ANSTO Submission

Inquiry into the Australian Manufacturing Industry

September 2021

Introduction

As the custodian of Australia's nuclear science, technology, and engineering capabilities, the Australian Nuclear Science and Technology Organisation (ANSTO) is pleased to make this submission to the Senate Standing Committee on Economics' inquiry into the Australian Manufacturing Industry.

ANSTO operates a large proportion of Australia's key research infrastructure, including the OPAL multipurpose reactor, the Australian Synchrotron, the Australian Centre for Neutron Scattering, the Centre for Accelerator Science, and the National Deuteration Facility. This infrastructure places Australia at the forefront of research and innovation for the benefit of public health, industry (including many manufacturers), and the environment, and is used by researchers and industry from around Australia and internationally. We undertake research and development of next-generation nuclear medicines, in addition to manufacturing nuclear medicines that are currently used in the diagnosis and treatment of many medical conditions.

ANSTO, therefore, is well placed to make a submission to this inquiry, which focuses on ANSTO's products and services and covers the following broad themes as they relate to the inquiry's Terms of Reference:

1. The Australian manufacturing industry's role and the drivers of growth;
2. The strengths of the Australian manufacturing industry and national advantages;
3. Required manufacturing capabilities;
4. Establishing the Australian manufacturing Industry as a global leader; and
5. Energy sources to support manufacturing.

1. Australian Manufacturing Industry's Role and the Drivers of Growth (Terms of Reference a, b, and c)

ANSTO has well-developed, advanced manufacturing capabilities in the fields of nuclear medicine, critical minerals, space, silicon irradiation, radiation detection, and environmental monitoring.

Nuclear Medicine

Through ANSTO, Australia is a world leader in the manufacture of diagnostic and therapeutic nuclear medicines. Nuclear medicines play an important role in the diagnosis and treatment of cancer, heart disease, and musculoskeletal conditions, among other ailments. On average, each Australian will benefit from at least two nuclear medicine procedures during their life. ANSTO is central to Australia's nuclear medicine manufacturing capabilities, meeting approximately 85 per cent of Australia's nuclear medicine needs from its facilities at Lucas Heights, Sydney. Each week, ANSTO produces and distributes an estimated 12,000 patient doses of nuclear medicine to Australian customers. Industry collaborators include approximately 250 nuclear medicine hospitals and clinics across Australia, plus export clients.

Case study – next generation nuclear medicines

Since 2018, ANSTO has partnered with the Peter MacCallum Cancer Centre on clinical trials into the use of Lutetium-177 PSMA, a radioisotope manufactured at ANSTO, for the treatment of advanced prostate cancer. Peter MacCallum recently reported on the favourable results of the Phase 2 clinical trial, which was conducted at 11 sites across Australia.

This builds on earlier results, which found that most men with metastatic prostate cancer responded to treatment with Lutetium-177 PSMA and lived a median of 13 months longer than the average nine-month survival time. Over 600 Australian patients have benefited

from ANSTO's manufacture of Lutetium-177 radiopharmaceuticals through clinical trials.

Critical Minerals and Resources Technology

ANSTO is providing crucial input and support to the Critical Minerals Facilitation Office within the Department of Industry, Science Energy and Resources (DISER) on work to advance Australia's Critical Minerals Strategy.

ANSTO provides consulting and process development services to the minerals industry, both in Australia and globally, conducting long-term research and development in partnership with Australian mining companies. This helps companies to extract critical minerals, uranium, rare earths, lithium, and other essential metals and minerals in an efficient and environmentally sustainable manner.

Case study – carbon capture for mining

A novel process designed by an ANSTO researcher has the capacity to capture carbon dioxide from mining operations for environmental benefit. The process uses existing low-cost and low-energy technologies to reuse stockpiled waste from mining operations and capture carbon dioxide in the form of valuable carbonate minerals. Mineral waste is reused, acid is neutralised, and carbon dioxide is captured. This process also has the potential to recover valuable minerals, such as nickel and cobalt, for further processing and manufacture, and, therefore, for economic benefit. The process is currently being tested in diamond mines in Africa and Canada.

