

## Newsletter of the Australian Society for History of Engineering and Technology

### 100 years ago: Australian fliers at war

The Australian Flying Corps (AFC) was established in 1912, the second air force in the world after the Royal Flying Corps. Four aircraft were ordered; two Royal Aircraft Factory B.E.2 two seat biplanes for reconnaissance, and two Deperdussin TT monoplanes, a French design built in England, as training aircraft. A site for a flying school was chosen at Point Cook in Victoria. The government authorised the formation of a single squadron, for which recruiting was commenced while a number of mechanics were transferred from the existing military forces.

Following the outbreak of war, the government sent one of the planes to New Guinea to assist in capturing the German colony, but the Germans surrendered before the aircraft could be unpacked. In 1915 the AFC was called on to assist in protecting British oil interests in Mesopotamia, now part of Iraq, initially in reconnaissance and later in the year in combat. Casualties were heavy and the operation was abandoned before the end of the year. In 1916 an Australian squadron was sent to the Middle East, and served there for the rest of the war. Three more squadrons were recruited and sent to France.

A total of nearly 4,000 men served in the AFC during the war, with 413 as pilots and 153 as observers. In 1921 The AFC became the Royal Australian Air Force.



World War I aircraft B.E.2



Australian Flying Corps, World War I

### Conference on aviation technology, culture and heritage



The forthcoming conference in Sydney on Thursday and Friday 10–11 December focuses on the current state of research into the technological, historical and cultural aspects of aviation. Including a wide range of presentations and a behind-the-scenes tour of Sydney’s Powerhouse Museum, it will appeal to those interested in the history, archaeology, technology and cultural representations of aviation. Registration is free, although delegates will need to fund their meal at the conference dinner. View the preliminary program at [http://sydney.edu.au/foundations\\_of\\_science/events/index.shtml](http://sydney.edu.au/foundations_of_science/events/index.shtml). To express interest or register, please contact ASHET member Dr. Peter Hobbins at [peter.hobbins@sydney.edu.au](mailto:peter.hobbins@sydney.edu.au).

This meeting has been generously supported by the Sydney Centre for the Foundations of Science, an interdisciplinary research centre exploring the historical, philosophical and cultural underpinnings of science, technology and medicine.

### Engineering Heritage Conference 2015 at Newcastle

Engineers Australia will hold its three day 2015 conference at the Newcastle Museum on 7–9 December. There will be a number of papers on the history of engineering in Newcastle. There will also be a pre-conference tour that will include the Blue Mountains, the Great North Road, the Australian Army site including museum at Singleton and the remains of a shale oil plant at Murrurundi.

Non-members or Engineers Australia are welcome. For more information go to <https://www.engineersaustralia.org.au/heritage-2015>



## Next ASHET events

### Thursday 26 November 2015

#### *A third telescope dome at Sydney Observatory - tour and talk by Andrew Jacob*

ASHET members and their partners are invited to visit Sydney Observatory for a guided tour commencing at 10 am on Thursday 26 November.

Andrew Jacob, Curator of Astronomy, will describe the recently completed project to restore and reinstate a historic metal dome and astrographic telescope which had been removed from the site in 1986. The astrograph was made in Dublin and installed in the Melbourne Observatory in 1890 to photograph a portion of the southern sky for an Astrographic Catalogue, an international project involving many observatories worldwide.

When the Melbourne Observatory closed the instrument was moved in the 1940s to the Sydney Observatory where it was housed in a new special-purpose dome built by Mort's Dock Engineering. The restored dome now houses a modern telescope with an innovative extendable eyepiece designed to make telescope viewing accessible to visitors with limited mobility.

This visit is limited to 20 participants, so please book early to ensure a place by e-mailing [ashetactivities@gmail.com](mailto:ashetactivities@gmail.com)

To celebrate another successful year for ASHET, participants will be welcome to follow their visit to Observatory Hill with an informal lunch at a local restaurant.

**Venue:** Sydney Observatory, Observatory Hill, Sydney

**Time:** 10:00 am sharp

**Cost:** ASHET members \$10 for the Observatory guided tour

**Bookings:** email [ashetactivities@gmail.com](mailto:ashetactivities@gmail.com)

### Thursday 22 October 2015

#### Talk by Andrew Grant

#### *"By George, the thoroughbrace is broke!": A brief historical overview of Australia's coaching enterprise Cobb & Co, including a consideration of the merits of leather as a suspension material in Cobb coaches.*

Cobb & Co was Australia's, and the world's, largest horse drawn coaching organisation. The company began its operation in Melbourne in 1854 with several "Concord" coaches of a type that had already proven its rugged reliability in North America. The innovative use of full leather springing had been a significant factor in the success of the Concord coach and it was no less successful in the punishing conditions of Australia's new coach routes.

