPPORT

\$82,500 in kind; plus \$2,500 (cash - Royal Alexandra Hospital for Children, NSW Cancer Council, Victoria Anti-Cancer Council).

BBA BIOLOGICAL DOSIMETRY

OBJECTIVE

To provide a routine service in biological dosimetry and conduct research on improved methods for estimating lower doses of radiation and for mutagen and tetratagen assays.

RESOURCES

3.5 person years.
Budget: \$249,000.

PROJECT MANAGER

Mr J Keith Brown.

ANSTO conducts a blood sampling service to determine radiation exposure in man following radiation accidents. In addition, two other techniques (rat fetal brain cells and micronuclei in mice) have been developed for potential use in drug testing for industry (tetratagen and mutagen assays).

IAEA.

EXTERNAL SUPPORT

Nil.

- IN MALNUTRITION STUDIES AND INVESTIGATION OF NEUTRON CAPTURE THERAPY AS A POTENTIAL TREATMENT FOR CERTAIN FORMS OF CANCER;
- RESEARCH IN RADIATION BIOLOGY WITH AN EMPHASIS ON BIOLOGICAL DOSIMETRY AND RADIOSENSITIVITY;
- THE DEVELOPMENT OF DIAGNOSTIC AND THERAPEUTIC RADIOPHARMACEUTICALS WITH POTENTIAL FOR COMMERCIAL EXPLOITATION THROUGH AUSTRALIAN RADIOISOTOPES (ARI);
- DEVELOPMENT, IN COLLABORATION WITH INDUSTRY, OF NEW DIAGNOSTIC AGENTS BASED ON RADIOLABELLED MONOCLONAL ANTIBODIES;
- THE USE OF COMPUTING EXPERTISE TO MODEL BIOLOGICAL SYSTEMS; AND

- THE MAINTENANCE OF COLONIES OF SPECIFIC PATHOGEN-FREE LABORATORY RODENTS UNTIL THE UNIVERSITY OF NSW FACILITY AT LITTLE BAY IS AVAILABLE TO SUPPLY THESE ANIMALS.

IN ADDITION TO THESE PROJECTS, THE BIOMEDICINE AND HEALTH PROGRAM WILL ASSIST ARI IN IMPROVING PROCESSES FOR THE MANUFACTURE OF TECHNETIUM-BASED RADIOPHARMACEUTICALS. THE PROPOSED INSTALLATION OF A MEDICAL CYCLOTRON AND POSITRON EMISSION TOMOGRAPHY (PET) FACILITY AT THE ROYAL PRINCE ALFRED HOSPITAL IN SYDNEY WILL PROVIDE OPPORTUNITIES TO DEVELOP RESEARCH PROJECTS IN THIS NEW AND EXCITING FIELD.

PROGRAM DIRECTOR (ACTING): DR PATRICK M KELLY

RECENT WORK & ACHIEVEMENTS

- (a) Protein has been laid down by gastrostomy feeding in cystic fibrosis children, protein gains observed in peritoneal but not haemodialysis renal patients, and protein loss observed in surgical patients.
- (b) The total body nitrogen method has been extended to protein determination in packaged meat and in grains.
- (c) Boron compounds have been tested by in-vitro and in-vivo experiments to and therapeutic concentrations obtained for the NCT of melanoma.
- (d) Radiation damage to cells has been investigated by electron microscopy.
- (e) The electrons displaced from gadolinium-157 undergoing Auger emission after neutron capture have been shown to cause double strand breaks.

WORK PLANNED

- (a) Clinical trials on synthetic growth hormone in children and protein loss in human immunodeficiency virus (HIV) positive subjects in the asymptomatic zidovudine trial.
- (b) The establishment of an IVBC unit in central Sydney.
- (c) Further studies on wheat protein.
- (d) Investigation of mode and site of uptake of boron biochemicals and monoclonal antibodies.
- (e) Further in-vivo tests of boron compounds and in-vivo NCT experiments on mice xenografts.

BA

Involvement in collaborative survey with the IAEA; 12 laboratories throughout the world specialising in biological dosimetry estimates in man to evaluate a new simple method (micronuclei) for estimating low doses of radiation.

- (a) Continuation of inter-laboratory comparison and development of micronuclei tests for the biological monitoring of drugs (mutagen assay) for industry.
- (b) Development of two methods for drug testing for industry.

BBA

BBB**CLONING OF
RADIORESISTANT GENES****OBJECTIVE**

To evaluate the potential of this micro-organism for genetic engineering, clone out the genes conferring radioresistance and then transfer them to the radiosensitive cells of man.

RESOURCES

2.5 person years.
Budget: \$119,000.

PROJECT MANAGER

Mr J Keith Brown.

