

### 3 The First Decade 1958 - 1968 – a firm foundation

The beginning of what was to become known as the 'Swinging Sixties' was also, in Australia, a period of economic stability and prosperity.

Post-secondary education was designed to be available to all, with most bright young people entering the trades, nursing, teacher training and for some, university. Government scholarships, company cadetships and other forms of financial assistance were available to those who wished to attend university. Most students who qualified for university entrance were the recipients of some form of assistance.

On the international stage, the Cold War was still in existence, and this came to a major and dangerous stand-off with the Cuban missile crisis in 1962.

The United Nations had established the International Atomic Energy Agency (IAEA) in July 1957, to *control and develop the use of atomic energy*. Australia was one of the seven nations which sponsored the draft resolution at the United Nations, one of the twelve nations which revised the statutes and one of the eighteen nations to ratify these. *Australia was selected (to the First Board of Governors) as the most advanced country in South-East Asia and the Pacific*<sup>38</sup>.

The AAEC experienced a decade of development in this period. Nuclear energy looked like a viable source of electrical power for Australia and the nation proved to have deposits of uranium that could be exploited. The AAEC was involved with research into many aspects of the nuclear fuel cycle and reactor technology including uranium enrichment, fuel fabrication and pebble-bed reactor design, all in preparation for the development of Australia's first nuclear power reactor. The proposed power reactor was to be located on Commonwealth land at Jervis Bay and was expected to feed power into the NSW power grid and produce enough electricity to supply the Australian Capital Territory (ACT). The Lucas Heights Research Establishment was electric with scientific output and excitement. This was certainly an era of the 'bright young scientist' working for the future. The project was announced in March 1969 and preliminary work including clearing of the site and the building of a high quality road commenced. However, in June 1971 the McMahon Government deferred the decision to proceed.

The Australian School of Nuclear Technology (ASNT) was set up by the AAEC and the University of New South Wales in 1965 to train people working with radioactive materials. AINSE supported researchers from member universities to attend courses until the School was discontinued in 1988.

In the midst of all this enthusiastic and stimulating activity, AINSE was beginning to establish its own unique identity. Over the decade, the organisation grew from the initial nine university members plus the AAEC to 14 plus the AAEC. During this time the AAEC diversified its research facilities to include other major pieces of infrastructure including accelerators and high intensity irradiation sources. As a result, AINSE-supported activities at Lucas Heights increased. The Institute's secretariat and scientific staff had grown from zero in 1958, where the AAEC undertook the Secretariat functions on behalf of the Institute, to two people at the beginning of 1960, then to eight people by 1969, as AINSE now provided professional and technical personnel to assist research on the accelerators and neutron-scattering instruments.

The salaries and administration budget had grown from £4,030 in 1960 to \$22,700 in 1969. The additional activities of AINSE at the end of the decade were funded by increases in member subscriptions and the government contributions to research and training (Table 2).

Source: 1960 AINSE accounts submitted to AINSE Council C1/61  
1969 AINSE Annual Report

38 AAEC Annual Report 1958, p40



*The AINSE building opening on 27 May 1960. From left: Senator Spooner, Philip Baxter and George Page, Head of Technical Physics Section, AAEC.*

**Table 2. Comparison of AINSE Income and Expenditure 1960 and 1969**

	1960 (£)	1969 (\$)
<b>Expenditure</b>		
Salaries	3,476	22,700
Administration	554	3,913
Fares, Travel, and Allowances	4,062	14,564
Studentships	9,032	22,722
Fellowships	2,741	23,934
Research Grants	10,731	73,918
Dating Project	4,045	0
Neutron Diffraction	391	24,646
Miscellaneous	0	599
<b>Total Expenditure</b>	<b>35,066</b>	<b>190,001</b>
<b>Income</b>		
Members' Subscriptions	22,500	74,000
Research and Training	50,000	150,000
Interest and Sundry	1,118	1,883
<b>Total Income</b>	<b>73,618</b>	<b>225,883</b>
<b>Balance</b>	<b>+38,552</b>	<b>+35,882</b>

### 3.1 AINSE's agenda is developed

Most of the meetings of both the AINSE Council and Executive Committee held in 1959, AINSE's first year of operation, were concerned with establishing the working relationship between these two bodies and establishing the protocols by which AINSE would function.

One of the first requests coming from the Executive Committee was that Council delegate all its powers to the Executive Committee, except certain reserve powers. This was agreed to on 29 April 1959. The reserve powers retained by Council were: introduction of new members to the Institute; the setting of the annual budget and establishment review; appointments of senior staff; fixing the dates of Council meetings; and the power to alter the Rules of the Institute.

In June 1959 Council discussed and agreed that *'the primary functions of the Institute should be:*

- (a) Provision of travel grants, accommodation, arrangement and other aid for use of Commission research facilities by the Universities;*
- (b) Provision of specialised training courses;*
- (c) Provision of scholarships.*

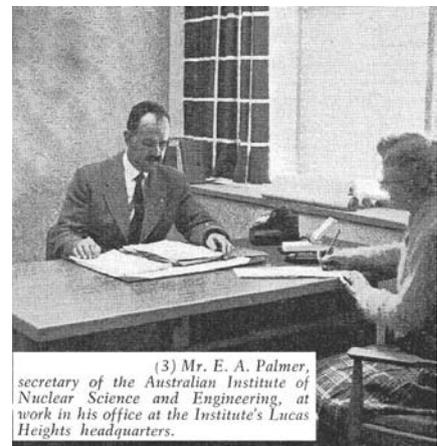
The 14 August 1959 Executive Committee proposed that all research proposals should be submitted to the Institute through university registrars. This was designed to ensure that all proposals were made through member institutions. On 25 November, the Executive agreed that the main criterion for award of a studentship would be the ability of the student and that the project should be of secondary importance. Both these decisions have continued to apply to the present and this has resulted, in particular, in the continuing high-quality of doctoral theses completed.



*The Motel at Lucas Heights; Stevens Hall in the 60s*



*The AINSE theatre in the 60s. Note the ashtrays!  
Image courtesy of ANSTO*



*(3) Mr. E. A. Palmer, secretary of the Australian Institute of Nuclear Science and Engineering, at work in his office at the Institute's Lucas Heights headquarters.*

*Bill Palmer and Jean Kearns in Bill's new office.  
From 'Atomic Energy' July 1960*

## 3.2 Membership

When AINSE was established, its Rules stated that

*Council may at its discretion admit to membership such Universities or similar institutions subject to such terms and conditions as it shall think fit.*

Initially its membership included all the existing autonomous universities in Australia and the AAEC. There was no obligation for universities to become members, but AINSE was the mechanism by which university researchers could gain access to Commission facilities at Lucas Heights. Researchers, who thus worked for organisations which were not members of AINSE, had no formal mechanism for access.

During the 50s, inspired by Ben Chifley's education initiatives, second capital-city universities were established in Melbourne and Sydney. The New South Wales University of Technology, later to become the University of New South Wales, was already established when AINSE was founded. Monash University in Melbourne, was the first institution given autonomous university status after the establishment of AINSE. It was granted membership of AINSE from 1 January 1962.

The process by which Monash became a member of AINSE established a practice that has been followed for all other new members. This process commenced with an initial enquiry to the Council. In response, the Council would state what the new member's annual subscription would be if the university were to join. This was then followed by a formal request from the university to become a member. Membership was usually granted from 1 January the following year and, in the interim, the prospective member could have a representative attending Council meetings as an observer. No AINSE research awards or fellowship would be considered from prospective members. The initial annual subscriptions for new members were on the lowest level of membership subscriptions. Initially there were three levels of subscription. In 2008 there are 14 levels.

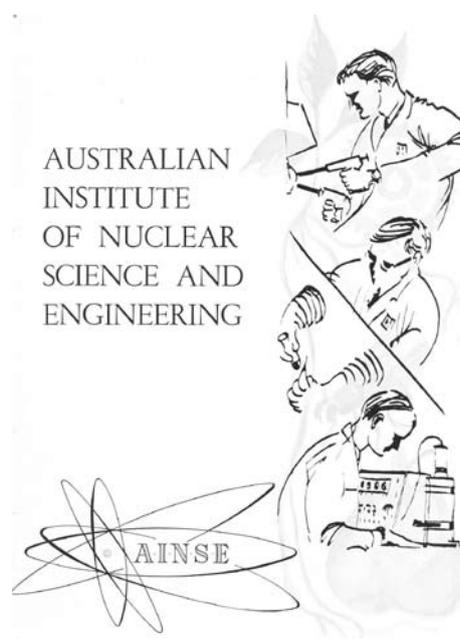
the University of Newcastle was the first of the former university colleges located outside the capital cities to apply for membership of AINSE and became a member of AINSE in 1965.

In 1965 Professor P H Karmel, Principal of the University of Adelaide at Bedford Park, wrote to AINSE stating that it would shortly split from the University of Adelaide and would like to become a member of AINSE. Professor Max Brennan, School of Physical Sciences, had been a past recipient of AINSE research awards and was the main driving force for the new University to establish links with AINSE. In mid 1966 the University of Adelaide at Bedford Park became Flinders University and joined AINSE.

As the Australian population grew following the post-war immigration schemes, it became apparent that a third university would be required in both Melbourne and Sydney. By the early 60s the two new universities, La Trobe in Melbourne and Macquarie in Sydney had been established. Both universities joined AINSE in 1967.

In mid 1967, the Council and the Executive Committee of AINSE discussed the possibility of Institutes of Technology becoming members of AINSE. The minutes mention both Technical Colleges and Institutes of Technology but made no differentiation between the two. It was accepted at the time that Technical Colleges, which did not undertake research, could not be eligible to become members while Institutes of Technology, which carried out some research, could. By September, the distinction between the two types of institution was made by calling Institutes of Technology 'Tertiary Technical Colleges'. At this time AINSE had noted that some institutions including the Western Australian Institute of Technology, the South Australian Institute of Technology, Royal Melbourne Institute of Technology and the New South Wales Institute of Technology were beginning to show interest in nuclear science and nuclear energy. None had, as yet, applied for grants or access to Commission facilities. It was agreed by the Council in September 1967

*... that no further action be taken at the present time to formulate a specific policy concerning the Institute's relations with technical colleges and related institutions, but that the matter be kept under continuous review.*



*AINSE livery used for publications, including annual reports, in the late 60s*

### 3.2.1 New Zealand membership

New Zealand institutions first started expressing interest in AINSE in 1963. On 18 July 1963 Maurice Timbs, then Executive Officer of the AAEC, wrote to J Nimo in the Prime Minister's Department stating, in part:

*Recently we had a visit from a team of scientists ... sponsored by the Atomic Energy Authority of New Zealand. They were somewhat impressed, and now they have come back with a proposal that some of the Universities in New Zealand might join AINS&E (sic). If they did, there would inevitably be the question whether funds available to AINS&E might be used in part to sponsor studentships by New Zealanders at Lucas Heights or, alternatively to award research contracts in New Zealand.*

The letter continued to say that Australia draws a lot of scientists from New Zealand since there are limited opportunities for them and in

*... radiation chemistry, the New Zealanders are extremely good ... we could benefit much by promoting the membership ... Would it be necessary to put a further submission to Cabinet, or would it be possible for you to seek a direction from the Prime Minister on it?<sup>39</sup>*

This letter was followed with a number of internal memos within the Prime Minister's Department concerning the costs of including New Zealand participation in AINSE.