Cobb & Co quickly developed a reputation for reliability and speed but passengers knew to expect an uncomfortable ride as the coach body rocked and jerked. On rare occasions, the leather gave way, as Mark Twain's account of a coaching experience in 1872 indicates (see the title above).

Contemporary technological developments in steel spring making in England would later deliver benefits to the entire coach building industry in terms of higher quality springs and spring systems. However, in Australia, leather retained its position as the preferred material for the suspension of "Cobb coaches", as they were called.

The success story of Cobb & Co in Australia took place against a background of the general introduction of American coach building

technology and industrial organisation from the 1850s, epitomised by the four-wheel buggy.

Andrew Grant has been deeply involved in preserving, documenting and promoting Australia's transport heritage since 1980, chiefly as a senior curator at the Powerhouse Museum, Sydney.

His career began in the 1970s in Industrial Arts education in which he took a leading role through the introduction of new courses in design method. He graduated with a B.Sc.(hons) from the UNSW and later gained an M.Sc. in Industrial Arts with a thesis about the coach building industry in Australia.

After retiring from the Powerhouse in 2012, Andrew has continued his involvement in transport history and preservation through heritage consultancy.

**Venue:** History House, 133 Macquarie Street, Sydney

**Time:** 5.30 for 6 pm

**Cost:** Includes light refreshments on arrival; RAHS and ASHET members \$10, others \$12

**Bookings:** phone RAHS on (02) 9247 8001 or email [history@rahs.org.au](mailto:history@rahs.org.au)

### Tuesday 8 December 2015

#### Talk by Leonard Janiszewski/Alexakis

#### *Selling an American Dream: Australia's Greek Café*

Historian Leonard Janiszewski and documentary photographer Effy Alexakis have been researching the historical and contemporary Greek-Australian presence, both within Australia and overseas, since 1982. Their ongoing project and archive – *In Their Own Image: Greek-Australians* – is recognised as one of the largest collections of Greek-Australian material in the country.

The archive encompasses a wealth of visual images, recorded interviews, paper-based textual documents and memorabilia. It is currently housed at Macquarie University, Sydney, in partnership with the Australian History Museum and Discipline of Modern History. Over 180 academic and popular journal articles, book chapters, conference papers and catalogues have been produced, as well as two major books and three film documentaries.

Both national and international touring exhibitions have been created. Of their exhibitions, the most pronounced have been 'In Their Own Image: Greek-Australians' and 'Selling an American Dream: Australia's Greek Café'. The former toured throughout Australia and travelled to both Athens and Thessaloniki. The latter opened at the National Museum of Australia in 2008, and is still touring nationally.

Janiszewski and Alexakis have received numerous grants. The most significant have been from the Australia Council, Visions of Australia, Film Australia, the Greek government, and various Australian state funding bodies. Alexakis' photographs are held in both public and private collections in Australia — most significantly in the Australian National Gallery, Canberra, and the New South Wales State Library, Sydney. Janiszewski has held both a NSW Ethnic Affairs Commission Fellowship and a NSW History Fellowship. Both Janiszewski and Alexakis have served on various history and/or arts advisory boards.

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## Nuclear energy and Australia, Part 2

This is the second part of an article on the history of nuclear energy in Australia. The first part, which took the story up to the point when the Australian Atomic Energy was about to be established, in 1953, was published in the July issue of *ASHET News*. The first part of the article also includes a list of sources and suggestions for further reading on nuclear energy in Australia. It may be read and downloaded from the ASHET website at <http://ashet.org.au/newsletter/>.

### The Australian Atomic Energy Commission (AAEC)



*Philip Baxter*

The first part of the article took the story to the establishment of the AAEC under the Atomic Energy Act 1953. Its three founding Commissioners were Major-General Jack Stevens, secretary of the Department of Supply (chairman), Philip Baxter (deputy) and H.M.Murray, general manager of Mt.Lyell Mining and Railway Company. Its most pressing task was to bring the Rum Jungle mine and treatment plant into production as quickly as possible to ensure supplies of uranium for the British and American nuclear weapons programs. A ten year contract to provide the American government with 150 tons per year for ten years was signed in January 1953, with full production to be reached within 15 months. 450 tons of ore was to be left in the ground for Australian use.

Under the Act, the AAEC was granted wide powers to conduct and arrange for exploration, mining and treatment of uranium, to negotiate and enter into agreements on behalf of the Commonwealth for the purchase and sale of uranium, to construct and operate plant and equipment for the liberation of atomic energy and its conversion into other forms of energy, and to conduct and coordinate research and investigations related to nuclear energy.