The slime mold *Dictyostelium* appears to be particularly suitable for genetic engineering experiments whereby human genes are transferred to this micro-organism which then produces large quantities of a biological product for medical use.

Macquarie University.

EXTERNAL SUPPORT
Nil.

BC**RADIOPHARMACEUTICAL
RESEARCH AND
DEVELOPMENT****OBJECTIVES**

To investigate, develop and apply nuclear technology to medical processes, problems and products for the benefit of the community and for exploitation by ANSTO through ARI or other suitable outlets, in collaboration with nuclear medicine clinicians and scientists.

RESOURCES

14 person years.
Budget: \$810,000.

PROJECT MANAGER

Mr Des J Maddalena.

Over the past three years, this work, previously more academically oriented, has concentrated on the development of selected new, clinically useful, diagnostic and therapeutic agents, with significant commercial potential to ANSTO, and assisting ARI with the pharmacological assessment of current and new products.

Collaborative research and trials at hospitals in Fremantle, Perth and Sydney; Universities of Queensland and Sydney; Queensland Institute of Medical Research.

EXTERNAL SUPPORT

Extensive clinical trials at no cost. NSW Cancer Council grant, \$8559; AINSE research grant, \$4500.

BD**MONOCLONAL ANTIBODIES****OBJECTIVE**

Develop and apply monoclonal antibodies and radioisotope labelling techniques to the diagnosis and therapy of disease in collaboration with industrial, university and hospital specialists.

RESOURCES

2.5 person years.
Budget: \$213,000.

PROJECT MANAGER

Dr Graeme R Boniface.

Monoclonal antibodies for the diagnosis and therapy of disease are under intensive study in many countries. Studies by ANSTO involve the use of in-vivo monoclonal antibodies with radioactive labels in diagnostic probes together with an investigation of their potential for the radiotherapy of tumours.

AGEN Biomedical, Queensland; University of Sydney; NSW Cancer Council; Royal Prince Alfred Hospital.

EXTERNAL SUPPORT

\$300,000 GIRD grant over 3 years with AGEN/University of Sydney.
\$27,000 per year (renewable) Cancer Council grant.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

The organism has been successfully grown in the laboratory but further work is hampered by equipment shortage.

- (a) To determine radiosensitivity by cell survival technique following γ -irradiation.
- (b) To learn cloning techniques.

BBB

- (a) Improvement of the fission product molybdenum-99 production process.
 - (b) Production of short-lived therapeutic radionuclides, e.g. samarium-153 and dysprosium-175.
 - (c) Development of a new patented dysprosium-165 method for arthritis therapy and the planning of clinical trials.
 - (d) Development of a samarium-153 bone seeking agent for bone cancer therapy and the start of clinical trials.
 - (e) Development of an iodine-131 meta-iodobenzylguanidine (MIBG) cancer diagnostic and therapeutic agent.
 - (f) Discovery of a new family of high affinity technetium-99m tumour diagnostic agents.
- (a) Completion of clinical trials on the samarium-153 bone agent and application for marketing approval.
 - (b) Start of clinical trials of the dysprosium-153 product.
 - (c) Start of clinical use of the iodine-131/iodine-123 MIBG cancer agent in individual patients.
 - (d) High activity studies with ARI on an improved fission product molybdenum process.
 - (e) Development of a new white blood cell kit.
 - (f) Commercial evaluation of new technetium-99m tumour agents.

BC

- (a) Successful labelling of monoclonal antibodies and fragments with a number of radioisotopes, including iodine-131, indium-111, technetium-99m and samarium-153.
 - (b) Successful diagnostic imaging of products in animals.
- (a) Continue study of labelling and animal trials of thrombosis diagnosis product.
 - (b) Continue study of labelling and animal trials of tumour diagnosis.
 - (c) Develop procedures to make products acceptable for human use.
 - (d) Seek approval for clinical tests.

BD

BF**BIOLOGICAL MODELLING****OBJECTIVE**

To apply and extend analogue and digital modelling techniques to problems arising from the industrial and medical use of radioisotopes and radiation.

RESOURCES

2 person years.
Budget: \$85,000.

PROJECT MANAGER

Mr Paul Miskelly.

Analogue computing facilities have been maintained at Lucas Heights for several years to complement the major effort on digital computing.

Recently, a major analogue computer was obtained which provides ANSTO with the largest analogue computing capability in Australia.

Royal Prince Alfred Hospital, Sydney; BHP; Comalco Ltd; State Departments.

EXTERNAL SUPPORT

Nil.

BH**ANIMAL HOUSE****OBJECTIVE**

To maintain SPF rodent colonies at Lucas Heights for ANSTO R&D programs, quality control for ARI, and to support selected external projects; and to act as consultant to national/international projects.

RESOURCES

3 person years.
Budget: \$171,000.