Space Testing and Research

ANSTO operates a large proportion of Australia's high-intensity radiation facilities, which are vital to the Australian space industry. Specifically, ANSTO supports Australian manufacturers looking to join international space industry supply chains by providing radiation testing of space-bound electronic components and systems to de-risk longer-term space missions for civilian and defence programs.

In addition, ANSTO's unique portfolio of synchrotron light, neutron scattering, and ion beam facilities provide industry partners with valuable insights that accelerate the development of new materials (such as printed metal alloys, ceramics, polymers, and composites), which are required for the manufacture of satellites and space vehicles.

Case study – Airbus Australia Pacific

ANSTO has recently collaborated with Airbus Pacific and Airbus experts based in Europe to address critical challenges in the Australian space industry. Specifically, radiation encountered in longer-term Earth orbits and beyond becomes a major risk to successful missions and testing of satellite electronic components and systems. ANSTO continues to work with Airbus to understand what critical radiation testing facilities will be needed in the space industry.

Silicon Irradiation – Neutron Transmutation Doped (NTD) Silicon

NTD silicon is used for special applications in high-powered electronics. Through a process in which silicon ingots are irradiated in the OPAL multipurpose reactor, they become semi-conducting and are then manufactured by customers into components that are used in applications including high-voltage products for greener power grids, high-speed rail systems, industrial automation, and the international electric vehicle and hybrid-electric vehicle automotive industries. ANSTO controls over 50 per cent of the global market share for NTD silicon.

CORIS360

Since 2013, ANSTO has been working to develop a novel gamma radiation imaging technology. The resultant product, known as CORIS360™, was launched for commercial sale in late 2020 and is the most advanced radiation imaging solution on the global market.

CORIS360™ is a highly specialised camera that visually displays 'hot spots' of gamma-emitting isotopes and provides accurate, real-time information on detected radiation levels. The device, which is manufactured in Australia, has utility across a wide range of industries, including defence and border security, mining and minerals, the health sector, and the wider nuclear industry globally.

Multi-wavelength Absorption Black Carbon (MABI) Instrument

The MABI instrument, a technology designed and built at ANSTO to measure the concentration of carbon in the atmosphere and to determine its source, is now commercially available. The modular desktop technology can be used to distinguish black carbon particles from two primary sources: diesel vehicles and biomass burning, such as bushfires or crop burning regimes. This information can provide environmental managers and researchers with valuable information about the source of air pollution and can guide manufacturers in the development of cleaner fuel sources.

2. The Strengths of the Australian Manufacturing Industry and National Advantages (Terms of Reference d and e)

ANSTO contributes to the Australian Manufacturing industry through innovation in additive manufacturing and nuclear component manufacturing, which strengthen Australia's sovereign capabilities across mining, defence, space, and nuclear medicine manufacturing.

Additive Manufacturing

ANSTO has a pipeline of advanced characterisation capabilities that can support advanced manufacturers to develop their products for market. ANSTO can assess how treatment and processing conditions affect the properties and behaviour of items produced through an additive manufacturing process.

In addition, ANSTO has unique capabilities in the post-production thermal treatment of ceramic, metal/alloy, or composite materials (particularly additive manufactured parts) using Hot Isostatic Pressing (HIP). HIP is an important thermal process mandated by international standards for treatment of additive manufactured medical devices (implants), as well as for structural components in aerospace and other sectors, to ensure components meet in-service performance requirements. ANSTO operates the largest hot isostatic press in Australia, but, as additive manufacturing becomes increasingly commonplace, there will be an increased need to thermally treat a broader range of components to ensure regulatory, safety, and performance requirements are met.

A national HIP facility, capable of meeting these increased needs, would support Australia's growing manufacturing sector and would help to establish a sovereign supply chain in advanced/additive manufacturing. This would de-risk the transition and up-take for emerging advanced manufacturers seeking to additively manufacture components for Australia's developing markets in space, medical technologies, and defence. ANSTO has over 30 years' experience in HIP manufacturing and therefore would be well-placed to support the establishment of such a facility.