The bill to establish the AAEC had passed through Parliament with enthusiastic support from both the Liberal and Labor parties, with members believing strongly that nuclear power would be very important for Australia, which was considered at the time to lack substantial resources of fossil fuels. The agreement to sell Rum Jungle ore to the Americans was widely criticised by groups including trade unions and the RSL who protested that it should be kept in Australia for industrial purposes.

### The AAEC Research Centre at Lucas Heights

During 1953, there were detailed discussions in Australia and Britain on arrangements for co-operation between Australia and Britain on nuclear

energy, and on the establishment of a research centre in Australia. It was agreed that Australia's primary objective in building a research establishment in Australia was to provide the opportunity to build in Australia a team of experts in the full range of disciplines that would be needed to keep up to date with world developments in the industrial use of nuclear energy.

The UK experts recommended that the proposed research establishment should have a high powered research reactor, similar to the DIDO reactor at Harwell, and offered to provide the technical advice and information to build it. This was agreed, and a site was chosen at Lucas Heights, around 20 km from the centre of Sydney. Work commenced on building the laboratories while the AAEC recruited key members of staff and seconded them to work at Harwell for two years or more until the new facilities were ready for occupation. In 1953 eight of the original team of Australian scientists seconded to Harwell under the 1947 agreement between UK and Australia were still there, and by 1955 the Australian team at Harwell numbered fifty.

### The international scene

Early in 1954 Howard Beale, Menzies' Minister for Supply, announced that 'At one step Australia was brought up to the present day without expense, with knowledge upon which the UK has spent a prodigious effort in money and manpower to obtain'. Britain had tested its first nuclear device at the Monte Bello islands in 1952 and was now conducting further tests on the Australian mainland, first at Emu Field and later at Maralinga.

America successfully tested its hydrogen bomb in 1953. Shortly afterwards President Eisenhower announced his Atoms for Peace initiative in which he proposed that America would divert fissile materials from military to civilian use through the establishment of an International Atomic Energy Agency (IAEA). An important objective was to discourage proliferation of nuclear weapons. It led to a series of International Conferences on Peaceful uses of Atomic Energy, the first held in Geneva in 1955, that resulted in the sharing of much information that had been previously classified.

### The AAEC research program

One of the tasks of the Australian team at Harwell was to formulate the research program to be undertaken at Lucas Heights. The leaders of the team were appointed early in 1955. The Chief Scientist, Charles Watson-Munro, was a New Zealander who had worked in Canada at the end of the war taking a leading role in the building of the first reactor there, at Chalk River, and who had subsequently been a Professor of Physics in New Zealand. His deputy and chief engineer was Cliff Dalton, a New Zealand Rhodes Scholar, who had started the first work on fast reactors at Harwell and who was subsequently Professor of Mechanical Engineering at Auckland University.

It was agreed that the Australian research program would concentrate around the use of beryllium as a neutron moderator material with studies of two possible reactor systems, a liquid metal fuel reactor with liquid sodium as the coolant, and a high temperature gas cooled reactor (HTGCR) using helium as the coolant. Members of the team at Harwell returned to Australia during 1956 and 1957 as the Lucas Height facilities became ready for use and the research program got under way. The reactor at Lucas Heights, named HIFAR, went critical on Australia Day 1958. It was soon realised that the original plan to work on two reactor systems was too ambitious and a choice was made to stop work on the liquid metal fuel reactor and concentrate on the beryllium moderated gas cooled reactor.



*Prime Minister Menzies opens the HIFAR reactor, accompanied by AAEC Chief Scientist Charles Watson-Munro*

Baxter succeeded Stevens as Chairman of AAEC in 1957. Watson-Munro resigned in 1959 to take the foundation Chair of Plasma Physics at the University of Sydney, and Dalton succeeded him as head of the Research Establishment with the title of Director. Dalton died in 1961 and was succeeded as Director by Keith Alder.

In 1966 Alder reported to the Commission that the HTGCR did not seem to be a promising potential competitor to other more developed reactor systems, including the pressurised water reactor (PWR) and boiling water reactor (BWR) that the Americans had developed out of their nuclear submarine program and which were by this time commercialised. The Canadians had built several commercial power plants based on their CANDU (Canadian Deuterium/Uranium) reactors that were fuelled with natural uranium and were developing a promising variant cooled with boiling light water. The British had built several advanced gas cooled reactors (AGRs) but realised that these were unlikely to be competitive on world markets with the American and Canadian water cooled designs. They had for several years been working on a steam generating heavy water moderated reactor (SGHW) reactor similar to the one being developed by the Canadians, and were building a 200Mw demonstration power reactor using this technology.