PROJECT MANAGER

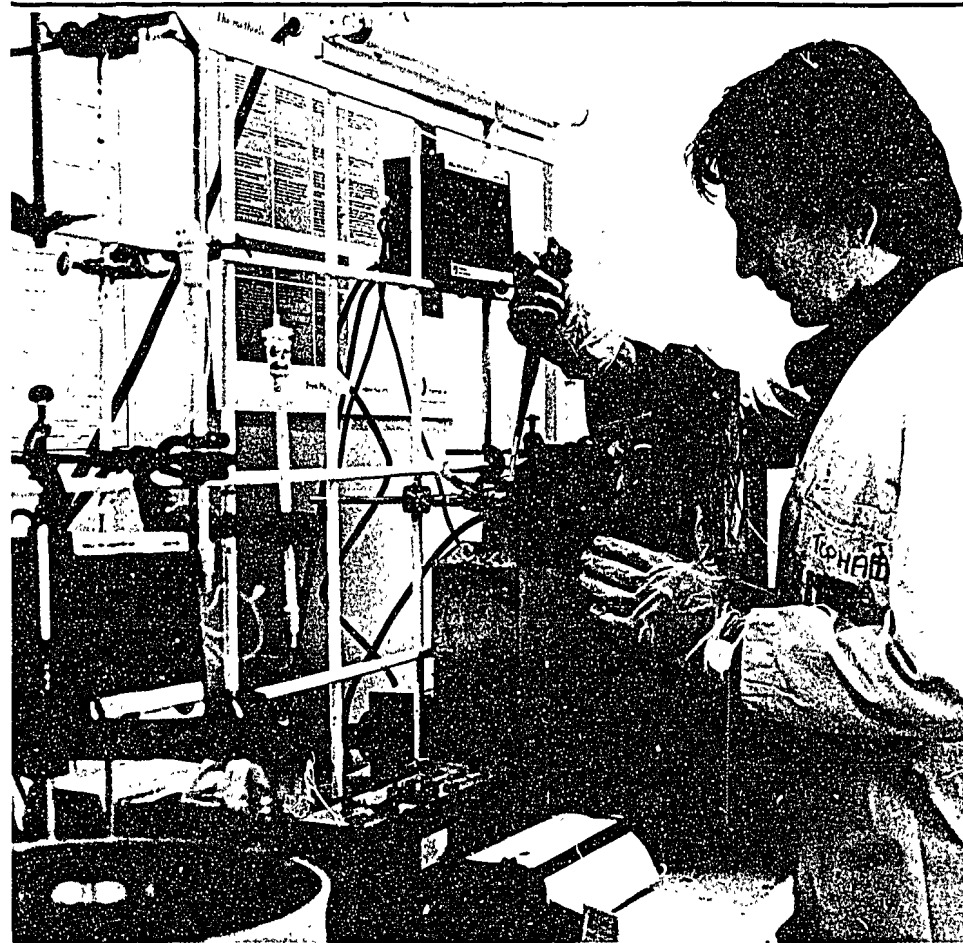
Mr Jim R McNeill.

For many years ANSTO has successfully produced infectious-disease-free (known also as specific pathogen free (SPF)) laboratory rodents. During that time, foundation stock has been provided to most of the major breeding facilities in Australia. Animals are provided routinely for ANSTO research and quality control programs and for a number of external collaborative projects.

University of NSW; University of Sydney; Royal Prince Alfred Hospital; Westmead Hospital; Ludwig Institute of Cancer Research; Royal North Shore Hospital; Macquarie University; Prince of Wales Childrens' Hospital; AIDAB; Institute of Medical and Veterinary Science; Dept of Agriculture, South Australia; Adelaide University; CSIRO Division of Animal Health, Sydney.

EXTERNAL SUPPORT

Two staff attached through University of Sydney/Royal Prince Alfred Hospital and University of Sydney/Royal North Shore Hospital consortium agreements (value \$52,000). Consultant fees ~ \$25,000).



