South Australian Defence Industry Leadership Program 2015

Industry Diversity

Nuclear Fuel Cycle opportunities for Defence Industry

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1. Executive Summary

Industry diversity can be critical for commercial operations. How can defence industry support considerations of the current 'Nuclear Fuel Cycle Royal Commission' that will offer opportunities for relevant expertise to target this strategic industry?

The Australian Defence Industry is comprised of some of the most high tech and innovative companies in the world. These companies have established high reliability processes and culture to successfully deliver products and services to the safety-critical field of Defence. This process and culture, along with an array of transferable expertise, creates strong parallels between the Defence and Nuclear Industries.

The Nuclear Fuel Cycle offers an excellent opportunity for the diversification of the Defence Industry.

Should the Royal Commission findings result in an increased South Australian participation in the fuel cycle, Defence Industry companies and the state's economy would see a large number of direct and spill-over benefits.

First generation Australian nuclear facilities would not be an indigenous design, as the investment is too high and the risk too great. Initial opportunities for local companies would exist at Tiers 3 and 4 of the supply chain, supporting an international Tier 1 who would lead acquisition activities. Facilities have an initial life of 30-40 years, with upgrade programs extending this further, offering significant opportunity for growth in through life support.

To effectively participate in the Nuclear Industry, a number of factors must be addressed. Education and training of Engineering disciplines and other functions is key. Increased capability and rigour around particular elements of governance, certification, and testing are also very important. The high reliability companies of the Defence Industry are ideally placed to respond to these needs.

Additional opportunities exist for organisations that focus on education and communication. These organisations can assist by not only upskilling other Defence Industry companies, but also engaging and educating the public, and creating cohesive pathways with government and the Nuclear industry to ensure that technical skills and capabilities are aligned with outcomes.

We recommend that an independent leadership body is established to ensure that Defence Industry is successful in its contribution to the Nuclear Fuel Cycle. This body must have significant Industry representation, and address clarity of outcomes, preparation, guidance and education.

We further recommend that the strategy implemented by this body targets long term growth, with the intention of establishing indigenous Tier 1 and 2 capabilities.

It is important that the Royal Commission take a balanced, analytical view of the Nuclear Industry to weigh the potential opportunities against many factors, including economic feasibility. A new industry cannot be seen as a Band-Aid for a weak economy; a considered long term outlook is required. The Defence Industry should actively support these considerations, and prepare itself for the wealth of opportunities presented.

Content

2. Introduction

1. What is the Defence Industry

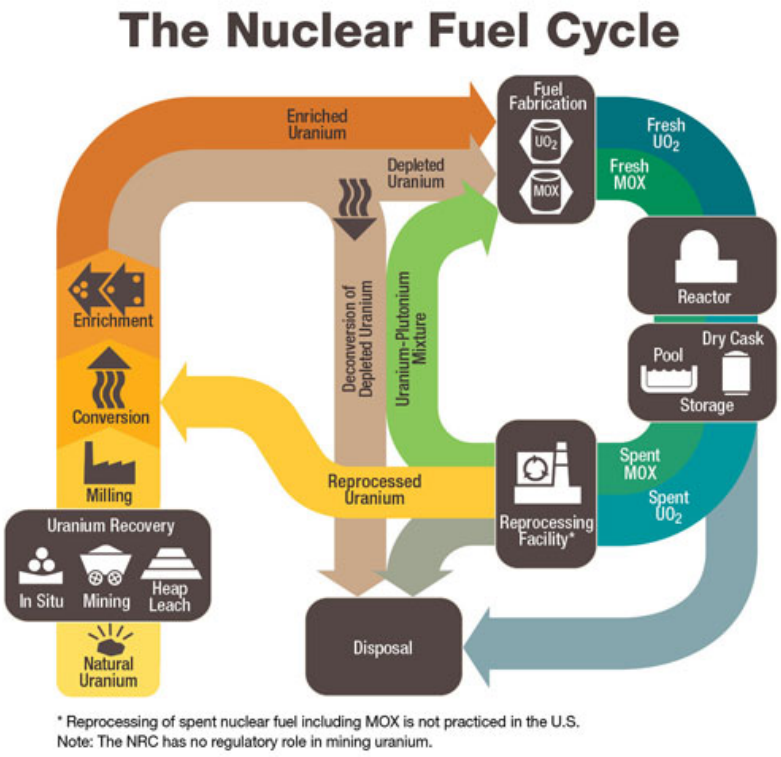
The breadth and scope of Australia's Defence Industry is not well understood because it is ill-defined. Without formal definition the Industry's capabilities and capacities cannot be fully comprehended or appreciated. It also limits the capacity to determine and measure the impact of Defence Industry on decisions related to Defence capabilities. The DTC proposes the following definition for inclusion in all future Defence policies and doctrine:

> *Australia's defence industry consists of Australian-based businesses that are actually or potentially involved in supplying military capability and/or are influenced by defence business policies or purchasing decisions.* (1)

2. The Royal Commission

A South Australian Royal Commission has been convened to investigate what, if any, participation the state should have in the Nuclear Fuel Cycle beyond its current mining activities. The Royal Commissioner, Kevin Scarce, will provide the findings of the commission to South Australian Governor by 6 May 2016. This paper explores opportunities arising from a positive finding.

3. The Nuclear Fuel Cycle



3. Mining and enrichment

Is the process of extracting/excavating the uranium for the earth and the process of separating the uranium hexafluoride for the next stage of the cycle.

4. Fuel Fabrication

Is the process of taking enriched uranium to a fuel fabrication plant where it is converted to uranium dioxide powder and pressed into small pellets. These pellets are inserted into thin tubes to form fuel rods. The rods are assembled in clusters to form fuel elements for use in the core of a nuclear reactor.

5. Reactor

The reactor uses the nuclear fuel to create nuclear chain reaction, releasing energy that can be harnessed for a number of purposes. Australia already has several small research and nuclear medicine reactors, so Royal Commission's focus is on reactors used for Electricity Generation.

6. Reactor Outputs

All sources and technologies used today to generate electrical power produce some form of waste. Whether it be carbon emissions from coal fired generating systems or the materials used in the manufacture of wind and solar technologies. Nuclear power generation is no exception. Technologies now exist to 'reprocess' the 'waste' for reuse as a reactor fuel.

7. Reprocessing of Waste

The reprocessing (recycling) cycle converts 'spent' nuclear power plant fuel (Plutonium and Uranium) into Mixed Oxide (MOX). MOX may be used in nuclear power plants to create more electricity. Reprocessed separated uranium can be used as new fuel in a commercial reactor. Plutonium may also be reprocessed

and used in 'advanced' reactors for commercial development. Nuclear material (waste) which cannot be recycled is stored in appropriate ways.

Regardless of the Royal Commission outcomes, current advanced technology dictates that a geological repository will be required for the by-products from all stages of the fuel cycle. The United States believes that a recycling facility would take 20 years from initial agreement to final construction. These long lead times require unambiguous and bi-partisan policy as the commercialisation is long term and capital intensive.

8. Disposal

The International Atomic Energy Agency (IAEA) has declared that storage is not a viable long time strategy. Unless treated, nuclear fuel remains radioactive for extremely long periods of time. South Australia is renowned as being the driest State on the driest Continent. These dry conditions and the geologically stable landform present ideal physical conditions for the co-location of a nuclear reprocessing plant and storage capability.