While these discussions were taking place in Canberra, AINSE's Executive Committee in October 1963 discussed letters from Victoria University, Wellington, and the New Zealand Atomic Energy Committee concerning possible participation in AINSE. The AINSE Council noted in December that *negotiations between Australian and New Zealand Governmental Authorities were continuing*. However, these negotiations did not result in an agreement and New Zealand universities did not become members at this time.

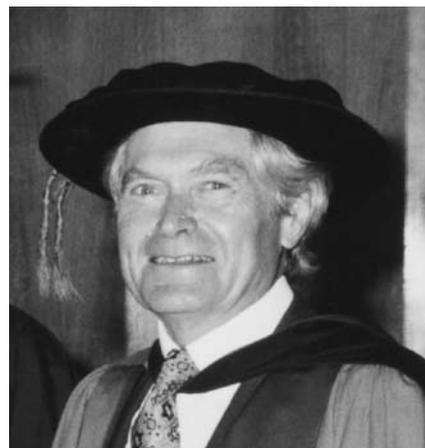
### 3.3 Finances

The issue of AAEC and Commonwealth Government funding for AINSE first came before the Council in June 1961. AINSE had wanted to purchase more equipment to be used at the AAEC Research Facility. Philip Baxter was not very supportive and suggested that AINSE approach industry for donations to make up for this funding shortfall. Possibly Baxter was reacting to the success that Harry Messel had achieved by approaching the non-government sector to fund the Nuclear Science Foundation at the University of Sydney. The Executive Committee, in August 1961, dutifully recommended that Council appeal to industry and also asked for approval for £500 for a brochure that could be sent together with a covering note to various industrial and commercial companies.

In February 1962, the Executive Committee noted that the expenditure in 1961 exceeded income and reserve funds had been used to meet this shortfall and it suggested that the AAEC should increase its contribution. The Council in June 1962 now realised how dire the funding situation was becoming. The university members had agreed, in principle, to increase their subscriptions by 50% but the AAEC members did not make a similar commitment to increase the AAEC contribution. The AINSE Council requested that the AAEC approach the Commonwealth Government to increase its contribution for research and training from £50,000 to £92,000. The AAEC could not commit itself since this funding allocation was totally in the hands of the Cabinet.

In January 1963, Cabinet agreed to an increase in the AAEC's subscription to AINSE from £11,000 to £16,000, less than the amount recommended by the Council. It also agreed to increase the Commonwealth grant to AINSE, for research and training purposes, from £50,000 to £75,000, also less than the £92,000 that AINSE had asked for. This type of negotiation for government funds would continue for many years. AINSE's requests for increases in funding from the government both as Commission subscriptions and as grants for training and research, would never match the amounts requested.

As part of its determination, Cabinet had instructed AINSE to *take action to obtain contributions from industry for its activities and will not seek to rely primarily and indefinitely*



Professor Hill Worner in 1982  
Photo courtesy of the University of Melbourne Archive

#### Professor Hill Worner AO

AINSE's fourth President in 1963 and 1964, Hill Worner was at the time Professor of Metallurgy at the University of Melbourne a post he held from 1956 to 1975. He was a member of the CSIRO Executive from 1976 to 1978 and Director of the Institute for Industrial Technology, CSIRO, from 1979 to 1981.

Hill Worner served for ten years on the AINSE Council from 1959 to 1965, 1968 to 1969 and in 1975. His contribution to AINSE activities included strong support for the authority and independence of AINSE Council.

Educated at the Bendigo School of Mines (Dip Appl Chem 1934) and the University of Melbourne (BSc 1936, MSc 1938, DSc 1953), Hill Worner became a Metallurgist at the Broken Hill Association of Smelters, Melbourne in 1939. He was appointed a Lecturer in Metallurgy at the University of Melbourne in 1940 and moved to CSIR, as a Research Metallurgist in the Lubricants and Bearings Section from 1941-42, Division of Industrial Chemistry 1943-45, Physical Metallurgy Section 1946 to 1953 and finally he was a Metallurgist at the Mines Board Canada, Ottawa from 1954 to 1955.

Hill Worner was awarded the Syme Prize (shared) in 1951 and in 1978 he was appointed a Fellow, Australian Academy of Technological Sciences and Engineering.

He received an Order of Australia (AO) in 1981.

<sup>39</sup> A463 Item 1963/3173 Australian Institute of Nuclear Science and Engineering, New Zealand Membership

on a Commonwealth Grant<sup>40</sup>. Further, the Commission had been arguing for the Commonwealth Government to build an accommodation block at Lucas Heights, not just for AINSE researchers but also for Commission visitors:

*The Atomic Energy Commission feels that the provision of hostel accommodation at Lucas Heights is an essential feature of the Research Establishment and that the existing arrangements do not make full use of the potential of Lucas Heights<sup>41</sup>.*

Cabinet agreed to this proposal and made

*provision of up to £60,000 to erect residential accommodation at Lucas Heights for postgraduate research workers and visiting scientists.<sup>42</sup>*

The construction of an accommodation block at Lucas Heights would also have the added benefit to AINSE that costs of accommodation for university researchers would also be reduced. The motel was ready for occupancy in 1965 and continues to accommodate visiting scientists to this day, see photo on page 14.

Since the Commonwealth had increased its funding to AINSE:

*... it was agreed to request member universities to give immediate effect to the decision to increase by 50% the individual membership subscriptions. Mr Timbs informed the Committee that the government had agreed to provide finance to erect residential accommodation at Lucas Heights for Postgraduate research workers and visiting scientists. This accommodation would of course be available for AINSE scholars who come to work at Lucas Heights.*

The result of the letters sent out to industry requesting donations was disappointing. Of the 169 companies contacted, 25 declined to make a donation, three responded with a total of £1,150. The largest contributions being £1,000 from The Myer Emporium Ltd, £100 from The Adelaide Steamship Co Ltd. and a fifty pound donation from Mauri Bros. and Thompson Ltd which was coupled with a commitment to donate £50 on an annual basis for a number of years. The other companies did not even reply. The mood was one of disappointment. As requested by Cabinet, AINSE had made a concerted attempt to raise its own funds from industry but the results were dismal.

Additional donations were received from Broken Hill Pty Co Ltd, £500, in February 1963 and from Tubemakers of Australia Ltd and subsidiary companies, £105, in May of the same year. The total contributions to the appeal to May were £1,755.

The Executive Committee in May 1963 recommended that Council approach the 138 companies who had not responded. Over the next few months donations trickled in.

By December 1963, 15 donations totalling £2,200 had been received. This amount was in the range of the annual subscription of a university member of AINSE. The £500 outlay in 1961 for the brochure had produced just over a £1,700 net return for the organisation.

At its first meeting in March 1964 the AINSE Council decided that it needed the help and advice of a professional fund-raising organisation on possible future courses of action to obtain financial support for the Institute from industry. However, at the February 1965 Council meeting, AINSE eventually abandoned the idea of seeking donations from industry.

The April 1964 Executive Committee meeting noted membership and annual subscriptions for the next three years (Table 3).

Subscriptions rose regularly during the decade and were matched by the Commonwealth Government in the form of the Commission's subscription although there was a declining response for the research and training grants. AINSE worked well within its budget during most of the 60s but the next decade would herald a new problem that no one had been able to foresee - that of inflation.

The Commonwealth Government paid AINSE (through AAEC subscriptions and the Contribution to Research and Training) at the rate of £6.2 for every university-contributed pound but by 1964 this had dropped to £4.5 for every university pound and by the end of the decade this had dropped to a ratio of \$2 for every university dollar.

40 National Archives of Australia A 5819 (A5819/2) Volume 13/Agendum 512 'Support for the Australian Institute of Nuclear Science and Engineering and Proposal to Erect Residential Accommodation at Lucas Heights.' Decision 615 (submission 512), 22 January 1963

41 ibid

42 ibid

**Table 3. Membership fees 1965 – 1968**

University	Membership Fee (£)
Monash University	750
University of New England	750
University of Tasmania	750
The University of Western Australia	750
The University of Adelaide	1,500
The University of Queensland	1,500
The Australian National University	3,000
The University of Melbourne	3,000
The University of New South Wales	3,000
The University of Sydney	3,000
AAEC	16,000

### 3.4 Governance and process

In 1963 the AINSE Council commenced a tradition that would generally be followed for some time and decided that half of its Council meetings would be held at a member institution.

The first travelling Council meeting was held at Monash University on 1 March 1963. A pattern emerged whereby members of Council would arrive the afternoon before the Council meeting, then visit the relevant university laboratories. This provided an opportunity to present AINSE to local researchers and their students. Following the Council meeting a visit to a relevant local industry was usually organised. There would be a working dinner hosted by the University followed by either a public lecture by one of the AINSE or AAEC visitors, or there would be some type of discussion/information evening for the local academics. Charles Watson-Munro gave the first public lecture on 28 February 1963. It was entitled 'The Possibilities of Thermo-Nuclear Power' and was attended by approximately 70 people (Appendix 8). The current meeting schedule still follows a similar pattern.

The first of AINSE's Annual Reports was also produced in 1963. The Rules of the Institute had not included any form of reporting and it became apparent that some form of reporting was needed. The October 1963 Executive Committee examined the situation and suggested that two

*... reports should be prepared on the Institute's activities each year. The two reports would be:*

*A report to Council by the Scientific Secretary for the information of Council and the Institute's member organisations, containing details of operations in the preceding year in the form similar to that of the annual reports previously presented*

*An Annual Report by the President containing a broad outline of the Institute's affairs, printed in booklet form with appropriate cover and illustrations, for distribution to interested organisations in Australia and overseas, approximately 750 copies being required.*

In the 60s the Annual Reports were brief accounts of the preceding year's operations but they gradually became more substantial and formalised documents.

### 3.5 Research facilities

From the earliest days, collaboration between AINSE and the AAEC (and later ANSTO) is evident. AINSE funds have been allocated, from the earliest years, to infrastructure development at Lucas Heights. For instance, the Institute provided finance to establish a neutron diffraction unit in 1960 and to support a Fellow at the University of Sydney to work on the development of crystallographic programs for the SILLIAC computer. A General Electric diffractometer was purchased by AINSE in 1960 and installed with the cooperation of the AAEC. AINSE, on the other hand, made use of the Commission's single-crystal spectrometer 4H2. A powder spectrometer 4H1 was jointly financed by the Institute and the Commission. By 1964 the Institute had installed a second single-crystal spectrometer 2TanA on HIFAR along with peripheral equipment.

A 3 MeV Van de Graaff accelerator was an early acquisition by the AAEC, and AINSE was quick to provide funds for peripheral equipment to enhance its capability. The Executive Committee in October 1964 authorised expenditure of £3,500 for modular electronic equipment to be used in association with the accelerator. At the same meeting, a request from Ron Cooper, at the University of Melbourne, for £4,000 for analytical facilities to be used by radiation chemists was approved.