Purification of monoclonal antibody fragments

RECENT WORK & ACHIEVEMENTS

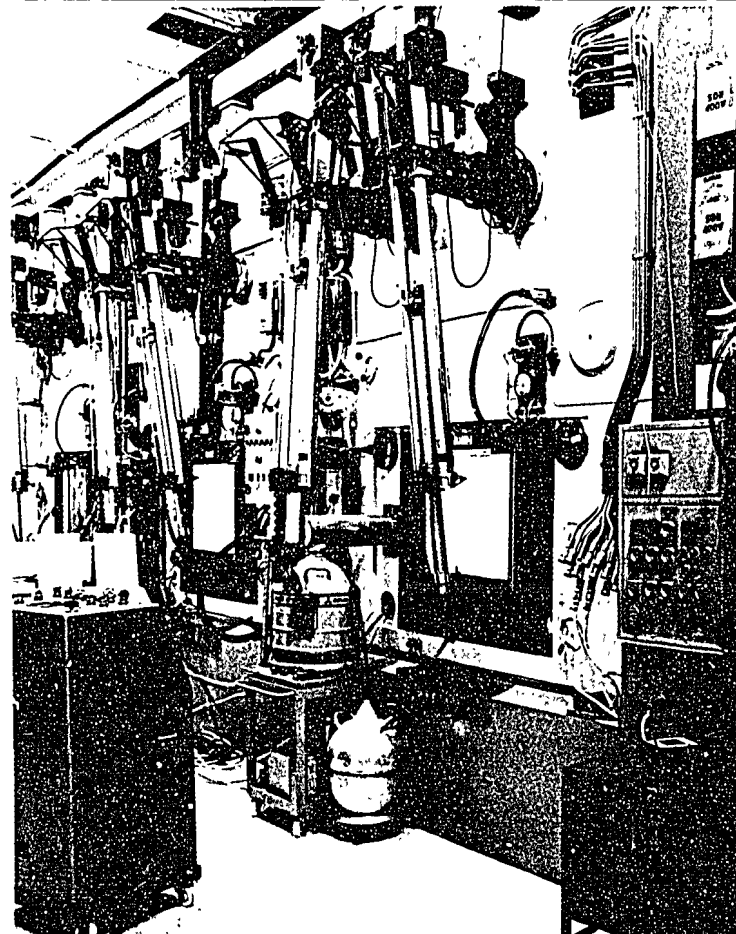
WORK PLANNED

- (a) Installation and commissioning of the new analogue computer.
 - (b) Preparation of working manuals and software.
 - (c) Preliminary discussions with nuclear medicine specialists to apply analogue computing techniques to modelling the liver function.
 - (d) Preliminary work on the modelling of radioisotope migration in several industrial fields.
- (a) Develop liver function model.
 - (b) Develop migration models for radioisotopes in industrial processes.

BF

- (a) Leader appointed as major consultant to new University of NSW Animal Breeding Facility at Little Bay.
 - (b) Start up of the breeding of a nude rat colony to complement the major Australian nude mouse colony held at Lucas Heights and extend medical research opportunities.
 - (c) Provision of high quality rodents to a large number of local collaborating organisations.
- (a) Continue the rodent breeding program.
 - (b) Commission the University of NSW facility at Little Bay.
 - (c) Microbiologically monitor both the Lucas Heights and Little Bay facilities to satisfy ANSTO standards for animals to be supplied in exchange for extensive consultancy and advice.

BH



A hot cell used for handling radioactivity in radiopharmaceuticals.

OTHER PROGRAMS

N —NUCLEAR TECHNOLOGY

LI —MARALINGA

DP —COMPUTING CENTRE

OH —OCCUPATIONAL
HEALTH AND SAFETY

ALTHOUGH EACH OF THESE PROGRAMS HAS A LARGE SERVICE COMPONENT, SOME RESEARCH IS CARRIED OUT IN SUPPORT OF THEIR PROGRAM ACTIVITIES OR AS A SPIN-OFF FROM SERVICE ACTIVITIES; THIS IS OUTLINED IN THE FOLLOWING PROJECT SUMMARIES.

BACKGROUND

NG NEUTRONICS

OBJECTIVE

To provide a base level of R&D support for the operation and safety assessment of ANSTO's reactors, the HIFAR refurbishing program and the Nuclear Safety Bureau requirements; to maintain expertise in fission reactor technology; and to provide methods of calculation and associated data-bases for the quantitative prediction of neutronics behaviour in on-site applications.

RESOURCES

5 person years.
Budget: \$240,000.

PROJECT MANAGER

Dr Brian E Clancy.

This project primarily involves a quantitative understanding of the behaviour of the neutron/gamma populations during normal operation of ANSTO's reactors and accurately predicting it in novel situations — planned or unplanned. Although the central theme is the influence of the neutron population on the reactors themselves (i.e. the safety theme), the same methods of calculation are used to predict the effects of neutrons/gammas on any proposed targets. The expertise and understanding acquired in this project is the basis for ANSTO's capability to provide appropriate advice on nuclear technology to government and non-government organisations.

EXTERNAL ORGANISATIONS & SUPPORT

OECD/NEA; Department of Defence; Natural Disasters Organisation.

EXTERNAL SUPPORT

Nil.

NH THERMAL ENGINEERING

OBJECTIVE

To maintain and develop competence in experimental and computational aspects of heat transfer and coolant flow relevant to nuclear technology, in particular in relation to safety aspects of the HIFAR reactor and fuel element transfer operations.