As a result the Commission decided to phase out most of its work on the HTGCR and concentrate on systems that might have application in Australia in the not too distant future. In particular there was interest in the heavy water moderated systems that could operate on natural (not enriched) uranium and thus lend themselves to using fuel wholly produced in Australia. There was a reasonable expectation that nuclear power would be economic in Australia by the mid seventies.

Also at this time it was becoming increasingly apparent that Australia had substantial resources of uranium and fossil fuels and that it might develop an industry around the export of uranium enriched in Australia or even the export of fabricated fuel elements. A small team started work at Lucas Heights on researching centrifuge enrichment of uranium, a technology that was in use in Russia since 1949 and being researched in several overseas countries. At that time all work on enrichment anywhere in the world was secret because of its potential for producing highly enriched uranium for weapons. The Commission continued to send staff on attachment to overseas establishments to ensure that it was up to date in its understanding of the commercial development of nuclear power, which was proceeding apace. It also continued research and assessment work at a low level on a variety of topics related to nuclear energy that included peaceful uses of nuclear explosions (but not nuclear weapons).

### **The Nuclear Test Ban Treaty and the Nuclear Proliferation Treaty (NPT)**

Meanwhile there were important developments internationally in the area of nuclear weapons. The Nuclear Test Ban Treaty, prohibiting all but underground testing of nuclear weapons, was signed by the UK, the USA and the USSR in 1963. The UK ceased testing in Australia in 1963. France and China refused to sign. China exploded a nuclear weapon in 1964 and an aerial H-bomb in 1957. France exploded an aerial H-bomb at its Pacific test site in 1968. With growing concern about proliferation of nuclear weapons, serious negotiation of a Nuclear Proliferation Treaty (NPT) began in 1965 and resulted in the United Nations opening the NPT for signature in 1968, already signed by UK, USA and USSR. The treaty defined a 'nuclear weapon state' as one that had exploded a nuclear device before 1 January 1967, so included the three initial signatories plus China and France. The treaty forbids the nuclear weapon states from transferring nuclear weapons or nuclear devices or control over them to any nation. It also prohibits the nuclear weapons states from helping any non-nuclear weapons state in the manufacture or acquisition of nuclear weapons.



*Keith Alder*



*William McMahon*

or explosive devices (including ones for peaceful purposes). The treaty requires non-nuclear weapon states party to the treaty not to accept the transfer or control of nuclear weapon or devices from any source and not to manufacture them. Non-nuclear weapons states were required to submit to international inspection through the International Atomic Energy Agency to verify their compliance.

The treaty became effective in March 1970 after ratification by the three initial signatories and 40 non-nuclear weapons states. Signatories to the treaty were not bound by it until they had ratified it, but after the treaty became effective any new signatories had to ratify the treaty at the time they signed it.



*Site of proposed Jervis Bay reactor*

The Australian government in 1968 wanted to keep its options on nuclear weapons open for as long as possible and cabinet was divided on whether or not the government should consider arming its forces with nuclear weapons. The government commissioned a top secret study of a possible Australian nuclear weapons program. AAEC was not involved in this study but some of the staff were seconded to Canberra to participate in it. The outcome was that the government decided to keep its options open.

The Australian government quietly signed the NPT in February 1970 and Prime Minister Gorton explained that 'our decision to sign is not to be taken in any way as a decision to ratify the treaty and of course the treaty is not binding on us until it is ratified'. The newly elected Whitlam government ratified the treaty on 23 January 1973.

## Peaceful uses of nuclear energy

In 1968 the Western Australian government asked the Commonwealth to undertake a feasibility study of the use of nuclear explosives to excavate a harbour at Cape Keraudren for the export of iron ore. AAEC and the USAEC agreed to undertake a joint study. The USAEC had been studying the use of nuclear explosives for many years under its Atoms for Peace and Plowshare programs, for mining, in situ leaching of minerals and construction of canals and harbours. AAEC had sent a technical mission to the USA in 1963 to review the program and reported favourably on the prospects for the use of nuclear explosives in the development of mineral resources in Australia. The study began early in 1969 with a sense of urgency because the harbour would need to be available for shipping iron ore in June 1970. The study was suddenly abandoned in March 1969. Little more was heard of peaceful uses of nuclear explosions which appear to be effectively ruled out for all states bound by the NPT.