*AINSE Research Fellow Dr Theron Felmlee, 1966 - 1968, from the University of Western Australia working on equipment for studying the oxides of curium-244. This image was first published in the AINSE 1968 Annual Report*

### 3.6 Research Areas – determining which areas to support

From the outset, university research interest at Lucas Heights in the nuclear area was broadly based. In the first decade, AINSE interaction was commonly informal and undertaken as both universities and the AAEC focused their research. Some important areas are addressed below.

#### 3.6.1 Theoretical and nuclear physics

In the early 60s there was a strong interaction in aspects of fundamental nuclear physics between the Australian university community and the relatively young staff within the Physics Division at the AAEC. Leading scientists such as Stuart Butler, Colin Pearson, Ken Small and Brian Frost from the University of Sydney, K Amos from the University of Melbourne, Lindsay Tassie from the Australian National University and Iain McCarthy from Flinders University had much to pass on to the fledgling research group at the AAEC. In anticipation of future studies in neutron reaction cross sections, this interaction involved studies of single particle states. Stuart Butler had established an international reputation in the analysis of (d,p) reactions, so much so that the process was called 'Simple Butler Stripping Theory'. As the quality of the experimental data improved, the original Stripping Theory began to be extended by more elaborate analyses. These included the Impulse Approximation (IA) and Distorted Wave Born Approximation Analyses (DWBA). The first was strongly supported by theorists at the University of Sydney while the strongest supporters of the DWBA approach were staff at the Australian National University and Adelaide/Flinders Universities.

Much of this interaction was informal and in the AINSE context did not always involve research awards. However, Iain McCarthy from the University of Adelaide (5 research awards in 1962 to 1963) and Stuart Butler from the University of Sydney (1 research award in 1964) held AINSE research awards; Bert Green from the University of Adelaide had six research awards between 1961 and 1967 in the area of dissipative processes in plasmas; Associate Professor Austin Keane from the University of New South Wales had two research awards in 1960 and 1961; Brian Davies from Flinders University had two AINSE research awards in 1968 and 1969; and Roger Hosking also from Flinders University had three research awards between 1968 and 1970.

A second area of interaction involved Ken Le Couteur from the Australian National University who studied energy level formulae (Ken Le Couteur received one research award in 1963).

This interaction was undertaken within the context of two United Nations conferences on the peaceful uses of atomic energy held in Geneva in 1955 and 1958 which led to a high level of international collaboration between the West and the East in the development of appropriate nuclear data and computational methods for the Peaceful Uses of Nuclear Energy.

The combined effort of University and AAEC staff made a major contribution to the international codes and data sets. While the computing facilities available at that time in Australia were somewhat limited, the contributions were distinguished by the high level of advanced analytical methods that were primarily introduced by the senior university staff.

The debate by the proponents of the two approaches (IA and DWBA) at the early AINSE Nuclear and Particle Physics Conferences could be described as fairly vigorous. These conferences continue to the present with the first one being held at the University of Melbourne in August 1965.

This research continued into the 70s and was applied in many experimental studies on the MOATA reactor (entirely AAEC) and in integral measurements on the Van de Graaff accelerator.

This program also provided the base methods that continued to be used in all analyses of the operations of the HIFAR reactor and now the OPAL research reactor.



#### Professor Brian Spicer\*

Brian Spicer was Professor of Physics at the University of Melbourne from 1965 to 1988, having started there as a lecturer in 1956. In 1989 he became Emeritus Professor of Physics at the University.

As a long-term representative of his university on the AINSE Council from 1965 to 1966, 1968 and 1973 to 1988, Brian was president of the Institute in 1987 and 1988, following four years as Vice President and membership of the AINSE Executive Committee.

His contributions to AINSE activities through his long association were many and valuable, particularly during the period of transition as the AAEC was restructured as ANSTO, as the number of Australian universities increased rapidly, and as AINSE underwent internal changes. Throughout his years as an AINSE Councillor Brian Spicer actively encouraged cooperation between research groups in the universities and at Lucas Heights as exemplified by joint projects involving his own research students with members of the AAEC Physics Division. In particular, his initiative led to the establishment of the AINSE Accelerator Group with two AINSE staff members at Lucas Heights to assist university staff and students using the AAEC's accelerators.

He was strongly involved in the biennial AINSE Nuclear Physics Conferences particularly in encouraging the attendance of distinguished visiting scientists with whom he had worked in overseas research centres.

His first AINSE Research Grant was gained in 1961 which was entitled 'Neutron slowing down' and over the next 36 years he held another 17 Research Grants which involved neutron-capture gamma ray studies

During his long career he was also an advisor to many government education and safety committees.

Brian Spicer passed away in Melbourne in July, 2004.

\* Photo of Professor Brian Spicer courtesy of the University of Melbourne Archive

### 3.6.2 Reactor science

The study of reactor systems, developed within the context of the proposed development of a nuclear power industry, was the highest profile activity within the AAEC in the 60s. One of the major programs was the study of specific Australian reactor concepts such as the beryllium oxide fuelled reactor. In this research there was a very strong interaction with the School of Nuclear Engineering, University of New South Wales, headed by Professor Jim Thompson.

In the AAEC Physics Division, at the outset, there were two main themes: the development of reactor codes; and the development of appropriate nuclear data sets. Both of these activities were supported in the short term (1965 onwards) by some limited research effort on the Van de Graaff accelerator but much more detailed studies on reactor assemblies were carried out utilising the MOATA reactor. These theoretical activities were the principal areas of interaction with the university community in the 60s.

### 3.6.3 Accelerator science

A key appointment to Physics Division staff at the AAEC in late 1963 was Roger Bird, a physics graduate from the University of Melbourne who had been working at Harwell. He was appointed to manage the research program on the newly acquired 3 MV Van de Graaff accelerator. While his area of expertise was neutron-capture cross Sections particularly in the keV region, he had wide experience in many aspects of nuclear physics. Roger Bird set as one of his objectives a dramatic expansion of interaction, through AINSE, with university research on the Van de Graaff accelerator. Many of the programs that he initiated continue to flourish today, in particular the AMS (Accelerator Mass Spectrometry) and IBA (Ion Beam Analysis) programs.

Other AAEC personnel involved in these studies included Michael Kenny, Barry Allen, John Boldeman, Tony Musgrove, and David Cohen who commenced as an AINSE technical officer and then became leader of the AINSE Accelerator Group. One of the first areas to be studied with the aid of the accelerator was neutron capture. Researchers from the Universities of Melbourne, Queensland, Wollongong, NSW, James Cook and some in New Zealand contributed to these studies and early AINSE Awards in this period included neutron-capture gamma-ray studies by Ray Taylor, from James Cook University, who had 13 AINSE research awards from 1967 to 1979; and Brian Spicer from the University of Melbourne, who had eight AINSE research awards from 1961 to 1972.

Neutron-capture studies continued to be an area of active research through the 70s and into the early 80s with Graeme Hicks and Ian Bubb from James Cook University; John de Laeter from Curtin University of Technology and Jagdish Mathur from the University of New South Wales and later the University of Wollongong.

The clear objective of the entire program, besides providing urgently needed experimental data, was to identify components of direct interaction processes and more statistical interactions. Australian researchers were able to have a direct link with researchers at ORNL where Barry Allen was attached for a period. Experimental data for all isotopes of relevance in reactor science generated at ORNL were analysed in Australia and because of the quantity of data, large portions were available for analysis by university groups. Analytical tools developed by Tony Musgrove and others were also particularly important. This program was supplemented by measurements on the Van de Graaff accelerator.

The neutron-capture program also led to considerable interest in astrophysics studies particularly the s-process for isotopic concentrations. A later experiment using the  $^{175}\text{Lu}$  30 keV cross-Section produced a measurement of the age of the universe. The University of Melbourne in particular had a very strong program in astrophysics.

### 3.6.4 Advanced neutron detector systems

Research into advanced neutron detector systems was undertaken by Hans Thies from the University of Western Australia, commencing in 1964 and continued for a period of 30 years. Many years later these theoretical studies were useful in the development of advanced neutron coincidence counting systems for International Nuclear Safeguards applications. Hans Thies had 28 AINSE research awards from 1964 to 1992 mostly in the area of absolute measurement of neutron production.

\* Photo courtesy of the University of Melbourne Archive



*Roger Bird loading obsidian samples into the PIGE analysis chamber on the 3 MV Van de Graaff accelerator in 1975.*

### Dr Roger Bird

Roger Bird graduated from the University of Melbourne with a PhD in nuclear physics and then headed overseas where he accepted an appointment with UKAERE, Harwell.

He returned to Australia in 1963 and became the Section Head for Neutron Physics at the AAEC, where he had responsibility for the completion of the construction of the 3 MV Van de Graaff accelerator, its development and use, and the management of a group of young researchers. In a manner similar to that adopted by David Sangster he was totally committed to the promotion of science in Australia. He championed the importance of the scientific interaction with the university community via AINSE and he promoted the use of the Van de Graaff accelerator to AINSE users. He was directly responsible for the major program in Australia of nuclear techniques of analysis, including Proton Induced X-ray Emission (PIXE), Proton Induced Gamma-ray Emission (PIGE), Rutherford Back Scattering (RBS), and Nuclear Reaction Analysis (NRA).

The application of these techniques by researchers in many disciplines is described throughout this document. In his nuclear physics activities he was one of the leaders in Australia on neutron and proton reactions. He foresaw the importance of Accelerator Mass Spectrometry and was the first to promote its use in Australia. AMS is now a key measurement tool for university researchers. A lasting legacy of Roger Bird's contribution to Australian science is the AINSE Nuclear Techniques of Analysis Conference Series.

Roger Bird passed away in November 2001.

### 3.6.5 Engineering and materials science

The engineering and materials science community had interest in the development of materials for use in nuclear reactors. Professor Keith Bullock from the University of Queensland had 13 research awards between 1964 and 1977 where he investigated the modification of turbulence structure for optimum heat transfer in circular ducts.

In 1965 Roger Bird in collaboration with Patrick Price and his student Bing Kwong Mak from the University of New South Wales developed the first recorded proton microprobe. This was achieved mainly with apertures using the high intensity of the Van de Graaff accelerator. The first experiment involved measurement of the oxygen content in titanium oxides. The work was reported in *Nature*<sup>43</sup> in 1966. The proton microprobe became a standard instrument on the Van de Graaff and had regular use by university researchers and AAEC staff. These experiments established a long-term interest in microbeams at the AAEC and in Australian science in general, leading many years later to the heavy ion microprobe on the ANTARES tandem accelerator, proton microprobes at the University of Melbourne and CSIRO, the use of synchrotron microprobes at overseas facilities particularly at the Advanced Photon Source at Chicago and a very high performance microfocus beam-line on the Australian Synchrotron.

Another early application of the charged particle beams on the Van de Graaff accelerator involved channelling of the beams down the crystal planes of target crystals. The backscattered and forward scattered response of proton and helium ions was used to determine the quality and properties of the crystal structure under investigation. A fairly large Australian community became interested in this technique. In particular researchers at the Royal Melbourne Institute of Technology, the Australian National University and the University of New South Wales had very strong programs. The University of Melbourne and the Australian National University installed low-energy tandem accelerators in their own laboratories to carry out this type of research and related activities. Key university staff involved in the early programs included Pat Price (the University of New South Wales), Jim Williams and his groups (Royal Melbourne Institute of Technology and later the Australian National University), Dinesh Sood (Royal Melbourne Institute of Technology).