RESOURCES

5 person years.
Budget: \$240,000.

PROJECT MANAGER

Dr Keith R Lawther.

In this project, thermal engineering is applied to such aspects of nuclear technology as heat transfer from nuclear fuel elements, the prediction of fuel element temperatures and coolant flow behaviour under various loss-of-coolant accident (LOCA) conditions. Post-LOCA thermodynamic behaviour of containment buildings is also of importance in reactor safety assessment. In recent times the project has concentrated on aspects of safety assessment of the HIFAR reactor, fuel element transfer operations and radioactive waste disposal.

None.

EXTERNAL SUPPORT

Nil.

NI**RISK AND RELIABILITY
ANALYSIS****OBJECTIVE**

To develop risk and reliability analysis techniques in support of ANSTO programs and to facilitate their transfer to Australian industry.

RESOURCES

6.7 person years (including staff being recruited).

Budget: \$350,000.

PROJECT MANAGER

Mr Eric Corran.

Application of reliability engineering technology to reactor HIFAR's protective systems has underlined the value of system review and numerical reliability estimation in safety submissions and risk studies. Other on-site projects have shown that this technology, developed largely by the nuclear industry, has potentially wider applications in Australian industry. An important aspect of risk and reliability analysis is the fact that many major accidents are caused by human error, either from a failure to follow established procedures or from incorrect actions due to anomalies or ambiguous instructions. This field, at present not studied in Australia, is of interest to a number of industrial and government organisations.

ACARRE; Department of Defence; Sydney and Wollongong Universities; IAEA; WHO; Worksafe Australia; NSW Dept of Housing; Tony Spurgin Associates (USA); Human Reliability Associates (UK); UKAEA; NERDCC; ELCOM; QEC.

EXTERNAL SUPPORT

Occasional consultancy fees

LI**PROGRAM MANAGEMENT
OF THE MARALINGA
REHABILITATION STUDIES****OBJECTIVE**

Obtain information for the development of practical and cost-effective options for cleaning up the former test sites.

RESOURCES

5.5 person years.

Budget: \$255,000.

PROJECT MANAGER

Dr J Michael Costello.

As a result of the recommendations of the Royal Commission on British Nuclear Tests in Australia, Australia and the UK has been conducting six studies of the residual contamination at the former UK nuclear weapons test sites at Maralinga and Emu, South Australia. ANSTO is managing the program of studies at the request of the Department of Primary Industry and Energy (DPIE).

DPIE; US Department of Energy; EG&G Energy Measurements Inc.; UK National Radiological Protection Board; UK Ministry of Defence.

EXTERNAL SUPPORT

Nil

DA**COMPUTING SERVICES****OBJECTIVES**

To provide a first class mathematical and computing service to all parts of the Lucas Heights Research Laboratories; maintain a centre of excellence in applied mathematics and computing at Lucas Heights; and exploit marketable products.

RESOURCES

4.2 person years (direct) + 1.5 (support).

Budget: \$320,000.

PROJECT MANAGER

Dr Don J Richardson.

The project provides a mathematical and computing service to ANSTO, AINSE and units of CSIRO located at Lucas Heights. Research and development in relevant areas of applied mathematics and computing is also undertaken.

IBM; National Advanced Systems; University of Tennessee; NATO Advanced Study Institute.

EXTERNAL SUPPORT

Pascal sales, \$2500.

RECENT WORK & ACHIEVEMENTS

WORK PLANNED

- | | |
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| <ul style="list-style-type: none">(a) Participation with the UK's National Centre of Systems Reliability/Central Electricity Generating Board (NCSR/CEGB) in a study of valve failure data using proportional hazards analysis (PSA).(b) Reliability study of coal-fired power station components.(c) Preliminary studies for a human factors analysis project and visits to organisations specialising in this field.(d) Organisation of courses on reliability engineering for practising engineers and managers.(e) Participation in an international research program on probabilistic safety analysis for the IAEA.(f) Assessment of hazards for industrial and defence organisations.(g) Compilation of a reliability data base. | <ul style="list-style-type: none">(a) Continue and extend reliability studies in collaboration with several industrial organisations.(b) Complete PSA analysis of research reactors.(c) Develop the Australian Reliability Technology Service (ARTS) and the Australian Centre for Advanced Risk and Reliability Engineering (ACARRE).(d) Collaborate with Worksafe Australia and the NSW Dept of Planning in an inter-agency risk management project.(e) Create a prototype reliability data base operating on a personal computer. |
|--|--|