A far more significant peaceful application of nuclear energy was its industrial use in nuclear reactors. In Australia Baxter led the way forward by convincing the Prime Minister John Gorton and its Minister for National Development, David Fairbairn, that a feasibility study should proceed on the Commonwealth building a commercial nuclear power plant as a prelude to the Australian states, which are responsible for electric power generation, building their own nuclear power plants. Their enthusiasm was not shared by the Commonwealth Treasurer and future Prime Minister William McMahon. The AAEC presented its report of its feasibility study to Minister Fairbairn in September 1969. Its contents were not made public but it was known that it recommended that an immediate start be made on building a nuclear power plant.

## The Jervis Bay project

In October 1969 Gorton announced that the Commonwealth government would proceed with building a 500 Mw nuclear power station at Jervis Bay. In November 1969 Reginald Swartz succeeded Fairbairn as Minister for National Development. Baxter retired from his position as Vice Chancellor of the University of New South Wales to become full-time

Chairman of the AAEC and give the project his undivided attention. The Electricity Commission of NSW cooperated in the project and was to become largely responsible for the non-nuclear parts of the project, such as the electricity generation plant. The government engaged US consultants Bechtel to assist in preparing specifications and assessing tenders.

When tenders closed in June 1970 there were fourteen offers from USA, UK, Germany and Canada. All were subject to a condition that the reactor had to be capable of being fuelled from Australian uranium, with the fuel elements to be made in Australia, though not for the initial

fuel loading. If uranium enrichment was required tenders were to show how it could be achieved in Australia.

The assessment team reduced the choice to four tenders:

- a PWR from Westinghouse of USA;**
- a PWR from Kraft Werk Union (KWU) of Germany**
- a CANDU from Atomic Energy of Canada;**
- a SGHW from the Nuclear Power Group of UK in collaboration with KWU.**

There were differences of opinion among the members of the assessment team on which of these tenders should be recommended, but in the end the AAEC recommended the SGHW and passed this along with its report on the assessment of the tenders to the Minister for National Development Reginald Swartz in February 1971. While Swartz was drafting the

submission to cabinet recommending acceptance of the SGHW tender, McMahon, who by this time was Prime Minister, requested him to refer the AAEC report to Treasury for review. In June Swartz announced that the government had deferred decision on the Jervis Bay reactor for twelve months, by which time the validity of the tenders would have expired. Swartz said that the costs were higher than had been expected in 1969 but none of the figures was officially made public.

In the meantime work had been proceeding on the Jervis Bay site and it was almost ready for construction to start. When the deferment was announced all work on the site was stopped. It was generally accepted that the deferment was in truth a cancellation. In 1972 the project was formally deferred indefinitely.

### A world-wide boom in nuclear energy, led by the USA

The efforts to build a nuclear power station at Jervis Bay had occurred at the height of a world-wide boom in nuclear energy. In 1973 there were 132 nuclear power reactors in operation round the world, compared with 25 in 1963, with a combined capacity of around 40,000 Mwe compared with 2,600 Mwe in 1963. Approximately half of these reactors were in the USA. A further 144 reactors were under construction there, with a combined capacity of 107,000 Mwe. The USA also had nearly 100,000 Mwe on order. During the remainder of the 1970s the rate of construction of new nuclear generating capacity declined drastically and many projects were delayed or cancelled, particularly in the USA. At the end of 2014, the combined capacity of the 438 reactors in operation was 376,000 Mwe with 70 more under construction with a combined capacity of 68,000 Mwe. The world-wide rush to nuclear power in the 1960s and early 1970s in which Australia nearly participated was a phenomenon not repeated.

The boom in nuclear reactor construction had not been reflected in Australian exports of uranium. The contracts to supply uranium from Rum Jungle to the USA and from Mary Kathleen to the UK were completed by 1963 and no further contracts followed. Ore remaining at Rum Jungle was processed and about 2,200 tons of uranium oxide was stockpiled at Lucas Heights. Mary Kathleen was closed and the remaining ore, estimated to contain around 7,700 tons of uranium oxide, was left in the ground until the mine reopened in 1974. The AAEC tried to encourage exploration even though short-term sales prospects were poor and world uranium prices remained very depressed.

The AAEC Annual Report for 1967 had noted that 'The Commission views with concern the fact that the known economically recoverable reserves of uranium in Australia are inadequate to support even a very modest nuclear power program'. In 1969, with the announcement of Jervis Bay, exploration picked up. In 1971-2 the AAEC was able to report 'Uranium exploration in Australia is at a record high... Important discoveries have been made in Queensland, Northern Territory, South Australia and more recently in Western Australia... It is clear that these additions to Australia's uranium reserves will ensure that Australia will rank as one of the world's leading uranium producers'.