Jim Williams had 18 AINSE Research Awards between 1978 and 2003, and Dinesh Sood had 20 AINSE Research Awards between 1992 and 2006

### 3.6.6 Radiation chemistry

Radiation chemistry research in Queensland began with the arrival of Jim O'Donnell at the University of Queensland in 1964. He completed his PhD at the University of Leeds in the UK in 1962 under the tutelage of Professor Ken Ivan on the chemistry of poly(alkene sulfone)s. Following his PhD, Jim then spent a postdoctoral year at the Polytechnic Institute in Brooklyn in New York with Herbert Morawetz, another well-known polymer chemist, where he studied solid-state polymerization.

In the early 60s Lord Fred Dainton was a Professor at Leeds University, so it was a world centre for radiation chemistry. Logically Jim's PhD research included, in part, a study of the radicals formed on irradiation of some polysulfones. This was his introduction to radiation chemistry, which later became one focus of his research.

Soon after his arrival in Queensland, through AINSE, Jim established a research collaboration with David Sangster that lasted 30 years. He had at least one AINSE research award every year from 1965 through to 1995. As well as publishing numerous papers on the radiation chemistry of polymers over this period, Jim and David also published their widely used textbook, *Principles of Radiation Chemistry*, in 1970, which was later translated into other languages.



David Sangster at work in about 1968

### Mr David Sangster, AINSE Honorary Fellow

David Sangster graduated from the University of Adelaide with first class honours. He then joined the Council for Scientific and Industrial Research (CSIR) and was seconded to the Atomic Energy Research Establishment, Harwell, UK for eight years. He returned to the AAEC and became associated with AINSE during its very earliest days.

His primary research interests were in radiation chemistry and his responsibilities included the gamma radiation facilities and a 1.3 MV Van der Graaff electron accelerator. Both instruments were utilised extensively by AINSE. For example Jim O'Donnell and his students from the University of Queensland found a compound that decomposed readily under irradiation and this led to the earliest development of masks in the USA for computer chips. There were other applications for research into chemical and biological systems where a steady flux of free radicals was required. One extensive use was for curing coatings. Another was to study the fate of radicals as they disappeared from polymerising emulsion systems. All of these investigations led to many papers in the AINSE Radiation Chemistry Conferences.

Following a visit to Argonne National Laboratory in the USA and with help from AINSE and AAEC staff, David Sangster built the pulse radiolysis facility based on the Electron Accelerator. A short pulse of electrons was fired into a chemical system and the appearance and reactions of the resulting species could be followed for the next several millionths of a second. Ron Cooper and he made the first hydrated electron to be observed in the Southern Hemisphere. This species lives for less than one thousandth of a second. This facility proved to be very popular especially for making and studying short-lived compounds which were difficult to access by other means.

During his career David Sangster collaborated with staff from seventeen AINSE member universities and trained many postdoctoral and PhD students in the 'mysteries' of radiation. He was heavily involved in AINSE conferences and in assessments for grants and awards and in the Winter School. He is an AINSE Honorary Fellow.

The Polymer Division of the Royal Australian Chemical Institute has renamed its biennial achievement award The David Sangster Polymer Science Achievement Award.

43 Bing Kwong Mak, Bird J R, Sabine T M. Proton Microanalysis. *Nature* 211(5050) 738-739 1966

Not surprisingly, Jim's first two PhD students, Jim Brown and Murrae Bowden, worked on the radiation degradation of poly(alkene sulfone)s and the radiation-induced solid-state polymerization of methacrylic acid derivatives, respectively, aspects of which Jim had studied at Leeds and Brooklyn Polytechnic. All of the gamma irradiations were organised through AINSE and performed in the gamma pond at Lucas Heights. After completing his PhD, Murrae Bowden joined Bell Laboratories in the USA and, through his knowledge of Jim Brown's polysulfone work with poly(1-butene sulfone), he was instrumental in the development of this polymer for the electron beam manufacture of photo-masks for use in the production of silicon chip devices. This was possibly one of the first industrial applications for a highly radiation-sensitive polymer.

Ron Cooper's group at the University of Melbourne studied the radiation stability of simple fluorocarbon gases - Freons. The new materials were thought to be of possible use in the cooling systems of power reactors. The pond irradiation facility at Lucas Heights was essential for these studies as it had a high dose rate resulting in short irradiation times. Analytical facilities provided by AINSE at Lucas Heights enabled on-the-spot analysis to be performed. Students from the University of Melbourne spent periods at the AAEC facility. The studies revealed significant radiation degradation in Freons and novel selective scavenging experiments helped distinguish between free radical processes and ionic reactions.

Associate Professor Jack Garnett and his team at the University of New South Wales worked on radiation catalysis with the aid of 31 AINSE Research Awards over the period 1961 to 1990.

Associate Professor John Hawke and his team, at the University of Sydney and then at Macquarie University from 1970, worked on a range of problems in radiation chemistry including collisional decomposition of molecules formed by recoil from nuclear reactions and hot atom reactions in molecules exposed to fast and thermal neutrons and gamma rays. He had 42 AINSE research awards between 1963 and 1986.

Associate Professor Jan Gebicki at Macquarie University worked on the radiolysis of polyunsaturated acids and esters and biomolecules. After 1989 he conducted experiments using pulse radiolysis. He held 23 AINSE research awards between 1968 and 1992

### 3.6.7 Neutron scattering research

Neutron scattering has been one of AINSE's enduring success stories although in 1959 neutron diffraction was a relatively new experimental technique. In this Section the establishment of strong university/AAEC interrelationships facilitated by AINSE in neutron scattering research is detailed.

In August 1959 the AINSE Executive Committee

*... noted with interest several requests for neutron spectrographic and neutron diffraction facilities and considered these to form a major project of considerable importance to the Institute ... in the Committee's view however it was necessary to convene a conference of all concerned to co-ordinate instrumental and other requirements and prepare an appreciation of all factors involved.*

The Executive Committee in September 1959 recommended that the Institute convene and sponsor a seminar of approximately 10-20 people to be held at the Lucas Heights Research Establishment on November 6-7 1959 ... letters be forwarded to all universities to send representatives interested in neutron diffraction and CSIRO, BHP Central Research Laboratories, ICI Central Research Laboratories and Defence Standards Laboratories. The Council endorsed the concept of a seminar but suggested that the participants be limited to people from the AAEC and universities.

A two-day Neutron Diffraction Seminar was held at Lucas Heights in November 1959. It was jointly organised by Terry Sabine from the AAEC and Charles Birkett-Clews from the University of Western Australia who was chair of the conference.

Following the success of the seminar in 1959, Terry Sabine had also suggested an annual two-week course on neutron diffraction, and these were then held regularly for over a decade.

By the 70s neutron diffraction techniques had entered the mainstream of solid-state science and were now being passed on from researcher to student as part of the overall education process.



Alan Hewat during his first visit to Lucas Heights in 1961

#### **D**r Alan Hewat

Alan Hewat was introduced to Lucas Heights and AINSE as a 1961-62 summer vacation student from Melbourne, on the 'sink-or-swim' principle. His AAEC supervisor, Arthur Pryor, a man of few words, handed him a Fortran manual and told him to compute tables of thermodynamic functions. Following a postdoc at Harwell he joined the Institut Laue-Langevin (ILL) in 1972. At the time the ILL reactor provided neutron beams of the highest intensity available.

He maintained an active interest in Lucas Heights, collaborating with Chris Howard in the construction of a new high-resolution powder diffractometer HRPD, similar to his work-horse D1A machine at ILL. The construction of HRPD with the technical support of AINSE, and the active user program on this instrument, helped neutron-scattering survive at Lucas Heights.

Alan Hewat remained at Grenoble and helped publish a highly cited paper on the structure of high-Tc superconductors in 1987, lectured to the Swedish Royal Academy and received an honorary doctorate. In 1992 he became head of the ILL's largest experimental group (Diffraction) for the next 13 years, with ILL employing four permanent Australian scientists. He was very helpful to Australian visitors, including many associated with AINSE. Cooperation was facilitated by David Wheeler, who was on the ILL staff after being an AINSE staff member (1965 - 1974) in the Neutron Diffraction Group.

In his retirement, Alan Hewat set up NeutronOptics.com to construct neutron-sensitive cameras for most of the world's neutron laboratories.

As a consequence of the 1959 seminar, the Executive Committee in December 1959 recommended four items to Council with respect to neutron diffraction:

- a capital expenditure for equipment of £6,500
- a sum of £3,500 be provided for operating expenses for the 1960/61 financial year
- support be given for the appointment of a postdoctoral fellow at the University of Sydney for the development of crystallographic computing techniques
- support for a visit to Australia in 1961 of a prominent authority or authorities on neutron diffraction work.

The Executive Committee in March 1960 considered the question of the Neutron Diffraction Project further and

*It was agreed to request the AAEC to employ, on behalf of the Institute, such technical officers as may be required for work at the Research Establishment on the Institute's projects, the AAEC to be reimbursed by the Institute for the services of the officers concerned. The first such employee to be a Technical Officer for the Neutron Diffraction Project.*

By the time of the April 1960 Executive Committee meeting, the AAEC had agreed to employ technicians to work on the AINSE Neutron Diffraction Project. Technical officer Mr Dennis Cato was employed by AINSE to work under the direction of Terry Sabine and commenced work on 17 November 1960.

In 1964 a special committee on neutron diffraction met on 20 November consisting of Professors Hill Worner and Robert Street, Brian Hickman and Terry Sabine from AAEC and Scientific Secretary Bill Palmer. The committee considered applications for research and training grants for 1965, staffing for the AINSE Neutron Diffraction Unit that would be needed to support the grants awarded, as well as procurement and installation of equipment at Lucas Heights.

Another person hired in these early days was Mr David Wheeler. He had worked as a technician in neutron diffraction at Harwell, UK. He was recruited by AINSE in 1965 and remained with AINSE until 1974 when he took a position at the Institut Laue-Langevin at Grenoble (ILL)<sup>44</sup>. The ILL followed AINSE's example whereby *all projects were treated equally irrespective of actual travelling costs*<sup>45</sup>, and Wheeler proved to be very helpful to Australian scientists seeking beam time at ILL. In 1975 the Directorship of ILL passed to an Australian, John White, a graduate from the University of Sydney who had remained at Oxford University since gaining his DPhil in 1961. Two AINSE-trained neutron scientists, Alan Hewat and Sax Mason came to ILL at that time. White returned to Australia in 1985 as Professor of Physical and Theoretical Chemistry at the Australian National University's Research School of Chemistry and became President of AINSE 2005-06.

Frank Moore led the AINSE Neutron Diffraction Unit from 1967 until 1983. As a PhD student at Oxford University, he had used the Harwell PLUTO reactor in an epic crystallographic study of vitamin B12 led by Nobel laureate Professor Dorothy Hodgkin. Another member of the Hodgkin team, Brian O'Connor, a Harwell Fellow, who had been introduced to neutron diffraction through AINSE while a PhD student at the University of Western Australia, subsequently served as AINSE President in 2007.