4. Industry Diversity

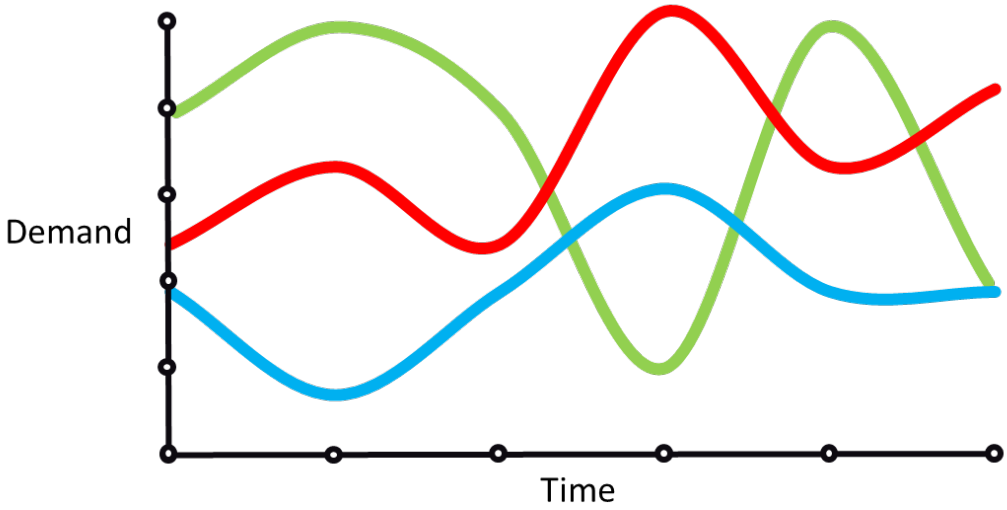


Figure 1 – Hypothetical representation of demand in various industries over time

When a company is involved in a single industry, it suffers peaks and troughs of demand. The Defence Industry, represented by the green line in Figure 1, may be especially susceptible to this as it is largely single-customer. This presents companies with the challenge of maintaining capability while also staying commercially viable. The Defence Industry has recently demonstrated it is possible to influence your customer to adopt demand levelling approaches, such as continuous ship build, but the reality of a project-based organisation is that there will always be ups and downs.

The blue line in Figure 1 represents a minor adjacent market a company might pursue as an alternative way to address this. The success of this can vary depending on the volume of work available, industry similarities, and strategic alignment. This can amount to just keeping people busy without advancing the goals of the organisation or realising the full potential of your workforce.

We believe that the nuclear industry, as depicted by the red line in Figure 1, is an excellent opportunity as there are many parallels between the Defence and nuclear industries. Facilities such as Nuclear Power Plants have an initial life of 30-40 years, and with potential upgrades and extension activities this increases to 60 or 80 years, ensuring a long term demand.

5. Industry Parallels

The two industries have several key characteristics in common:

- Safety Critical
- Big Science
- High Tech
- High Precision

Successfully operating in these environments demands high reliability organisations. Nuclear industry is a great fit for defence companies seeking to diversify, as their high-reliability process and culture would be an asset in this very similar adjacent market.