NI

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| <ul style="list-style-type: none">(a) Contracts were let with the Maralinga Tjarutja for anthropological studies, the Australian Radiation Laboratory for inhalation hazard assessment, and the US Department of Energy for aerial surveys.(b) The aerial surveys of Maralinga and Emu were satisfactorily conducted between May and July 1987.(c) Facilities and protocols have been established for quality assurance in the preparation and despatch of analytical samples. Samples of contaminated substrates have been obtained and processed for the bioavailability study and an estimate of the volume of contaminated soil in ploughed areas has been made from measurements of soil profiles. | <ul style="list-style-type: none">(a) Geological/hydrological/geomorphological survey of the Maralinga (Taranaki) area.(b) Engineering cost assessment of rehabilitation options.(c) Backhoeing of non-radioactive burial pits at Maralinga.(d) Mathematical modelling of radiological dosimetry.(e) Preparation of report on rehabilitation options and indicative costs for the Technical Assessment Group (TAG).(f) Examination of soil decontamination technologies; inter-laboratory comparison for consistency of analytical results. |
|---|--|

LI

-
- | | |
|---|---|
| <ul style="list-style-type: none">(a) The installation of Stage 1 of a fibre optics based terminal network at Lucas Heights.(b) Development of the ADD relational database, now widely used on site.(c) Development of the efficient mathematical convergence technique MINI.(d) Production of a marketable version of Pascal 8000.(e) Development of FORMIS, a marketable data storage and retrieval system for mini and personal computers. | <ul style="list-style-type: none">(a) Continue computer software and hardware development, including the production of a marketable version of the relational database ADD, and the development of a high speed Ethernet-based file transfer system for use on the fibre optics network.(b) Develop techniques in computational mathematics.(c) Analyse the marketability of the network software and hardware products developed at Lucas Heights.(d) Continue negotiations for collaborative research and development. |
|---|---|

DA

OE**COMMERCIAL
DEVELOPMENT OF AMES
MUTAGEN TESTING
SERVICE****OBJECTIVE**

To extend and commercialise the Ames mutagen testing system.

RESOURCES

About 0.3 person years.
Budget: \$100,000.

PROJECT MANAGER

Mr John A Grey.

Research laboratories require a screening test which quickly determines the toxicity of chemicals, particularly those for which there are no toxicological data. The preferred system is the Ames mutagen testing system. During 1988 it is anticipated that Federal legislation will make the use of this test mandatory for all new chemical compounds. Consequently, there is an urgent need to develop this screening test further to realise its full commercial potential.

National Institute of Occupational Health and Safety Toxicology.

EXTERNAL SUPPORT

Nil.

OH**DEVELOPMENT OF
RADIATION MONITORING
SURVEILLANCE SYSTEM****OBJECTIVE**

To develop and manufacture a radiation and meteorological monitoring surveillance system which integrates site meteorological data with operating data from HIFAR and transfers it to a computer in the Emergency Operations Control Centre. The computerised information will provide decision making information in the event of an accident which causes the release of radioactivity.

RESOURCES

0.3 person years.
Budget: \$2000.

PROJECT MANAGER

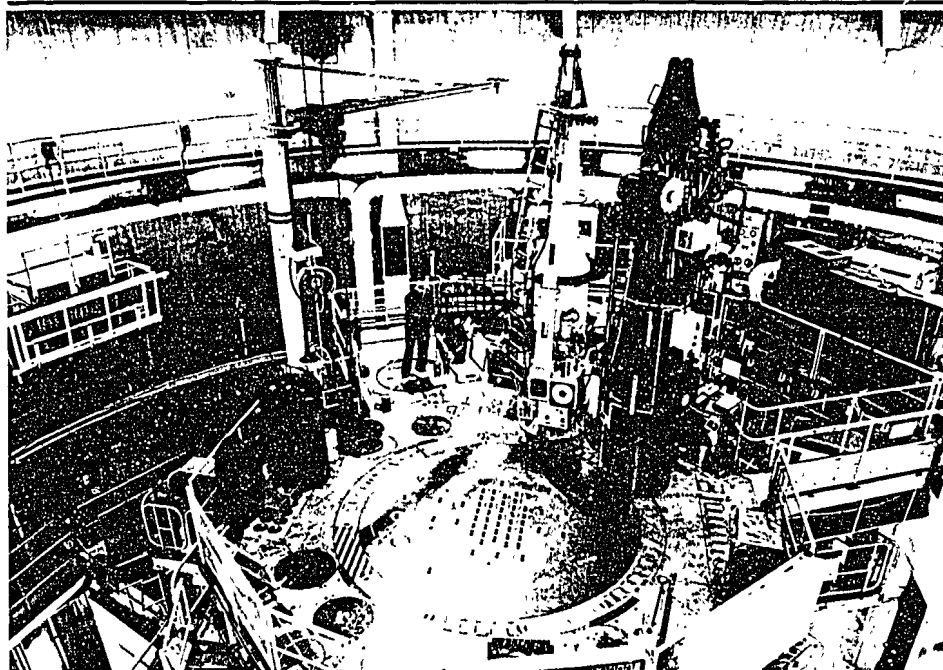
Mr Paul Wright.