Nuclear Component Manufacturing

An additional focus of ANSTO is the manufacture of high-quality stainless steel canisters that contain waste by-products from the Organisation's nuclear medicine production process.

These canisters are manufactured via an automated process at ANSTO and will be processed in the Organisation's soon-to-be-completed Synroc Waste Treatment Plant, where they will be thermally treated via HIP to produce a solid, durable product for interim storage and, ultimately, for final disposal. An Australian innovation, the Synroc Waste Treatment Plant will be the first-of-its kind in the world.

3. Required Manufacturing Capabilities (Terms of Reference f)

ANSTO aims to maintain and expand its landmark infrastructure to ensure it continues to meet the needs of researchers and industry partners and to support Australia's advanced manufacturing sectors.

Decadal Plan for research infrastructure

The ANSTO Research Infrastructure Decadal Plan, which is currently being developed, will provide the Organisation with a multi-year outlook for its research facilities, informed by ANSTO's mission, research and business needs, and the needs of Australian industry, researchers, and government. The Plan will ensure that ANSTO is well-placed to respond to emerging technological developments and to deliver economic benefits for Australia and the surrounding region.

The core components of the Plan are outlined below:

INFRASTRUCTURE	UTILITY
OPAL multi-purpose reactor	The OPAL multi-purpose reactor has been operating since 2007. Its Cold Neutron Source has a limited operating life; however, a planned upgrade is scheduled to occur in 2022. These upgrades will optimally position ANSTO to reliably supply radioisotopes, undertake effective silicon irradiations, and deliver neutrons for research and industry applications, which will have utility for Australia's manufacturing industries.
Australian Synchrotron	To date, $95.6 million has been secured for capital expansion at the Australian Synchrotron (Project BR-GHT) from universities, research institutes, and government agencies across Australia and New Zealand. This project is enabling ANSTO to construct eight additional beamlines at the Australian Synchrotron over the coming years, almost doubling current research capacity. This expansion will benefit a wide range of Australian manufacturing sectors, including mining, agriculture, energy, transport, health, defence, and aerospace.
Australian Centre for Neutron Scattering (ACNS)	In financial year 2022, ANSTO will upgrade critical instrument systems and expand equipment at ACNS. Funded through the New South Wales Research Attraction and Acceleration Program, a world-first additive manufacturing capability will be established for in-situ neutron scattering measurements, while undertaking additive manufacturing repair processes. This upgrade will benefit the mineral, energy, bioengineering, aerospace, and automotive industries.
Centre for Accelerator Science (CAS)	In financial year 2022, CAS will deliver Australia's first external Megaelectron volt (MeV) ion beam for irradiation at atmospheric pressure. This will become a key national resource for

	radiobiology and manufactured space component testing.
National Deuteration Facility (NDF)	The NDF capability expansion in financial year 2022 will provide solutions to industry by evaluating the effect of deuteration on performance or material properties in industrial, medical, or environmental applications. This work is critical in providing onshore support to drug discovery and manufacturing programs in Australia.

4. Establishing the Australian Manufacturing Industry as a Global Leader (Terms of Reference f and g)

ANSTO has significant insights across supply chain management, advanced manufacturing processes and techniques, skills and training, and innovation that could be drawn on and further utilised in the development of the country's manufacturing and broader research and development policies. Examples of where ANSTO can contribute are provided below:

Attracting Investment

ANSTO's Innovation Precinct is creating a globally connected place for researchers, startups, and industries to partner to deliver inspired solutions for a more sustainable world. The Precinct, which is being established at the Organisation's Lucas Heights campus, leverages ANSTO's world-class research infrastructure and expertise to attract leading companies and entrepreneurs to stimulate economic activity.

nandin, ANSTO's deep technology incubator – a key component of the Precinct, attracts many start-ups and small-to-medium-sized enterprises. There now are nearly 30 members within *nandin* focusing on developing new solutions for health and respiratory medicine, safety systems and emergency services, air quality infrastructure design and fabrication, cybersecurity, defence and aerospace, and automated asset tracking and management. ANSTO also is partnering with Haymarket HQ to support international deep-tech startups wanting to launch in Australia through the Sydney Landing Pad program.

