



Nuclear-based science benefiting all Australians

Submission to the House Standing Committee on Employment, Education and Training: Inquiry into innovation and creativity: workforce for the new economy

Table of Contents

1. About ANSTO.....	2
2. Scope of the Submission	2
3. Term of Reference 1: The extent to which students are graduating with the skills needed for the jobs of today and the future.	3
4. Term of Reference 3: Factors that discourage closer partnerships between industry; in particular small and medium enterprises, the research sector and education providers; including but not limited to: intellectual property; technology transfer; doctoral training practices; and rapid commercialisation.	6
5. Term of Reference 4: Opportunities for generating increased economic activity, including further investment and jobs, through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry; including but not limited to: co-location, cluster formation and development of precincts between universities and industry.....	9
6. Term of Reference 5: Relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators.	10

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1. About ANSTO

The Australian Nuclear Science and Technology Organisation (ANSTO) is Australia's national nuclear research and development organisation, and the centre of Australian nuclear expertise. ANSTO operates a large proportion of Australia's landmark research infrastructure, including the OPAL multipurpose research reactor, the Australian Synchrotron, the Australian Centre for Neutron Scattering and the Centre for Accelerator Science. This infrastructure places Australia at the forefront of research and innovation for the benefit of public health, industry and the environment, and is used by universities, researchers and industry from around Australia and internationally.

ANSTO's research infrastructure and unique expertise is a critical part of Australia's economic, education and skills base – enabling knowledge production and technological breakthroughs; solving problems for industry; maintaining a highly skilled Science, Technology, Engineering and Maths (STEM) workforce; and sustaining Australia's business and research competitiveness and global relevance.

The Australian Centre for Neutron Scattering, the Australian Synchrotron and the Centre for Accelerator Science attracted approximately 6,000 Australian and international researchers from universities, other research institutions and industry in 2015/16, and supported more than 1,500 experiments in that year.

Australian industries benefiting from the capabilities include SMEs and multinationals in major economic sectors, including mining, manufacturing, agriculture and healthcare. These businesses are seeking insights that only ANSTO's infrastructure and nuclear expertise can provide. From enhancing water monitoring equipment, optimising minerals exploration, creating new pharmaceuticals and improving aircraft safety to increasing food nutrition, the combination of landmark infrastructure and nuclear expertise is providing solutions for Australian industry.

2. Scope of the Submission

ANSTO utilises its multidisciplinary landmark and national research infrastructure, in addition to its status as a leading science agency, to deliver a number of programs to prepare tertiary students and recent graduates for dynamic careers in STEM, whether it be in industry or research. By delivering high-quality research opportunities, access to world class research infrastructure and on-the-job training, ANSTO is addressing some of the major challenges outlined in the 2015 Review of Australia's Research and Training System by ACOLA¹ and is committed to ensuring that alumni of these programs are workforce ready.

However, ANSTO is cognisant of a number of pervasive barriers to developing close links between the tertiary education, research, and industry sectors, and has a number of initiatives in place to address these, which will be discussed in this paper.

¹ Australian Council of Learned Academies, *Review of Australia's Research Training System*, March 2016 (<http://www.acola.org.au/PDF/SAF13/SAF13%20RTS%20report.pdf>)

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ANSTO is well placed to comment upon the following terms of reference:

- The extent to which students are graduating with the skills needed for the jobs of today and of the future;
- Factors that discourage closer partnerships between industry; in particular small and medium enterprises, the research sector and education providers; including but not limited to: intellectual property; technology transfer; doctoral training practices; and rapid commercialisation;
- Opportunities for generating increased economic activity, including further investment and jobs, through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry; including but not limited to: co-location, cluster formation and development of precincts between universities and industry; and
- Relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators.

3. Term of Reference 1: The extent to which students are graduating with the skills needed for the jobs of today and the future.

While there has been a decline in the number of students studying STEM-related courses, over the coming years, 'employment is predicted to increase in professional, scientific and technical services by 14 per cent'². The chasm between the uptake of STEM education and future market demand for STEM-qualified professionals is something ANSTO has been working hard to address through the provision of formal and informal training and education for students at all stages of their schooling, from primary school through to post-doctoral research fellowships.