### A change in direction for the Australian nuclear energy industry

Baxter retired as chairman of the AAEC in April 1972 and was succeeded as full-time chairman by Robert Boswell. Boswell had held several senior positions in government and had been an AAEC Commissioner from 1965 to 1968. On becoming chairman he initiated a major review of AAEC's organisation. Just eight months after his appointment there was a change in government with Gough Whitlam becoming the new Prime Minister. The Department of National Development was abolished and Reginald ('Rex') Connor as Minister for Fuels and Energy became responsible for the AAEC. Secretary of the Department of Minerals and Energy Sir Lennox Hewitt became an AAEC Commissioner early in 1973.

Connor was convinced that Australia's natural resources were the key to future greatness. He forecast in 1974 that the value of Australia's uranium reserves, if enrichment were carried out in Australia, would be 'worth very close to thirty billion dollars... the biggest deal in Australia's



*'Rex' Connor*

history'. In 1974 world uranium prices, which had been around \$6 per pound of uranium oxide for several years until 1973, were rising and had reached \$15 by the end of 1974.

On coming to office Connor had refused to approve further export contracts for uranium and was progressively relinquishing exploration licences in the Northern Territory while he considered a new uranium policy. He announced the new policy in October 1974. The AAEC, as agent for the government, would participate in mining and treatment of uranium located in the Northern Territory (where the largest resources had been discovered) and would undertake all new exploration in the Territory. A treatment plant, financed by the AAEC and the Ranger participants, would be established to treat the ore from Ranger, a large deposit surrounded by Kakadu National Park discovered in 1969. Its output would be used to meet existing contracts for sale of Australian uranium and the remainder would be sold by the AAEC. The government would be the sole marketing authority for Australian uranium and the AAEC the government's agent in mining, treatment and sales. All future uranium exploration would be undertaken by the AAEC. With world uranium prices now in an upward trend, the government began a strong marketing campaign.

The 1974 policy announcement caught the AAEC and the mining companies by surprise. There was a degree of urgency as the Japanese Prime Minister was scheduled to visit Australia shortly and was looking for assurance that the existing contracts for supply of uranium to Japan would be honoured. The government had in mind that if necessary the stockpile of uranium at Lucas Heights would be used to fulfil the contracts.

In July 1975 the government established the Ranger Uranium Environmental Inquiry under Commissioner Justice Fox. Mining of the deposit would be delayed pending consideration of the outcome of the inquiry.

Following the declaration of policy, Whitlam and his Ministers engaged in efforts to sell Australian uranium to various countries including Japan, France and Iran. It was prepared for the time being to sell uranium as oxide (yellowcake) but Connor indicated his intention that eventually Australia would sell only enriched uranium. His efforts to raise funds in the Middle East to finance an enrichment plant and other Projects came to grief and shortly afterwards the Labor government was dismissed by the Governor-General.

Whitlam and his Ministers had shown little interest in the early introduction of nuclear energy for electricity production in Australia, and were opposed to Australia acquiring nuclear weapons. Some Labor members had serious concerns about testing of weapons, particularly the French atmospheric tests of nuclear devices in the Pacific area, and about acqui-

sition of nuclear weapons by countries such as India, which exploded a nuclear device in 1974.

### Australian nuclear energy policy under the Fraser government

In the 1975 election that immediately followed the dismissal of the Whitlam government, Malcolm Fraser became Prime Minister and Doug Anthony the Deputy in a Liberal-Country coalition government. Fraser announced that his government would make no decisions that would pre-empt the recommendations of the Fox Inquiry. The first Fox Inquiry report, in October 1976, recommended that if properly regulated and controlled neither the hazards of mining and milling of uranium nor the hazards involved in the ordinary operation of nuclear reactors justified a decision not to mine and sell Australian uranium. However he recommended that ‘policy respecting uranium exports, for the time being at least, should be based on a full recognition of the hazards, dangers and problems . . . of the production of nuclear energy’, and that the government ‘should therefore seek to limit or restrict expansion of that production’.

Within two weeks Fraser announced that Australia would continue to honour existing contracts for the export of 9,000 tons of uranium from Mary Kathleen. Ranger and Queensland Mines would be able to meet their contracts from the government’s stockpile. The government would develop a policy on new contracts while Fox worked on his second report. In May 1977, when the second report of the Fox Inquiry was released, Fraser announced that Australia would export only to countries that accepted the safeguards and inspections of the International Atomic Energy Agency through either the NPT or some bilateral arrangement. Those countries could not in turn re-export to third countries without Australia’s consent at the time of sale. They would have to agree not to enrich Australian sourced uranium beyond 20 per cent or reprocess spent fuel without Australia’s prior consent. Justice Fox agreed to become Fraser’s Ambassador-at-Large for Non-Proliferation.