The Executive Committee, in September 1965, noted that the Neutron Diffraction Group continued to grow and additional staff members, including a research assistant and a technician, were hired by AINSE to assist researchers. Later that year the Council decided that AINSE should establish an AINSE Neutron Diffraction Group, which would have the following positions: a group leader; a staff scientist; a research assistant; and two technicians. AINSE would also provide funds for equipment.

By the end of the decade the project employed three AINSE staff members: Dr Frank Moore, group leader, Mr David Wheeler and Mr Roy Ebdon. In 1968 the project had been allocated \$55,942, of which \$23,324 was for salaries and running costs and \$32,618 for equipment. AINSE equipment operating throughout 1968 consisted of:

44 Wheeler D A. I began as a Scientific Assistant: Harwell to Grenoble via Lucas Heights. In Bacon G E (editor) *Fifty Years of Neutron Diffraction* Adam Hilger, Bristol (year of publication is not listed), p148

45 Sabine T. Neutron Diffraction in Australia. In Bacon G E (editor) *Fifty Years of Neutron Diffraction* Adam Hilger, Bristol (year of publication is not listed), p107



Photo of Professor Robert Street by Terry Martin, courtesy of Monash University Archives - IN1603

## **E**meritus Professor Robert Street, AO FAA

Robert Street was born 16 December 1920 in the UK. He was AINSE's fifth President in 1965 and 1966, while he was Professor in the Department of Physics, Monash University (1960 to 1974). He was Director of the Research School of Physical Sciences, Institute of Advanced Studies, Australian National University, from 1974 to 1978, Vice Chancellor, University of Western Australia from 1978 to 1986 and has been Emeritus Professor, Department of Physics since then.

His research interests were in the development and properties of magnetic materials and used neutron diffraction techniques to elucidate chemical structures and this led, later in his career, to elucidating magnetic structures in metals and alloys. He had an active research program which utilised AINSE from 1962 through to 1976.

He was instrumental in procuring for AINSE the first three-circle goniometer for installation on one of the Institute's neutron diffractometers on HIFAR.

Other positions held were Senior Research Fellow at the Research Centre for Advanced Mineral and Materials Processing, Chairman, National Standards Commission 1967 to 1978, Chairman, Australian Research Grants Committee 1972 to 1976, Fellow, Australian Academy of Science 1973, Fellow, Institute of Physics; Fellow, Australian Institute of Physics, President, Australian Institute of Physics 1971 and President, Atomic Energy Advisory Committee.

Robert Street served as Councillor from 1961 to 1966 and from 1968 to 1973. He was awarded an AO in 1985.

- a powder diffractometer 4H1
- a single-crystal diffractometer 2TanA
- a second single-crystal diffractometer 4H5b and
- a small-angle scattering diffractometer 4H5.

Proposals for funding for neutron diffraction were considered by the Executive Committee until the establishment of the Neutron Diffraction Specialist Committee in 1986.

In the first decade, this fledgling group generated 21 refereed papers in journals including two in *Nature*, one *Physical Review Letters* and most of the rest in *Acta Crystallographica*, *Acta Metallurgica* and the *Journal of Physical Chemistry*.

During the next four decades the acquisition of equipment for neutron diffraction research would be facilitated by AINSE, more recently with the Australian Research Council (ARC) and university financial support. This equipment would be housed at Lucas Heights. As new techniques were developed and technology advanced, the latest equipment would be made available to Australian researchers through AINSE. The highlights of AINSE's interest in and contribution to neutron-scattering research in ensuing decades is documented throughout this history.

The increasing propensity to acquire equipment, while going beyond AINSE's training objective, is nonetheless, consistent with its objective *to carry out research and investigations in connection with matters associated with uranium or atomic energy*.

The AINSE Council in this respect was proactive in facilitating the acquisition of equipment and the staff to operate it.

The initial use of HIFAR neutrons by university researchers was led by Dr Ted Maslen, Physics, the University of Western Australia; Eric Hall, Metallurgy, University of New South Wales and the University of Newcastle; and jointly by Bob Street and Jack Smith, Physics, Monash University. The emphasis was predominantly on structural crystallography during this period, with the Street group also laying the foundations for the neutron spectroscopy work which was to follow in the 70s.

The Maslen group, with the support of Terry Sabine of the AAEC, published the first paper on structural crystallography using HIFAR single-crystal data which appeared in *Nature* in 1961, see page 1 and Figure 1. This pioneering publication saw the emergence of Hugo Rietveld, then Ted Maslen's research student, as a highly cited diffractionist. The group produced five papers on organic structures (co-authored by students Mary Paton, Syd Hall, Brian O'Connor and Tony O'Connell) during this first decade which led to the combined x-ray and neutron diffraction studies on electron density distributions in crystals which were to follow in the 70s.

Eric Hall and students, of the University of Newcastle, published four papers on site occupancies in metals and metal oxides, with the broad theme being radiation damage in alloys and the effect on mechanical properties.

The early success of the Monash group was remarkable, given that the university had been established early in the decade. The Street-Smith group published eight papers in this period which acknowledged AINSE. The research addressed magnetic moment distributions in metals and metal alloys. The students included Trevor Hicks who was to become the widely acknowledged leader of magnetism research in Australia and Geoff Wilson who became Rector of the Australian Defence Force Academy, ultimately retiring from his position as Vice-Chancellor of Deakin University.

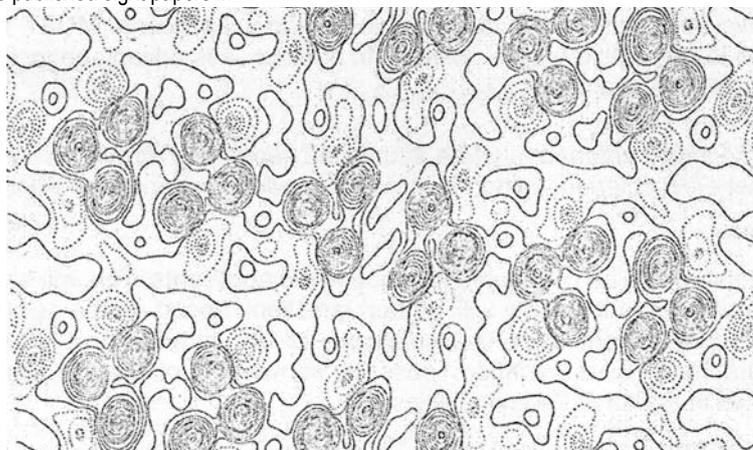


Figure 1. A Figure from the first structural crystallography paper citing HIFAR neutron data by Clews, Maslen, Rietveld and Sabine in *Nature*<sup>1</sup> see page 1

### 3.6.8 Plasma/fusion research

In 1962 a comprehensive review on plasma research in Australian universities undertaken by Jack Somerville at the behest of the Executive Committee determined that this area of research required a capital investment of several hundred thousand pounds, the effort of approximately 30 full-time academic staff, a comparable number of research students and technical staff. Future running costs, exclusive of salaries was estimated to lie between £50,000 and £100,000.

University research in this area was categorised into:

- work associated with controlled thermonuclear release of energy (such as the study of magnetohydrodynamic waves in plasmas undertaken in the Department of Plasma Physics, the University of Sydney directed by Charles Watson-Munro; studies in plasma physics in the School of Physical Sciences at the Australian National University directed by Sir Mark Oliphant; and studies in the containment of plasmas by rotating magnetic fields in the Department of Physics at the University of New England directed by Harry Blevin);
- work associated with direct conversion of energy (such as projects undertaken in the Department of Electrical Engineering at the University of Sydney under Hugo Messerle);
- plasma research directed towards other applications (such as basic research in the area of electricity generation and distribution at the Department of Electrical Engineering at the University of Queensland under S A Prentice);
- basic research in various aspects of plasma and ionisation physics undertaken at the universities of New England, Newcastle, New South Wales and the Australian National University; and theoretical work.

Jack Somerville concluded that while

*...funds on the scale which the Institute has provided in the past could make a significant contribution to future work, but, as they would not constitute a large proportion of the total cost it is desirable that their allocation should be carefully controlled ...*

In 1962 the AINSE Council determined that the Institute should continue to support plasma research and agreed to set up a committee to advise the Institute on the type of plasma research it should support; to consider applications for research grants and to promote cooperation between research groups.<sup>46</sup>

The Plasma Science Specialist Committee was established in 1962. The central task of this Committee was to peer review applications for AINSE research grants, studentships and fellowships in the field and to assist in the organisation and support of plasma science conferences. The Committee met for the first time on 4 October 1962.

In line with its growing support for plasma research, the Institute acted as a co-sponsor with the University of Sydney for an 'informal' plasma physics conference at the University in August 1962. Following this conference, the Institute decided to purchase a high-speed framing camera at a cost of £5,824 for use in plasma research for use by member organisations<sup>47</sup>. The camera was installed in June 1963, lent to the University of Sydney, the Australian National University and Flinders University.

The Institute assisted the University of New England's Summer School on Electrical Discharge and Plasma Physics in February 1963, and co-sponsored other informal plasma physics conferences in 1963, 1964 and 1967.

In the 1963 round of research awards, the areas supported covered a broad range:

- studies of the stability of confined high-temperature plasmas with controlled magnetic field configurations at the University of New England;
- work on the development of methods of preparation of plasmas and methods of measurement of plasma properties, investigations into the heating of deuterium plasmas, a project on the continuation of the study of energy conversion processes in plasmas using magnetohydrodynamic principles, a project on the determination of temperature and particle densities, a study of conversion processes using multiple electrode systems, at the University of Sydney;<sup>48</sup>

<sup>46</sup> AINSE Council C3/62 p 12

<sup>47</sup> AINSE Council C2/63 p 120

<sup>48</sup> AINSE Council C4/62



#### **P**rofessor Hugo Messerle

Professor Hugo Messerle (1925-2004) headed the department of Electrical Engineering at the University of Sydney for almost 20 years. He established a major research program in Power Engineering, Plasma Technology and Magnetohydrodynamic (MHD) Power Generation at the University of Sydney and made internationally recognised contributions to research in the field of MHD, being elected Chairman of the UNESCO International Liaison Group for MHD power generation for many years. His major publications included the following books 'Dynamic Circuit Theory' (1965) 'Energy Conversion Statics' (1969) and 'Magnetohydrodynamic Power Generation', published after he retired. He held 17 AINSE research awards between 1962 and 1976.

Hugo Messerle told a friend once that he 'landed in Australia speaking only German with a small suitcase in one hand and a violin in the other'. He went on to graduate with first class honours in electrical engineering (1952) and an MSc from the University of Melbourne, then a PhD from the University of Sydney. He was later awarded a DSc from the University of Melbourne (1968). He joined the University of Sydney in 1952 and became the Head of the School of Electrical Engineering in 1972, the position he retired from in 1992.

He made many contributions to both University and public life, with a particular interest in Engineering Education, setting up the International Liaison Group on Engineering Education in 1989. He also became the founder and chairman of the Committee on Sustainable Development of the Academy of Technological Sciences and Engineering in 1993. He was recognised with a number of awards, in particular he was awarded the 1984 Centennial Medal of the IEEE, the Medal of the Australasian Association of Engineering and a Centenary Medal of Australia.