A skilled science and technology workforce for the future is largely dependent on young people choosing STEM-related subjects at school. Therefore, ANSTO partners with schools and like-minded organisations to create conditions where young people will be attracted to STEM education in greater numbers. ANSTO has a comprehensive education and outreach program, connecting with thousands of high school and primary school students and teachers each year. Activities include tours of the facilities, school excursions, teacher training, virtual tour programs and a range of educational events.

In the Australian innovation system, universities have traditionally had the primary responsibility for the development of human capital for Australia's research sector, attracting and preparing Australia's future STEM-literate workforce. However, in recent decades, student-led demand for nuclear-related education in Australia has been limited, and universities have responded by reducing or discontinuing nuclear-related courses. As

² Education Council, *National STEM School Education Strategy, 2016-2026*, December 2015 (www.educationcouncil.edu.au), p. 4

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such, ANSTO has been a primary source of training and development for nuclear expertise in Australia.

ANSTO's ability to generate benefit for Australia, including the production of life-saving nuclear medicine and world class research outcomes, is founded on qualified people. Scientists, engineers, technicians and professional services staff who understand and contribute to the scientific platforms and core competencies of the organisation are essential. To rectify the deficit of nuclear education from university curriculums, ANSTO has partnered (through the provision of course content and expert lecturers) with the University of New South Wales to deliver a Masters-level nuclear engineering course. Graduates go on to share new knowledge, ideas, skills and expertise in what is a growing industry in our region, not just with ANSTO, but right across the Australian industry and research sectors.

Given ANSTO's unique mandate in the Australian research setting, it has a particular interest in ensuring Australians are graduating with the right qualifications and skills to ensure that it can continue to deliver the benefits of nuclear science and technology into the future. ANSTO recognises the need for students to gain applied skills throughout their studies and acknowledges the chasm that often exists between academic teaching and the realities of the workplace, particularly in the STEM field. The ongoing exchange of ideas and personnel between the PFRAs, universities and industry is essential for maintaining a skilled and innovative workforce.

ANSTO's employment of new graduates, PhD students, and post-doctoral students provides renewed links, ensuring that industry, ANSTO and universities continue to share and collaborate. Highly skilled graduates in STEM can contribute new knowledge and ideas, advanced research skills, an understanding of recent research and the ability to generate new approaches to existing problems. ANSTO's graduate program continues to provide the organisation with a cohort of highly skilled and adaptable graduates who will contribute to the success of the organisation well into the future.

The most significant upcoming development for ANSTO in this area is the proposed ANSTO Graduate Institute, which will sit within a larger Innovation Precinct and technology park. ANSTO is reviewing its model for engagement with universities, and intends to shift from an infrastructure provider model to a more collaborative research model, with an increased number of PhD students and post-doctoral fellows situated mainly at ANSTO. Such a shift will leave ANSTO better placed to support excellent science and develop the next generation of leading researchers across a wide variety of scientific disciplines.

In close partnership with key universities, ANSTO intends to establish a structured training and education program aimed at developing scientific knowledge, management techniques and an innovative mindset. This approach will include partnering with innovative industry.

Currently, at any one point in time there are around 120 postgraduate researchers from more than 30 universities conducting research at ANSTO. It is anticipated that the Graduate Institute will establish a more formal program, with potentially up to 400 graduate and postgraduate students undertaking research studies primarily at ANSTO in Sydney and Melbourne. Further discussion of the planned ANSTO Graduate Institute is provided later in this submission.