Supply Chain Support

Nuclear medicine products have a short half-life, which rely on just-in-time manufacturing and delivery. This creates logistical pressures, as missed transport connections can have significant impacts on patients. In extenuating circumstances, such as the COVID-19 pandemic, this places further pressure on all logistical stakeholders, leading to difficulties in product delivery. In addition, the operation of complex nuclear manufacturing facilities often requires niche parts to be sourced at short notice; in these circumstances, a robust supply chain is of the utmost importance. ANSTO's expertise in complex supply chain management can be drawn on to support other complex manufacturing industries in the country.

Skills and Training

ANSTO is a major centre of STEM skills and training. Due to the niche nature of the nuclear industry skill set, it is essential to have a development pipeline for a nuclear-capable workforce. This ensures the sustainability of manufacturing and supply, which are key requirements of ANSTO's products and services. In the context of skill and training, ANSTO liaises closely with the Australian Institute of Nuclear Science and Engineering, university partners – including the University of New South Wales, the Australian National University, and the University of Wollongong, and conducts educational outreach with primary and secondary school students. It is imperative that the Government continue its investment in

STEM education and pathways to ensure future workforce availability, particularly for Australia's growing nuclear industry.

Synroc Technology

ANSTO has developed an engineering capability for the treatment of its own radioactive waste. An Australian innovation, ANSTO Synroc® technology is a cost effective, low-risk solution for the final disposal of complex intermediate and high-level radioactive waste. This innovative waste treatment technology minimises environmental impact, reduces disposal volume, lowers life-cycle costs, and provides optimal durability. In developing this technology in-house, ANSTO has established a team of researchers and engineers who can translate research concepts into industrial scale processes that have relevance to both nuclear and other regulated industries.

5. Energy Sources (Terms of Reference h)

Growing Australia's manufacturing capabilities brings with it increased energy requirements. In this context, ANSTO's research and work with the Generation IV International Forum and our deep knowledge of functional energy materials (including hydrogen materials and production), could help to deliver the reliable, cheap, and clean energy that is needed in a low-carbon future.

Generation IV Reactors

The Generation IV International Forum (GIF) provides the platform for international cooperation on the development of advanced power reactor designs, which promise to be even safer and more environmentally sustainable than the current reactor fleet. Australia was invited to join the GIF in recognition of the unique contribution that the country can make to its work, which largely is attributable to ANSTO's nuclear and materials engineering capabilities. ANSTO's participation in the GIF is helping Australia to maintain and extend national capabilities in leading-edge manufactured nuclear technologies, such as fuel resources and systems.

Research and Development of Functional Energy Materials

There are many projects that ANSTO supports in the fields of energy generation and storage, with a focus on the development of functional energy materials. Functional materials are those that undergo function and change during application; these materials are the working heart of devices that deliver and store energy as part of energy systems.

In this regard, ANSTO has recognised world leading capabilities in the analysis of battery materials performance and rechargeable battery functions. More than 50 per cent of publications worldwide examining the real-time function of electrodes within batteries draw on data derived from experiments at ANSTO. In addition, ANSTO's neutron beamlines, microscopes, and the Australian Synchrotron are used in the study and development of fuel cells, gas separation, hydrogen, and catalyst materials.

Hydrogen Materials and Hydrogen Production Research

One of the key challenges to the hydrogen economy of the future is to generate sufficient hydrogen to satisfy demand. Currently, hydrogen largely is sourced from hydrocarbons and coal, which negates the reduction in carbon emissions gained when using hydrogen.

An alternative method of hydrogen production is to use low-carbon fuels, such as biomass and non-recyclable wastes. ANSTO is involved in a project to determine the optimum conditions to selectively produce hydrogen from biomass and waste fuels using a fluidised-bed gasification process coupled with in-situ carbon dioxide sequestration. ANSTO is using its neutron-scattering techniques to monitor the hydrogen generation reactions, which

ultimately will identify optimum conditions for large-scale, sustainable hydrogen production to support Australian manufacturing industries.

6. Further Information

For more information on ANSTO and its capabilities relevant to this inquiry, please contact:
[redacted]