- a study of the problems associated with the preparation of rotating plasmas, studies of the density and temperature of plasmas in the absence of a magnetic field, at the University of New England;
- studies of the absorption of r-f energy by a plasma, exploration of plasma densities, studies to develop diagnostic techniques to analyse high-density plasmas, at the University of Sydney; and
- a study to determine losses of useful energy in plasmas due to radiation, electrical diffusion and thermal conduction, at the University of Adelaide<sup>49</sup>.

An example of the positive effect of AINSE support is that of Flinders University, which quickly established a strong presence in plasma physics following its foundation in 1966. By the end of the decade, researchers at the University were publishing, with acknowledgement to AINSE, significant papers on normal ionising shock waves.

AINSE support for research in plasma physics remained constant for some years; however, changing university priorities are reflected in a decline in the scope of awards in this area as the decade progressed. While AINSE was underwriting an eighth plasma physics conference in February 1971 the Plasma Physics Committee in November 1970 declined to support the purchase of a high-speed framing camera to replace the camera purchased in 1963. By the end of the decade only the University of Sydney was the recipient of (five) awards in the plasma physics area.

### 3.6.9 Dating research

Following the successful Neutron Spectroscopy Seminar held at Lucas Heights in late 1959, a conference on Radioactive Dating was also held at Lucas Heights in April 1960 under the Chairmanship of Charles Focken, Director of the Museum (Institute from late 1960) of Applied Science of Victoria, Melbourne. As a result of this conference the Dating Project was established.

In April 1960 a number of recommendations were subsequently made to Council by the Executive Committee to establish the Dating Project

- immediate assistance to the University of New South Wales and the Victorian Museum of Applied Science ... to provide a radiocarbon dating service
- the appointment of a staff member in the Physics Department of the University of Western Australia to carry out rubidium-strontium dating on behalf of members of the Institute
- the appointment of a Senior Fellow ... to work with the facilities at Lucas Heights on the improvement of existing methods and the development of new methods of dating geological specimens.

By April 1961 the appointment of an AINSE Senior Fellow, Glen Riley, was made and his research over the two and a half years of his fellowship related to the use of isotopic geochronology.<sup>50</sup>

The Dating Project functioned for several years and while it resulted in the publication of four papers by Riley it did not attain the momentum achieved by the neutron diffraction project. It was abandoned in 1964 after the four papers had been prepared for publication.<sup>51</sup>

The dating project is a good example of AINSE's ability to react positively to the perceived needs within the universities, provide support and conclude its assistance if requirements changed. Radiocarbon dating using accelerator techniques later became a focus for AINSE-supported research at Lucas Heights.

49 AINSE Council C2/63

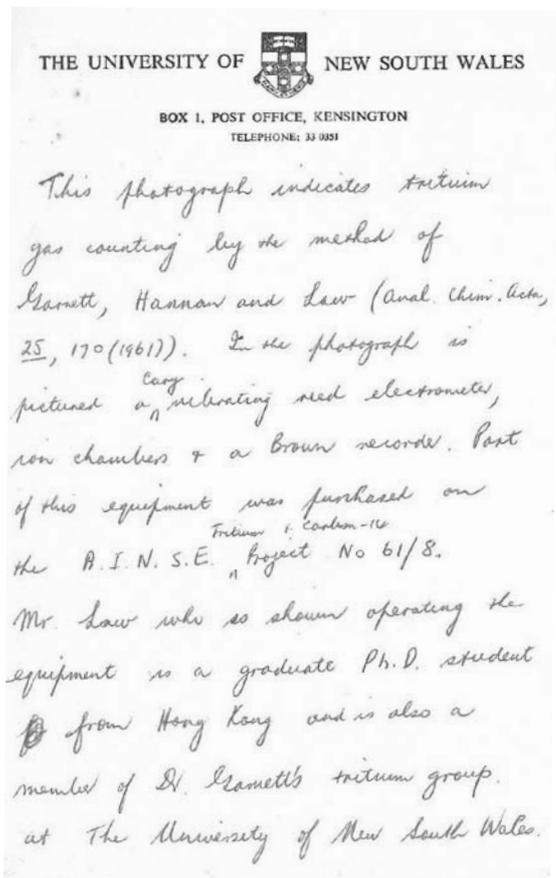
50 Subsequently Riley was appointed acting Supervising Scientist, from April 1993 to February 1994. The office of the Supervising Scientist is responsible for overseeing the environmental impact of mining in the Alligator River area.

51 1 Errors in determining radiogenic strontium by isotope dilution.

2 Rb-Sr Ages of intrusions in the Arunta Basement, Central Australia.

3 Isotopic analysis of rhenium from a thermal ionisation source.

4 Rhenium concentration of Australian molybdenites by stable isotope dilution.



(Extract)

This photograph indicates tritium gas counting by the method of Garnett, Hannan and Law... In the photograph is pictured a Cary vibrating reed electrometer, ion chambers & a Brown recorder. Part of this equipment was purchased on the AINSE Tritium & <sup>14</sup>C Project No 61/8. Mr Law, who is operating the equipment, was a graduate student from Hong Kong working at the University of New South Wales.



AINSE tritium gas counting equipment in use in 1961, described above

### 3.6.10 Provision of heavy water for university research

In April 1960 the Executive Committee considered the issues relating to the use of heavy water in universities. The AAEC had referred requests for heavy water received from Associate Professor Keith Lauder, University of Queensland (Chemistry) and Associate Professor Jack Garnett, the University of New South Wales (Chemistry) for radiation catalysis, the request being for the purchase of small amounts (200 and 500 grams respectively) of deuterated water for experimental purposes. The AAEC had supplies of heavy water for its own use but under the conditions of its purchase of the material, the AAEC was not allowed to supply it to third parties even on loan.

At this time heavy water was a scarce commodity and the sole accessible producer was a company in the United States of America. Since this was the time of the Cold War, heavy water was also a material of military significance. In addition, the redesign of reactors was making a strong demand for heavy water as graphite-moderated reactors gave way to heavy-water moderated reactors.

The Council in 1960 having received further advice from the AAEC that the bilateral agreement with the United States Atomic Energy Commission did not allow release of any of its own stocks, agreed to purchase the minimum amount of heavy water (125 pounds) from the USA at a rate of \$US28 per pound or approximately £1,750 in total on the basis that the AAEC would store and transport the heavy water on behalf of the Institute.

In August, the AINSE Executive Committee noted that university members would require approximately 10 pounds (weight) of heavy water per year and that AINSE was negotiating a contract with the USAEA for the purchase of 125 pounds (weight). The material was supplied subject to the provisions of the 'Agreement for Co-operation in the Peaceful Uses of Atomic Energy' between the USA and Australia, and was subject to rigorous accounting. AINSE decided that the heavy water would be supplied at cost which was set at £13 per pound plus packaging and transport. There was no allowance made for the return of the degraded material.

More heavy water was purchased until the 70s when the international restrictions on heavy water had eased, though AINSE continued to provide universities with heavy water for research purposes, such as biological research for some years.

In 2007 ANSTO won \$3.3 million from National Collaborative Research Infrastructure Strategy (NCRIS) funding for the establishment of a chemical deuteration facility to partially fund the National Deuteration Facility which will build on ANSTO's existing biodeuteration facilities and extend capabilities to include chemical deuteration of small molecules for the soft-matter community using neutron-scattering techniques.

### 3.7 Formation of specialist committees

From the time of their establishment, the central task of Specialist Committees has been to peer review applications for AINSE research grants, studentships and fellowships. These committees have also assisted in the organisation and support of the regular AINSE-sponsored conferences.

The first Specialist Committee, the Plasma Science Specialist Committee, was established in 1962. It met for the first time on 4 October 1962 and the following recommendations concerning priorities related to Plasma Physics were agreed by the Executive Committee in November 1962

*1<sup>st</sup> Priority*

*Plasma Physics research directed specifically towards the controlled thermonuclear release of energy, and the associated discharge physics*

*2<sup>nd</sup> Priority*

*Research directed towards use of energy from nuclear sources through employment of plasmas in such fields as power generation and rocket propulsion.*

In 1963, AINSE established a number of other committees with similar functions to the existing Plasma Science Specialist Committee. These were the Nuclear Physics Committee formed in May, the Heat Transfer and Fluid Flow Committee formed in November and the Radiation Chemistry Committee formed in December. These committees continued for the rest of the decade. Bill Palmer said that Charles Birkett-Clews, in the absence of a



Photo courtesy of the University of Melbourne Archive

### Professor John Lovering AO FAA

John Lovering had 22 AINSE research awards between 1961 and 1987. His work in the 60s and early 70s centred on activation studies in meteorites and rocks. Later he extended into particle track analysis, a precursor to fission track analysis.

Professor Andrew Gleadow writes

John Lovering was my PhD supervisor, and there is continuity between his stream of AINSE research awards and mine. John is one of Australia's leading geologists. He spent the early part of his career at the Australian National University where his principal interest was in the geochemistry of meteorites and he was well known internationally. As part of this work, AINSE supported neutron activation analysis (NAA). During the 60s he became interested in fission track analysis (FT), both as a uranium analytical method and also as a new geological dating technique. In 1969 he was as one of the three Australian Principal Investigators on the Apollo program for the analysis of lunar samples, in the early 70s using both NAA and FT uranium analytical studies.

In 1969 he was appointed to the Chair of Geology at the University of Melbourne. I became his first PhD student and developed the geological dating side of FT analysis. At that time the dating application of FT analysis was wide open for development, so that became my primary interest through my PhD and subsequently during my postdoctoral period at the University of London in 1975.

In 1976 I returned to Melbourne and began a sequence of very productive research projects with him based on fission track dating, during which time AINSE support was continued under John's grants. This pattern of close collaboration continued through most of the 80s as the group became much larger (up to 22 people at any one time) and I progressively took over management of its affairs.

specific Neutron Scattering Committee had initially provided advice on grant applications for neutron-scattering applications.

The Executive Committee, in April 1966, established a subcommittee to determine the criteria for the allocation of research and training grants. This was to ensure that the same criteria were being used by the different specialist committees. The Council in May 1966 subsequently adopted these criteria for AINSE Research and Training Grants:

- A. *The project requires the use of the unique facilities at Lucas Heights or other facilities at Lucas Heights which are not reasonably available to the proposer.*
- B. *The project has possible significance in the development of knowledge concerning material, systems and processes which may have importance in the controlled release of nuclear energy or in technology associated therewith.*
- C. *The project has possible significance in the development of knowledge concerning the effects of radiation on materials, systems or processes.*
- D. *It is in a field which ... may be important in the longer term development of nuclear technology in Australia and in which it is desirable to develop and maintain Australian expertise.*
- E. *Involves the direct scientific cooperation between officers of the AAEC and research workers of one or more of the Institute's other member organisations in fields which are related to the research interests of the Commission.*

The Specialist Committees soon became involved in the organisation of discipline-specific conferences and seminars. Members of the Specialist Committees were invited to assist in conference organisation in a variety of ways by: providing the Conference Chair; suggesting who should present the invited papers or peer review papers submitted for possible inclusion at the conference; and publicising the conferences within their disciplines.

### 3.8 Initial research grants

The awarding of research grants has constituted a major mechanism through which the Institute has supported research and training undertaken by the member universities in nuclear and related fields.