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ANSTO further seeks to address workforce skill challenges and enhance the STEM pipeline for Australia in a number of ways as outlined below:

Program	Details
Australian Institute of Nuclear Science and Engineering (AINSE)	ANSTO is a member of AINSE, a consortium of 40 Australian and New Zealand universities, in addition to CSIRO and ANSTO. The organisation is chiefly focused upon providing quality training in nuclear science, and offers undergraduate and postgraduate awards and fellowships. AINSE has also recently begun offering membership to businesses seeking to take advantage of access to ANSTO's world class research infrastructure, opening another channel for industry-STEM engagement.
Graduate Development program	<p>Since 2008, ANSTO has offered a two-year Graduate Development Program. The 2017-18 Graduate Development Program will host 10 future leaders in science, engineering, business and policy. The graduates complete rotations across all areas of ANSTO, including nuclear science and technology, nuclear medicine production, reactor operations, minerals consulting, business development and science communication.</p> <p>The program is split between experience-based training, informal learning, and structured training and development programs. This combination maximises the applied experience gained by graduates.</p>
Internship program	ANSTO's internship program engages enthusiastic students, usually on a part-time basis. Students from a variety of universities are usually connected with ANSTO through AINSE, or directly through their home institution.
Year in Industry program	ANSTO's Year in Industry program is targeted towards students studying relevant science, engineering or information technology degrees, who have at least one year remaining in their studies. The program gives students the opportunity to apply the theory and practice of their chosen field in the reality of the workplace, and gain an understanding of the work ethic, especially related to quality and safety, required for success in high tech industry. Students can also use this experience to enhance the value of their remaining study.

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Program	Details
Young Researchers Club	The ANSTO Young Researchers Club is an initiative that aims to provide support for young researchers (post-doctoral fellows and PhD, masters, year-in-industry, and honours students) at ANSTO, including ANSTO's Graduate Development Program participants. The Club was initiated in 2009 to enable pathways for young researchers across ANSTO to connect and develop networks that will support them through their careers. The Club fosters career development by creating new opportunities and encouraging professional relationships and training, for example in science communications. Formal and informal talks, workshops and meetings are offered to connect early career researchers and students within ANSTO and with external organisations. This enables them to learn more about the research and innovation undertaken in ANSTO's various research units, as well as at partner organisations, and to exchange experiences with their counterparts.
Teachers Professional Training	ANSTO is an endorsed provider with BOSTES for Standards 2 and 3 of the Australian Professional Standards for Teachers at the level of Proficient Teacher. Teachers can accrue BOSTES-registered professional development hours for many of our professional development programs.

4. Term of Reference 3: Factors that discourage closer partnerships between industry; in particular small and medium enterprises, the research sector and education providers; including but not limited to: intellectual property; technology transfer; doctoral training practices; and rapid commercialisation.

Scientific research and innovation, and its interconnectivity with industry is fundamental to the economic and social prosperity of Australia. The combination of ANSTO's unique infrastructure and nuclear expertise positions ANSTO as an important player in Australia's innovation system.

In ANSTO's experience as a PFRA that straddles the divide between academia and industry, there are four factors that discourage closer collaboration between research agencies, universities and industry:

- a. Geographical barriers
- b. Traditional academic models
- c. The grant system
- d. Long-term funding of research infrastructure

a. Geographical barriers:

The co-location of research and innovation facilities and high tech industry encourages a collaborative approach to conducting research and business. In places where industry and research sectors are separated geographically, collaboration does not occur so readily.

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ANSTO's Australian Synchrotron, located adjacent to Monash University in Clayton, Victoria, is testament to the value of co-locating tertiary institutes and research facilities. Around 42.6 per cent of registered users in Victoria, and around 17.5 per cent of users Australia-wide, are from Monash University. As a result, the University has been able to conduct important research across 19 schools and departments, which has led to 570 publications in 194 scientific journals in the past four years alone. Leveraging the demonstrated success of co-location, the Victorian Planning Authority has launched the Monash National Employment Cluster, with a view to growing jobs and investment in the Monash area. ANSTO, CSIRO and Monash University are all members of the associated taskforce, which has discussed the possibility of an innovation hub.

Of the 27 OECD countries where data is available, Australia is ranked last for the percentage of innovation-active SMEs and large businesses collaborating with universities or other research institutions³. The Australian industry and research sectors do not typically operate on shared campuses or in designated precincts, and this geographic disconnect is contributing to Australia's poor ranking.

To address this, ANSTO is developing a proposal for an Innovation Precinct, which will co-locate industry participants with ANSTO's research facilities and infrastructure, as well as universities through the proposed ANSTO Graduate Institute.