In August 1977 Fraser announced that Australia would enter into new contracts for sale of uranium. The mining companies and AAEC began formal negotiations for development of Ranger and Nabarlek deposits in the Northern Territory. The government issued mining leases for Ranger and Nabarlek in 1979. In 1980 the government approved the development by Western Mining Corporation of the Yeelirrie deposit in Western Australia. Difficulties in negotiating sales contracts in a falling uranium market led to the government weakening some of its requirements for safeguards and for 100 per cent Australian ownership. In 1975 Western Mining had discovered at Olympic Dam in South Australia a huge deposit of copper, gold and uranium. Its economic development depended on sale of the uranium. By the time the Fraser government was defeated by Labor in the 1982 election the Ranger mine was in full production; Nabarlek had been mined out and the stockpile of ore was being processed; Mary Kathleen was being rehabilitated following closure in 1982. Yeelirrie was expected to go ahead and development of potentially commercial deposits at Jabiluka and Koongarra, both in the Northern Territory was on hold.

### Changes under the Hawke Labor government elected in 1983

The 1983 election was won by Labor and Bob Hawke became Prime Minister. The party’s uranium policy had changed markedly since it was last in government in 1975. In 1977 South Australian Premier Don Dunstan had moved successfully at the ALP national conference that an ALP government would ban uranium mining and exporting until the party was satisfied that the problems of waste disposal and weapons proliferation had been solved. A Labor government would repudiate any contracts which the Liberal-Country Party might sign in the meantime. Before the 1980 election, at which the Fraser government was re-elected, Labor leader Bill Hayden had reaffirmed the party’s policy but expressed optimism that the problems with uranium were ‘technical’ and would soon be overcome by a Labor government. In 1982 the party conference excluded Olympic Dam from its ban on new mines.



*Ranger mine site*

The Hawke government adopted a ‘three mines’ policy under which Olympic Dam was allowed to proceed and the Ranger and Nabarlek projects were permitted to seek new contracts. The government, in line with the Labor party policy opposing Australian nuclear power and enrichment plants, instructed AAEC to wind down its work on enrichment, but to continue work on Synroc, a technology for treating nuclear waste to render it safe for burial. In 1986 the government legislated to replace the AAEC with the Australian Nuclear Science and Technology Organisation (ANSTO), whose principal activities were to be research and development on the use of isotopes in science, medicine and industry, and maintaining a national centre of competence in nuclear science and technology.

### The AAEC after Jervis Bay

With the cancellation of the Jervis Bay project, the AAEC shifted its research and development emphasis from nuclear power reactors to uranium enrichment. This coincided with the discovery of substantial new uranium deposits in Australia and a growing international demand for uranium. It seemed logical that Australia should develop the capability to add value to its future uranium exports by carrying out enrichment in Australia. In 1970 an AAEC delegation visited potential purchasers of enriched uranium in Japan and Europe and received a warm response. France and America were interested in the idea of licensing their enrichment technology off-shore. From 1972 the AAEC undertook joint studies of uranium enrichment with France, USA and Japan and also with a UK–German–Dutch consortium CENTEC-URENCO, that was developing capabilities for centrifuge enrichment in the UK and Holland. At the same time the AAEC stepped up its own work on centrifuge enrichment, with encouraging results. When the Whitlam government was elected in 1972, its Minister for Minerals and Energy Connor strongly supported these AAEC initiatives. The Fraser government, elected in 1975, continued to support the AAEC work on uranium enrichment including the continuation of centrifuge enrichment research at Lucas Heights.

Early in 1980 four major Australian companies, BHP, CSR, Peko-Wallsend and Western Mining, formed a joint venture, the Uranium Enrichment Group of Australia (UEGA) to assess the viability of a commercial enrichment industry in Australia. This led to a full feasibility study, funded by the participants, and with technical assistance from the AAEC. It selected the CENTEC-URENCO centrifuge enrichment technology that was incorporated in enrichment plants in UK and Holland as the best available and concluded that the best arrangement would be for Australia to become a fourth member of CENTEC-URENCO, along with the existing members, UK, Germany and the Netherlands. The preferred site for an Australian enrichment plant was at Caboolture in Queensland. In 1983 a start was made on entering into the necessary agreements and contracts, which necessarily involved the companies and the governments as parties. The process halted abruptly in 1983 when the newly elected Hawke government announced that it would not be entering into any government to government agreement related to uranium enrichment. At the same time the AAEC wound down its work on centrifuge enrichment.