The first AINSE research grants were awarded in 1960. Seven grants in total for 1960 were awarded to researchers from the University of New South Wales (2), the University of Melbourne (2), University of Tasmania (1) and the University of Western Australia (2). Areas of research included theoretical and nuclear physics as well as neutron diffraction and radiation science (Table 4).

**Table 4. Inaugural AINSE research awards 1960**

Researcher	Uni	Project Title
E O Hall	NSW	Radiation damage and mechanical properties of metals
A Keane	NSW	Theoretical investigation of thorium resonance integrals
J F Duncan	MEL	Neutron diffraction studies
J F Duncan	MEL	Preparation of high specific activity sources
J M Polya	TAS	New chelating agents for separation of rare earths
C J Birkett-Clews	UWA	Neutron diffraction studies on metals & on diphenyl compounds
D J (Judge) Bevan	UWA	Construction of a Hagg-Guinier crystallographic camera

In the following year 24 research awards were taken up at ten universities and the areas of research had expanded to include radiation, materials science and engineering.

Initially the Executive Committee considered grant proposals<sup>52</sup> but as more proposals were received, it became necessary to delegate the assessment of the proposals to the Specialist Committees. Their recommendations were forwarded to the Executive Committee which made formal recommendations to the Council. In this way all universities had an opportunity to comment on the distribution of the grants.

<sup>52</sup> Grants are considered to have been awarded by the AINSE Council.



### **D**r John Boldeman

John graduated from the University of Queensland in 1959 and then joined the Physics Division at the AAEC. He was awarded a PhD in 1971 and a DSc in 1984 from the University of New South Wales. Under Roger Bird's influence, he became strongly committed to the collaboration with university staff via AINSE. John's most important contribution to AINSE followed from his determination to upgrade and improve key experimental equipment at ANSTO. In 1987 he became Chief of Physics Division which included responsibility for the neutron-scattering facilities. With the exception of LONGPOL, all of the neutron-scattering instruments were close to obsolete so a program was initiated to upgrade various instruments in turn. With Chris Howard the science manager and John Edwards the project manager, the high resolution powder diffractometer and the medium resolution powder diffractometer were installed on 4H1, which was jointly funded by the AAEC and AINSE, and 4H2. In 1989 the decision was made to build a small-angle scattering facility at a cost of \$1.3 M with AINSE agreeing to provide \$400k. The next instrument to undergo improvement was 2TanA, which was funded by AINSE. John also negotiated Australian access to ISIS and accepted the annual cost of \$400k in the recurring expenses of the Physics Division from 1992 until AINSE took over responsibility for the payment in 1997.

He drove the installation and refurbishment of an FN tandem accelerator that would have world-class capabilities for Accelerator Mass Spectrometry and nuclear analyses for Australian researchers through AINSE. His most recent involvement has been with the Australian Synchrotron.

These grants were soon regarded as a lifeline that allowed university researchers to access HIFAR and other facilities at Lucas Heights. The grants also provided for the purchase of specialist equipment and materials, which could be housed at a particular university. Travel and accommodation costs for grant holders and any other university researchers and students were included in the grants.

As an example, an application from Charles Birkett-Clews requesting support to conduct research into the structure of a number of related organic molecules using x-ray crystallography procedures involving the use of neutron diffraction measurements was considered at the Executive Committee meeting in March 1960.

The request included support for a researcher and a postgraduate student to travel from Perth to Lucas Heights to conduct the neutron diffraction work and access to the only university computer, SILLIAC at the University of Sydney then available in Australia for data analysis. Hugo Rietveld was at this time a postgraduate student at the University of Western Australia and the other researcher was Dr Ted Maslen, Rietveld's PhD supervisor. The grant given to Birkett-Clews totalled £1,340 in 1960. This resulted in the paper published in *Nature* (see page 1). The *Nature* paper was one of the first of many thousands of publications in internationally renowned journals that have been produced as a direct result of the financial support awarded by AINSE in the last fifty years to postgraduate students, early career scientists and established university researchers.

Hugo Rietveld gained his PhD from the University of Western Australia for his thesis entitled 'The Structure of p-diphenylbenzene and Other Compounds'. It was a single-crystal neutron and x-ray diffraction study and was the first investigation to use single-crystal neutron diffraction in Australia. Rietveld's exposure to the SILLIAC computer possibly provided him with the insight that later developed into the computational method that bears his name, the 'Rietveld Method', for analysing powder diffraction data. Rietveld returned to his home in the Netherlands in 1964 and it was while continuing with his work on neutron diffraction techniques that he published the paper in 1967 that describes his analytical method<sup>53</sup> which has achieved an extraordinary impact in condensed matter research.

The number of research grants grew from the initial seven in 1960 to four universities to 97 in 1969 to 13 universities. In this year the allocation of grants<sup>54</sup> to member universities was as follows: the University of Queensland (10), University of New England (4), the University of Newcastle (8), the University of Sydney (12), the University of New South Wales (17), the Australian National University (5), the University of Melbourne (10), Monash University (7), La Trobe University (3), University of Tasmania (3), the University of Adelaide (5), Flinders University (9), and the University of Western Australia (4).

### 3.9 The initial research fellowships scheme

In March 1960 the Executive Committee discussed the criteria for establishing postdoctoral research fellowships. They agreed that only exceptional candidates would be considered and that only projects that would involve facilities at Lucas Heights should be considered. The salaries and conditions that were to be paid to postdoctoral fellows were to be in-line with those paid by universities for their postdoctoral positions.

In 1960 one award was offered but was not proceeded with because the candidate and the Institute could not agree on a mutually satisfactory research project. Two awards were offered in 1961: to Dr Hari Sinha of the Indian Institute of Technology, Bombay to work at the University of Melbourne on the project 'Effects of structural defects and impurities on the ductility of magnesium oxide with special reference to grain boundary phenomena'; and to Mr D H Dale, of Oxford University, to work at the University of Western Australia and at Lucas Heights on neutron diffraction studies of 'Hydrogen bond systems and steric hindrance effects in organic molecules'. In 1962 four fellowships were extant: Sinha; Dale; M Lovell; and J G Sime, both from the University of Sydney.

AINSE's records of the achievements of research fellows later in their careers is sadly incomplete. Some outstanding individuals include the following

- Professor Jimpei Harada who is a leading international Figure in crystallography has maintained strong links with Australia with Australia since his AINSE fellowship

<sup>53</sup> Rietveld H M. Line profiles of neutron powder-diffraction peaks for structure refinement. *Acta Crystallogr* **22** 151-2 1967

<sup>54</sup> AINSE Annual Report 1969, Appendix G for the full scope of grants awarded



#### **D**r Hugo Rietveld

Hugo Rietveld is widely acknowledged as one of the most prominent crystallographers of the 20th century. He is best known for his invention of the Rietveld Method. The introduction of this technique was a major step in the diffraction analysis of polycrystalline materials. The success of the method can be gauged by the publication of more than a thousand scientific papers yearly citing it.

Hugo was born in The Netherlands in 1932. After completing grammar school he moved to Australia with his family and studied physics at the University of Western Australia (UWA). In 1964 he obtained his PhD degree from UWA with a thesis entitled 'The Structure of p-Diphenylbenzene and Other Compounds', on research involving single-crystal neutron and x-ray diffraction measurements. This investigation included the first single-crystal neutron diffraction study conducted in Australia using the then new HIFAR reactor. This pioneering neutron work was funded by AINSE.

In 1964 he returned to the Netherlands to take up a research position in neutron powder diffraction at the Energy Research Foundation ECN at Petten. After a scientific and managerial career with ECN he retired in 1992.

His awards have included

- (1) the 1995 Aminoff prize awarded by the Royal Swedish Academy of Sciences;
- (2) the 2003 Barrett Award awarded by the Denver X-ray Conference; and
- (3) the award in 2004 of the Netherlands Royal Award of Officer in the Order of Oranje-Nassau.

days at Melbourne. Jimpei Harada is a Senior Vice President and the Director of the X-ray Research Laboratory of the Rigaku Corporation. Following his AINSE research fellowship he became a Senior Researcher at Brookhaven National Laboratory of USA from 1968 to 1970. In 1970 he returned to Japan and joined Nagoya University as an Associate Professor and became a Full Professor in 1979. He retired from Nagoya University in 1994 and is now a Professor Emeritus.

- Dr John Barclay has been the Chief Technology Officer of Prometheus Energy Company since 2003. Prometheus obtained the purification & liquefaction technology from CryoFuel Systems, Inc; a company founded and grown by Dr Barclay from 1993 until 2002. He held a tenured professorship of Mechanical Engineering at the University of Victoria, British Columbia (1992 to 2001), was a manager and eventually the director of Advanced Technology at Astronautics Corporation of America (ACA), and was a research scientist in the Energy Division of Los Alamos National Laboratory (LANL).

Awards continued until 1994. A complete list of research fellows can be found in Appendix 7.

As with the studentships, Council also delegated the selection of research fellows to the Executive Committee. It was agreed that only a small number should be given. One or two new fellowships were offered each year and their duration was a little over two years. During the period in which postdoctoral fellowships operated (1961 - 1993), about six would be active at any time, and a total of 77 would be supported.

In 1966 the Postdoctoral Fellowship was renamed as the AINSE Research Fellowship

*... for individuals at the threshold of an independent career, involving a minimum tenure of two years.*

In April 1966 Council subsequently agreed

*... that the existing AINSE Postdoctoral Fellowship Scheme be replaced by the AINSE Research Fellowship Scheme.*

In February 1968, the Executive Committee

*... noted that the AAEC does not award Fellowships similar to the AINSE awards, and does not make provision for the support of post-doctoral research workers in universities under the terms of AAEC Research Contracts.*

The AAEC did, in fact, offer postdoctoral fellowships, but these were within the AAEC and were not tenable at universities.

AINSE was, at this time, the only organisation that supported Postdoctoral researchers in a university environment and allowed them to work on their projects on AAEC facilities.

Senior fellowships were established somewhat later than the postdoctoral fellowships. It was intended that *Senior Fellowships would be ... for mature individuals of established high reputation in their fields and be tenable for a minimum period of 1 year.* Individuals could not self nominate but were to be nominated by an Australian university or AAEC. The senior fellow would be of such high calibre that they would be expected to disseminate their knowledge and expertise to researchers in the same or related areas. These fellowships were formally established by the Council at its meeting 26 May 1966. No nomination was received until 1971 and that nomination was not awarded. Only one senior fellow was ever appointed, Dr Tony Lane (Section 4.7).

In 2006 AINSE research fellowships were reintroduced to seed new neutron-scattering groups in universities and to enhance long-term, high-quality, research output from the new instruments at ANSTO's new research reactor, OPAL (Section 7.9).