In order to move forward with the proposal for an ANSTO Innovation Precinct, changes to the Australian Nuclear Science and Technology Organisation Act 1987 (ANSTO Act) will be required. A similar legislative barrier may also be faced by other PFRA's seeking to overcome geographic barriers in similar ways.

b. Traditional academic models:

The traditional academic model sees many strong students complete their doctoral and post-doctoral studies, then be retained as university researchers rather than expand into careers in industry. ANSTO is attempting to disrupt this cycle by hosting and supervising doctoral research; at any given time around 45 PhD students from a variety of universities are supervised by ANSTO staff. ANSTO is seeking to increase its capacity in this regard through the proposed ANSTO Graduate Institute.

c. The grant system:

Another mechanism by which ANSTO collaborates with industry is through the Australian Research Council (ARC) Linkage Grant Scheme. However, as a PFRA, ANSTO is not eligible to directly apply for linkage grants from the ARC (or the National Health and Medical Research Council). If the eligibility rules were amended to allow PFRA's to apply for linkage grants, ANSTO could better support industry, and take on the role of an administering organisation.

The Scheme, as currently constructed, requires an industry participant to partner with a university for a project in order to be eligible for a grant. In cases where the industry

³ Department of Industry Innovation and Science, *Australian Innovation System Report 2015*, November 2015, p. 115, (www.industry.gov.au/Innovationreport)

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participant then uses its partnership with a university to access landmark research infrastructure operated by a PFRA like ANSTO, the university partner often acts as a superfluous broker. The rationale for excluding the PFRA from Linkage Grants has been that PFRA already receive government funding. However, given that the bulk of university research activities are also already funded by government through block grants, it is clear that this principle is not consistently applied.

ANSTO suggests a review of the eligibility rules for the Linkage Grant Scheme could result in increased opportunities for PFRA to engage with industry. This is especially the case in instances where PFRA are the custodians and operators of landmark research infrastructure, which can deliver great benefits to industry.

ANSTO's research and commercial expertise can play an important translational research role and assist in enhancing innovation and technological progress for new products as they traverse the 'valley of death' that often exists between research and commercialisation.

ANSTO recommends that the ARC Linkage Grant Scheme be amended to provide support for direct interaction between PFRA and industry; eligibility should be based on merit and suitability.

d. Long-term funding of research infrastructure:

Industry will be attracted to and derive the most benefit from collaboration with PFRA if Australian research capabilities remain world class through strategic planning, including predictable funding over the long term. Through both capital expansion and securing predictable ongoing operating funding, Australia can achieve maximum return for investment from its existing research infrastructure and be better placed to invest in new research infrastructure as needed.

In this regard, ANSTO welcomes the development of the National Research Infrastructure Roadmap and the funding of \$520 million over 10 years for the continued operation of the Australian Synchrotron. ANSTO is also encouraged by the continuation of funding for the National Collaborative Research Infrastructure Strategy (NCRIS) announced in the National Innovation and Science Agenda (NISA). At ANSTO, the Centre for Accelerator Science, the National Deuteration Facility, three neutron beam instruments at the Australian Centre for Neutron Scattering, and the National Imaging Facility Cyclotron are all supported by NCRIS. These facilities are allowing Australian and international researchers to partner with industry to address the world's most pressing issues, including energy and resource security, population health, environmental sustainability and economic productivity. The allocation of future NCRIS funding has not yet been announced.

ANSTO recommends that ongoing and predictable funding of landmark and national research infrastructure, including the Centre for Accelerator Science, the National Deuteration Facility, the National Imaging Facility Cyclotron and the Australian Centre for Neutron Scattering, remain a priority.