Keith Alder retired from the AAEC in January 1982 and was succeeded as its CEO by Dr. D.G. (Terry) Walker, a long term senior research scientist with the AAEC. With the winding down of work on centrifuge enrichment, the research and development activities of the AAEC were



*Opal reactor at Lucas Heights*

limited to work on applications of isotopes, work on Synroc, and various small physics and materials research projects making use of the AAEC facilities such as the reactor HIFAR. By this time the AAEC was sharing the Lucas Heights research establishment with CSIRO.

### ANSTO replaces the AAEC

In 1987 the AAEC was replaced by a new Commonwealth government organisation, the Australian Nuclear Science and Technology Organisation (ANSTO), which took over most of the existing facilities, projects and programs of the AAEC. Terry Walker, CEO of the AAEC, was appointed as Executive Director of ANSTO. In general ANSTO was to be a national centre of competence in nuclear science and technology. The original nuclear reactor at Lucas Heights, HIFAR, was shut down permanently in 2007 and replaced by the reactor OPAL, which is designed for research and for making radioactive isotopes.

A Liberal/National Party Coalition government came to power under John Howard in the election of 1996, replacing the Keating Labor government. The new government indicated an interest in nuclear power in Australia as a response to the growing concern about global warming. Almost at the end of its term, in 2006, the Howard government commissioned the Switkowski report, an investigation into the merits of nuclear power in Australia. The report concluded that it is likely to be between 20 and 50 per cent more costly to produce than power from a new coal-fired plant at current fossil fuel prices in Australia. This gap may close in the decades ahead, but nuclear power, and renewable energy sources, are only likely to become competitive in Australia in a system where the costs of greenhouse gas emissions are explicitly recognised. In 2007 the government appointed Switkowski chairman of ANSTO. The Labor governments elected in 2007 and 2010 under Prime Ministers Kevin Rudd and Julia Gillard maintained the party's opposition to nuclear power in Australia.

The Coalition government under Prime Minister Tony Abbott elected in 2013 has reopened discussion of nuclear power, without making commitments or announcing a formal policy. The South Australian Premier Jay Weatherill established a Royal Commission in February 2015 to investigate South Australia's future role in the nuclear fuel cycle. It is due to report in 2016. A White Paper on energy released by the Commonwealth government in April 2015 recommends that the government 'consider the outcomes of the South Australian Royal Commission into its future involvement in the nuclear fuel cycle including the mining, enrichment, energy and storage phases for the peaceful use of nuclear energy' and that it 'will allow for a considered and informed community discussion on nuclear industries and energy, examining the opportunities and the risks'.

### Recent history

In 2014 Australian uranium production was 5,897 tonnes of U<sub>3</sub>O<sub>8</sub>, making it the world's third largest producer, behind Kazakhstan and Canada. Australian uranium reserves are currently the world's largest, 31 per cent of the world total. Most of the Australian current production of uranium comes from underground mining at Olympic Dam in South Australia, the largest known uranium ore body in the world. There are no current plans

to enrich uranium in Australia, or to generate electricity from nuclear energy. Australian uranium production is currently well below the peak levels reached during 2008 and 2009 which exceeded 10,000 tonnes per year of U<sub>3</sub>O<sub>8</sub>. Current prices barely cover costs. However most forecasts are for a steady growth in world nuclear power production until at least 2050 with a corresponding increase in demand for uranium, much of which is likely to be mined in Australia.

### Conclusion



*Olympic Dam mine and processing site*

Nuclear energy became a subject of major concern to Australian governments from the end of World War II, centred around nuclear weapons, uranium resources and the prospect of low cost energy for industry. Over time the relative importance and urgency of each of these issues has changed, and a new issue, global warming, is becoming increasingly significant worldwide and for Australia. Nuclear energy could make an important contribution to reducing Australia's emissions of greenhouse gases.

As historian Ann Moyal concludes in her paper listed in the sources for this article, the story of nuclear energy in Australia poses important questions for government on managing of science and technology development. She sees the history of AAEC as a case study in the problems and dangers of closed government and undue influence of one powerful administrator, Philip Baxter. Keith Alder, in his book also listed in the sources, approaches the same problems from a different perspective. Alder's central claim is that the AAEC tried to 'bring Australia into the nuclear age' but was frustrated by politicians. But he provides no convincing evidence that building the SGHW power plant at Jervis Bay, or the establishment of a uranium enrichment capability in Australia along the lines recommended by the AAEC would have had good outcomes for Australia. Alice Cawte in her book *Atomic Australia* provides further evidence of the problems. Now, with the benefit of hindsight, there is a good opportunity for further historical research that would provide some valuable guidance on the management of major scientific and industrial development in Australia.

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