Nuclear establishments throughout the world are developing integrated radiation and meteorological monitoring systems to provide early warning of accidental releases of radioactive materials from nuclear reactors. ANSTO has made international enquiries regarding the purchase of such a system but even the cheapest would be too costly and require considerable modifications before being commissioned at Lucas Heights.

None.

EXTERNAL SUPPORT

Nil.



Interior of the containment building showing the reactor, HIFAR.

RECENT WORK & ACHIEVEMENTS

The Ames mutagen testing system has been developed at Lucas Heights on a small scale. The results are consistent and the test has been standardised.

WORK PLANNED

To upgrade facilities to undertake chemical toxicity testing on a commercial scale using existing staff and equipment.

OE

ANSTO staff have collaborated in the design and manufacture of integrated radiation detectors. Radiation detection equipment which could be adapted to provide a suitable field monitor has been designed and manufactured at Lucas Heights.

To design and manufacture seven solar-powered field monitors for a radiation monitoring surveillance system.

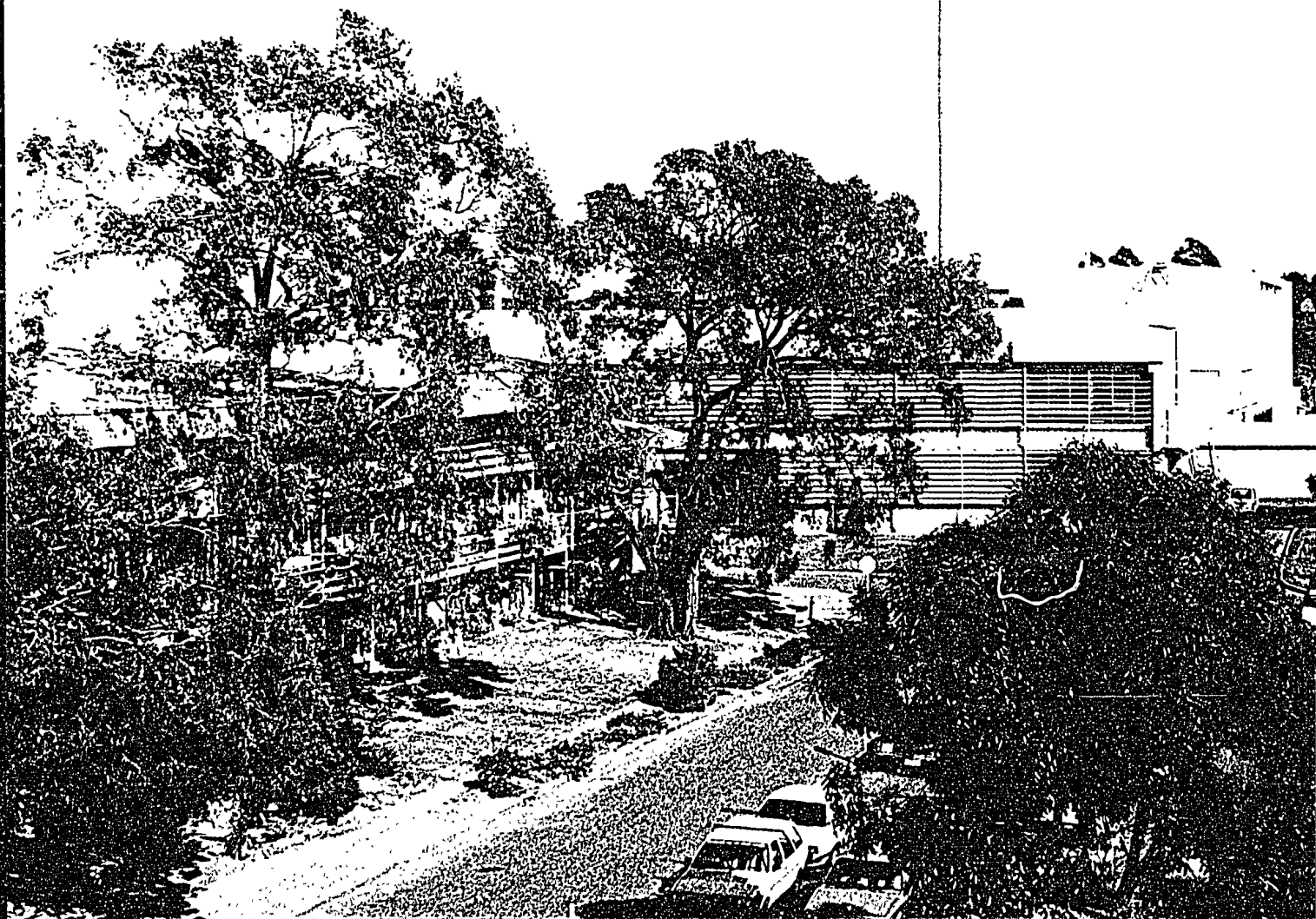
OH



FORMIS: a computer program developed by ANSTO and now a commercial product.