### 3.10 Research studentships established

The studentships program commenced with Council considerations at its third meeting held in June 1959. At that meeting, Council determined that

*The Institute offer an unstated number of scholarships ... to a value not in excess of £1,500 per annum each, from which the Universities should determine the stipend. The scholarship would be awarded in fields which must be related to the general field of atomic energy and preference would be given to those projects which will utilize the facilities available at Lucas heights or which relate to the programme of the*

*Australian Atomic Energy Commission.*

The Council also determined that travel expenses and special grants for equipment could also be considered under certain circumstances. In AINSE's first Annual Report the studentships were described as having a *maximum value [per annum] of £1,500 plus [University] fees.*

In September, Council empowered the Executive Committee to award a maximum of seven studentships. The students were nominated by their respective universities. The first cohort of seven students, in 1960, included two people who have had a long-standing relationship with AINSE: Eric Weigold and Robin Storer. In November, Council agreed that the main criterion for awarding studentships should be the *ability of the candidates.* The nature of the project would be secondary. In 1961 ten studentships were concurrently active.

The Executive Committee, in November 1959, recommended that the main criterion for choosing the students would be the ability of the student and that the project was of secondary importance. This simple decision meant that all future students chosen for an AINSE scholarship would be the most able. The stipends the students received were, and have remained, generous in comparison to other similar scholarships. AINSE wanted the best students and it was prepared to attract them with a higher stipend (Table 5).

**Table 5. Inaugural AINSE Studentships which commenced in 1960**

Name	Department	Uni	Project
M I Erisk	Chemical Engineering	SYD	Liquid-liquid extraction of electrolytes, and mechanisms of mass transfer
J A Lehane	Physics	SYD	Giant air shower experiment
A J Morton	Metallurgy	NSW	A study of the homogeneous strain accompanying the formation of a martensite plate with particular reference to the determination of the direction of displacement
J W Lee	Chemistry	NSW	Theoretical study of chemical reactions of positronium
E Weigold	Nuclear Physics	ANU	Study of (n,d) and (n,p) reactions
J E Baglin	Physics	MEL	Photo-nuclear giant resonance via photoproton measurements
R G Storer	Mathematical Physics	ADE	Plasma dynamics/high energy nuclear interactions

Students who received an AINSE studentship were enrolled at a university and they usually travelled to Lucas Heights to conduct experiments. They were expected to spend not less than one quarter of their candidature at Lucas Heights. While at Lucas Heights these students were commonly supervised by AAEC research staff as well as their university supervisors.

The Council in May 1963 considered a paper outlining and summarising university regulations that would apply to research students working at Lucas Heights under AINSE auspices. Some Councillors were concerned with the time students spent away from their university. The Council, after some discussion, agreed to detailed conditions applying to the scheme, determined that there would be a maximum of six students current at any time and agreed that the holder of the award would be required to spend not less than one-quarter of the total period of tenure at Lucas Heights. It was also agreed that, where required by the University, a person at Lucas heights be appointed as co-supervisor of the student. Three years later in February 1966 the Council agreed that maximum tenure of the Postgraduate Research Studentships would be four years.

The fully funded studentships continued until 1994 when they were phased out as the Postgraduate Research Awards (PGRAs) program was introduced in 1990. The PGRA is a supplementary scholarship for the finest students who already have been awarded an Australian Postgraduate Research Award or equivalent scholarship.

## Associate Professor John Lehane

John Lehane worked on cosmic ray research for his PhD in Physics at the University of Sydney, and was posted to Jamaica during that time. On his return he joined the plasma physics group which had just been established by Charles Watson-Munro leading a small group which included Max Brennan and Don Millar. They built two machines, SUPPER 1 and SUPPER 2.

He was promoted to Associate Professor in the early 70s and was put in charge of the 3rd Year Undergraduate Laboratories soon after. In 1978, armed with an ARC grant of \$32,000 construction commenced on a tokamak. John was in charge of building the vacuum vessel, which with AINSE assistance was constructed at Lucas Heights. The TORTUS machine was officially opened in 1981 after a four-year construction period, and continued until 1995 when the last four PhD students finished their work. The machine was used for the study of Alfvén wave physics.

John Lehane taught undergraduate physics during his time at the university, and was especially interested in the undergraduate laboratories which he helped to upgrade to modern standards.

## Dr John Baglin

John Baglin is now a Research Staff Member Emeritus at the IBM Almaden Research Center, San Jose, California, USA.

He received BSc, MSc and PhD degrees in Physics from the University of Melbourne, Australia, in 1957, 1959 and 1963 respectively, where his thesis research involved photonuclear giant resonance studies. After completion of his PhD and his AINSE studentship, he received a Fulbright Fellowship and continued nuclear physics research and teaching at Iowa State University/Ames Laboratory, and subsequently at Yale University, before joining IBM in 1972. He conducted research in thin film interactions, radiation effects in solids, and ion beam analysis at the IBM Watson Research Center, Yorktown Heights, NY, and in 1988 he moved to IBM-Almaden to establish new programs in ion beam analysis and materials physics. He is currently investigating nanoscale-resolution ion beam patterning and lithography, with special focus on device fabrication and magnetic storage applications, and ion beam fabrication of nano-structured / self-assembled materials, and exploring the physics of ion beam hardening of polymers to form diamond-like carbon tribological protective coatings.

John Baglin is the author/editor of 30 book chapters/books in these topics, and over 200 publications in peer-reviewed journals, and 20 patents. He is a Fellow of the American Physical Society, a former President of the Materials Research Society, Secretary (and former Vice President) of the International Union of Materials Research Societies, Chair of the IUMRS Membership Commission, and IUMRS Liaison to ICSU. He is Vice-President of the International Materials Education Council, and Editor-in-Chief of the *Journal of Materials Education*, and he serves on the Editorial Board of *Applied Physics Reviews*.

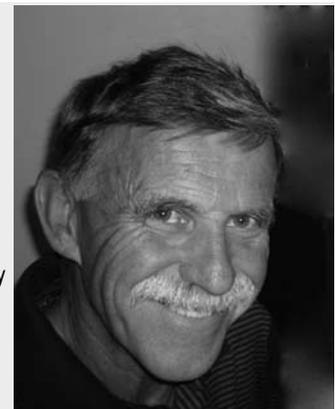
## Professor Robin Storer

The early AINSE postgraduate scholarships were full scholarships and provided a generous stipend which was similar to a graduate starting salary. Robin undertook his PhD with Bert Green as supervisor at the University of Adelaide's Department of Mathematical Physics. His thesis title was 'The Statistical Thermodynamics of Irreversible Processes in Fluids and Plasmas'. Robin's research was theoretical and involved no experimentation at ANSTO. It was not unique in this for scholarships (or research grants) at the time.

In 1963 he took a postdoctoral position at the Courant Institute for Mathematical Sciences at New York University in Harold Grad's research group in the Institute for Magneto-Fluid Dynamics. This was followed by a foundation staff position in Physics at Flinders University in 1965.

Robin Storer stayed at Flinders for the bulk of his career, however he worked as a visiting scientist at many overseas plasma physics laboratories including the Princeton Plasma Physics Laboratory in the USA, the United Kingdom Atomic Energy Authority at Culham, the Japan Atomic Energy Research Institute (JAERI), the Centre de Recherches en Physique des Plasmas (CRPP) (Switzerland), the Max Planck Institute for Astrophysics (MPI-Garching) (Germany) and the Foundation for Fundamental Research on Matter (FOM) (Netherlands).

Most of his AINSE research awards were to support work on resistive instabilities of tokamak and stellarator plasmas. He retired as Professor Emeritus in 2005 after forty years at Flinders University. He has maintained his interest in the field as a member of the plasma fusion group. One of his graduate students, Tony Schellhase, received an AINSE studentship in 1991 to work on computational magnetohydrodynamics using the super-computing facilities at ANSTO. Tony Schellhase is now a senior scientist at the Defence Science and Technology Organisation (DSTO).



## **D**r Allan Morton

Allan Morton's PhD was awarded in 1964 by the University of New South Wales. His thesis was entitled, 'A Study of the Homogeneous Strain Accompanying the Formation of a Martensite Plate'. The following story of his success is typical of many of AINSE's post-graduate students.

In November 1963 Allan Morton took up a CSIRO Post-doctoral Fellowship to continue research in phase transformation working with Profs C M Wayman and T A Read in the Department of Mining, Metallurgy & Petroleum Engineering, University of Illinois, USA and in August 1964 he was appointed to the position of Research Assistant Professor at the University.

On returning to Australia in 1965 Allan Morton joined the CSIRO, Division of Tribophysics, Melbourne as a member of the Metal Physics group led by Dr Leo Clarebrough. His job changed as the CSIRO underwent many reorganisations during the next 30 years, and in 2002 he accepted the position of Deputy Chief (Research) in the newly formed CSIRO Manufacturing and Infrastructure Technology. He retired from CSIRO in January 2003.

Since that time he has remained active with Honorary Research Fellowship positions at Monash University, Department of Physics and Materials Engineering and at CSIRO Manufacturing and Infrastructure Technology as well as some consulting in the light alloys area. He is also a member of the International Technical Advisory Committee of the newly formed Australian Research Centre of Excellence for the Design in Light Metals.

Allan Morton has been a member of a number of organisations and committees relating to metallurgy, including Australia's National Committee for Electron Microscopy from 1986 to 1994 and Course Advisory Committee, Department of Metallurgical Engineering, Royal Melbourne Institute of Technology from 1988 to 1990. From 1999 to 2003 he served on the Boards of two Co-operative Research Centres (CRC), the CRC for Micro Technology and the CRC for Cast Metals Manufacturing and in 2003 was a director of Cast Centre Pty Ltd. He was also the Australian representative in the Vacuum Metallurgy Committee of the International Union for Vacuum Sciences, Techniques and Applications (IUVSTA) for the period 1998-2003.



## **P**rofessor Erich Weigold FAA

Following the completion of his PhD at the Australian National University in 1962 Erich Weigold undertook an AINSE Fellowship (postdoctoral position) at the Research School of Physical Sciences, ANU, for six months before taking up a Lectureship in the Physics Department at the University of Adelaide 1962-64. In 1964 he moved to the US Air Force Office of Scientific Research, Washington DC 1964-70 as physicist, becoming Chief of its Nuclear Physics Division at the beginning of 1966. He returned to South Australia as senior lecturer in Physics at Flinders University 1970-73 where he was promoted to Professor of Physics 1978-92, and Director of the Electronic Structure of Materials Centre 1988-92. He then moved to the Australian National University as Director of the Research School of Physical Sciences and Engineering, 1992-2002.

In 2004 he took up the position of Executive Director, Physics, Chemistry and Geoscience and the Centres of Excellence Scheme at the Australian Research Council. In 2006 Erich moved to La Trobe University as its Pro Vice Chancellor (Research). He is now an Emeritus Professor at both Flinders University and ANU and a Visiting Fellow in the Atomic and Molecular Physics Laboratories at the ANU.

Erich became a Fellow of the Australian Academy of Science in 1986 and was awarded the Lyle Medal by the Australian Academy of Science in 1993. He became a Fellow of the Australian Academy of Technological Sciences and Engineering 1996.

Erich is also a Fellow of the American Physical Society and Fellow of the Australian Institute of Physics.

He was National Chairman of the Committee for the International Survey on Atomic and Molecular Sciences 1983-84; Secretary (Physical Sciences) at Australian Academy of Science 1992-96 and Vice-President 1991-92. In 2000 he was awarded the Humboldt Research Prize by the Alexander von Humboldt Foundation, Germany, and in 2001 the Centenary Medal by the Commonwealth Government.



*Erich Weigold in 1992. Photo courtesy of the Australian Academy of Science*