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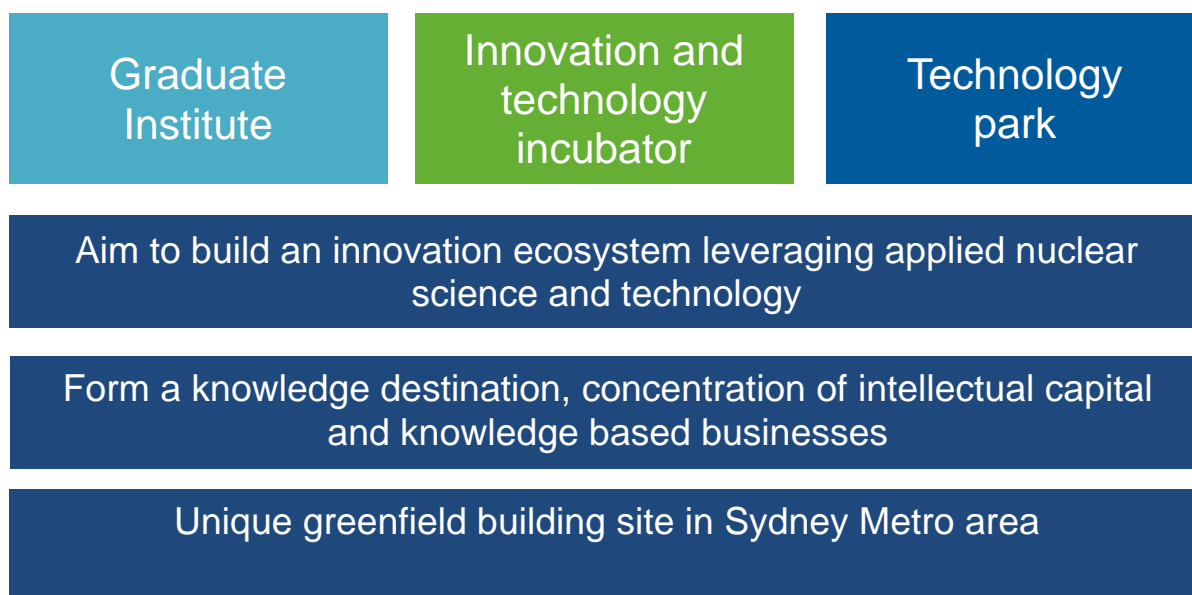
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- 5. Term of Reference 4: Opportunities for generating increased economic activity, including further investment and jobs, through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry; including but not limited to: co-location, cluster formation and development of precincts between universities and industry.**

ANSTO's commitment to developing highly-skilled, industry-ready graduates and early career researchers is evidenced by its current investment in training and development. However, ANSTO recognises it is capable of making a greater contribution to the training of early career professionals, and furthermore improve the culture and framework of the training provided in Australia to better align with the needs of industry.

As outlined in the ANSTO 2016-2020 Corporate Plan⁴, ANSTO is developing a proposal for an Innovation Precinct at its main campus in Southern Sydney. This Precinct will bring together scientific partners, subject matter experts, high-tech businesses, industry, and graduates, and utilise ANSTO's unique capabilities and research infrastructure to create an innovation ecosystem. The Precinct will remove barriers to mobility for researchers between the PFRAs, universities and industry, boosting researcher, university and other research organisation engagement with industry.

Consultations have been held with stakeholders from higher education and industry sectors during 2016, and ANSTO intends to increase these activities and formalise planning throughout 2017.



The Graduate Institute aims to establish a more formal program with approximately 300-400 graduate and postgraduate students undertaking research studies at ANSTO's Sydney and Melbourne campuses. Under the proposal, students would be enrolled at universities, with supervision and access to infrastructure provided at ANSTO. In establishing such a

⁴ <http://www.ansto.gov.au/Resources/Publications/CorporatePlan/index.htm>

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program, ANSTO aims to act as a conduit between the academic and industry sectors, providing students with first-hand experiences as working scientists.

ANSTO recommends that Australian PFRAs and universities should be encouraged and supported in the establishment of innovation precincts.

6. Term of Reference 5: Relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators.

ANSTO recognises that dedicated programs supporting technology entrepreneurship, including incubating and accelerating start-up companies and SMEs, can have a positive impact on the technology transfer and commercialisation profile of an economy's research sector. The proposed ANSTO Innovation Precinct includes Australia's first dedicated innovation and technology incubator, which will make a sizeable contribution to the country's innovation system.

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