GLOSSARY

AAEC	Australian Atomic Energy Commission (now ANSTO)	MIBG	Methyl-iodobenzylguanidine
ACARRE	Australian Centre for Advanced Risk and Reliability Engineering	MV	Megavolts
AERE	Atomic Energy Research Establishment (UK)	MWS&DB	Metropolitan Water Sewerage and Drainage Board
AIDAB	Australian International Development Aid Bureau	NAA	Neutron activation analysis
AINSE	Australian Institute of Nuclear Science and Engineering	NATO	North Atlantic Treaty Organisation
AMDEL	Australian Mineral Development Laboratories	NCSR	National Centre of Systems Reliability (UK)
AMS	Accelerator mass spectrometer	NCT	Neutron Capture Therapy
AMSTAC	Australian Marine Science and Technology Advisory Council	NDO	Natural Disasters Organisation
ANSTO	Australian Nuclear Science and Technology Organisation	NDT	Non-destructive testing
ANU	Australian National University	NEA	OECD-Nuclear Energy Agency
ARAP	Alligator Rivers Analogue Project	NERDCC	National Energy Research, Development and Demonstration Council
ARGS	Australian Research Grants Scheme	NERDPP	National Energy Research, Development and Demonstration Program
ARI	Australian Radioisotopes	NTD-Si	Neutron transmission-doped silicon
ARTS	Australian Reliability Technology Service	OECD	Organisation for Economic and Cooperative Development
ASO	Australian Safeguards Office	OSS	Office of the Supervising Scientist
AWRAC	Australian Water Resources Advisory Council	PC	Personal computer
BHP	Broken Hill Proprietary Co.Ltd	PET	Positron emission tomography
BMR	Bureau of Mineral Resources and Geophysics	PIGME	Proton irradiation gamma emission
CCV	Coal Corporation of Victoria	PIXE	Proton irradiation X-ray emission
CEGB	Central Electricity Generating Board (UK)	PNC	Nuclear Power Corporation of Japan
CRA	Conzinc Riotinto Australia	PSA	Probabilistic safety analysis
CSIRO	Commonwealth Scientific and Industrial Research Organisation	QDPI	Queensland Department of Primary Industry
DFA	Department of Foreign Affairs	QEC	Queensland Electricity Commission
DITEC	Department of Industry, Technology and Commerce	QML	Queensland Mines Ltd
DOD	Department of Defence	RCA	Regional Cooperative Agreement
DPIE	Department of Primary Industry and Energy	R&D	Research and development
DSIR	Department of Science and Industrial Research (NZ)	RMS	Roxby Management Services
ECS	Environmental Chemistry Section	RPAH	Royal Prince Alfred Hospital
ELCOM	Electricity Commission of NSW	RUM	Ranger Uranium Mines
ENEA	Comitato Nazionale per la Ricerca e per lo Sviluppo dell' Energia Nucleare e delle Energie Alternative (Italian Commission for Nuclear and Alternative Energy Sources)	SECV	Central Electricity Commission of Victoria
EZ	Electrolytic Zinc Corporation	SI	Le Systeme International d'Unites (International System of Units)
FET	Field-effect transistor	SKI	Swedish Nuclear Power Inspectorate
FIRC	Fishing Industry Research Council	SNIF	Standard Neutron Irradiation Facility
FIRTA	Fishing Industry Research Trust Account	SPCC	(NSW) State Pollution Control Commission
GIRD	Generic Industrial Research and Development	SPF	Specific pathogen free
HIFAR	High Flux Australian Reactor	TAG	Technical Assessment Group, Maralinga
HIV	Human immunodeficiency virus	TEA	Transverse excited atmospheric (laser)
HRPD	High resolution powder diffraction	TLD	Thermoluminescent dosimetry
IAEA	International Atomic Energy Agency	UKAEA	United Kingdom Atomic Energy Authority
IVBC	In-vivo body composition	UKDOE	UK Department of the Environment
JAERI	Japan Atomic Energy Research Institute	UNDP	United Nations Development Program
kV	Kilovolts	UNEP	United Nations Environment Program
LOCA	Loss-of-coolant accident	USNRC	US Nuclear Regulatory Commission
LSNCC	Liquid scintillator neutron coincidence counter	W	Watt
MCA	Multichannel analyser	WHO	World Health Organisation
		WMO	World Meteorological Organisation



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