6. Nuclear Supply Chain & Industry Opportunities

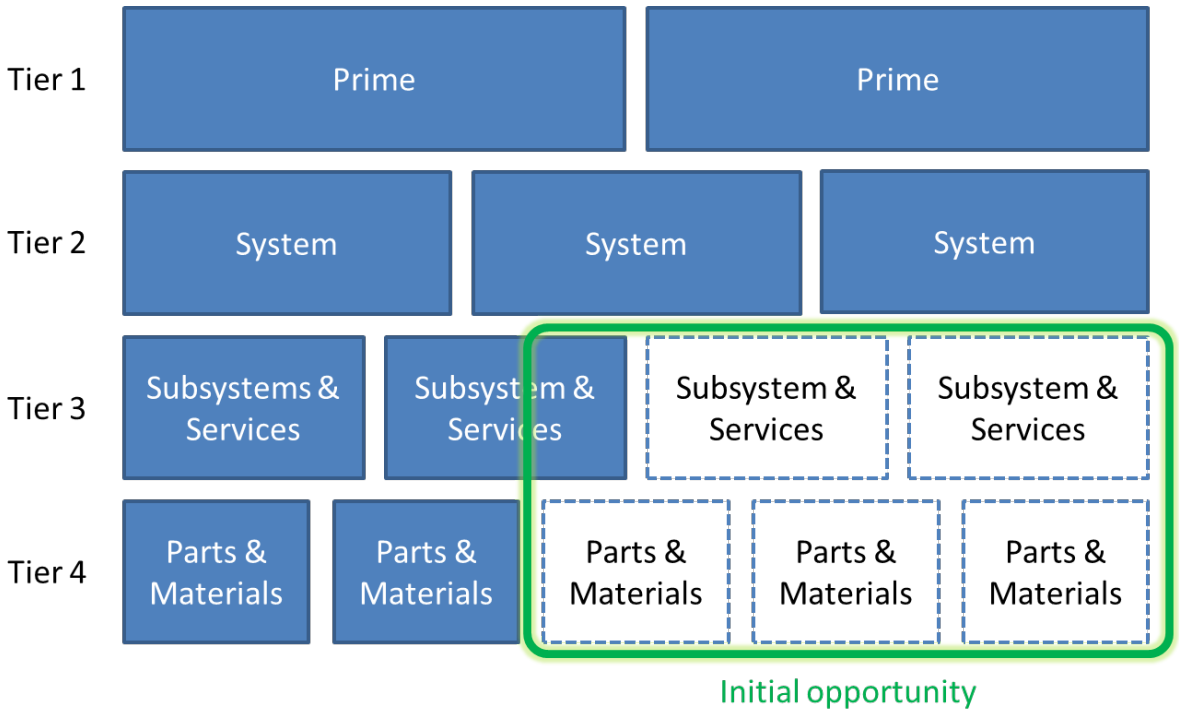


Figure 2 Industry Tiers

Design localisation, logistics, and local content requirements present the initial opportunity for established Defence Industry companies to enter the nuclear industry at Tier 3 or 4. From here, capability can be built and roles expanded; with support from an overseas prime this is achievable.

An example of this approach is BAE Systems Australia's expansion in to Oil & Gas. Starting with a Tier 4 contract, a company can demonstrate their expertise, build their reputation and expand their work share over time.

9. Nuclear Fuel Cycle Facilities

Primary opportunities are in contributions to facilities construction, operation and maintenance. Some facilities are heavily automated and have a clear dependency monitoring the plants behaviour. Skills of companies such as Schneider Electrical and Sage Automation who supply electrical and logic controller equipment are applicable. These two companies support Defence Industry in variety of areas such as air (F/A-18 Hornet fighter), land (Land Vehicles) and sea (AWD, Collins class).

Investment in research and development is mandatory and not dissimilar to the how the Defence Industry uses the Defence Science and Technology Group (DSTG) to support research into Defence projects. Noting the long lead time it would take for Australia to develop a fuel fabrication ability and facility; it could take advantage of existing opportunities for collaboration with Defence companies such as DSTG and Nuclear organisations such as Australian Nuclear Science and Technology Organisation's (ANSTO) OPAL research centre.

Dedicated Systems is a specialist supplier of Embedded System Hardware, Firmware and Software, based in South Australia. They act as a reseller for many suppliers that already participate in the nuclear industry in other countries due to their safety critical specialisation. Dedicated Systems add value by applying their expertise to match requirements with solution, and ensure ongoing support, rather than just selling products.

Sensors and monitoring equipment for facilities need to be redundant, segregated, and diverse. Even multiple sensors of the same design, spread out physically, could all fail due to a common condition in the system, or fail to detect an undesirable anomaly. The Defence Industry has a number of companies specialising in advanced sensors, providing an opportunity for innovation.

A result of this extensive instrumentation is high volumes of data generated every minute. There is a long running debate of human vs automated monitoring given the consequences of getting something wrong, and the differing flaws in both approaches. There's likely to be a place for both for the foreseeable future. A local innovator, Palamir, specialises in Big Data analysis, and could apply this to the output of the sensor network, driving improvements in both safety and operational performance.

10. Containment Vessels and transport requirements

There will be a requirement to transport nuclear material in a safe and regulated manner. A number of international safety standards exist dependent on what method of transport the material will take either by sea/land/air. Regulations, which Australia already adheres to, need to be followed if further advancements were made in the nuclear industry.

There are a number of requirements for the waste transport and storage vessels dependant on their classification. There are five categories: Excepted, Industrial, Type A, Type B and Type C. The section below will focus more on the type A, B, and C containers compared to the excepted and industrial containers which relate more to lower levels of radiation stored in 44 Gallon drums.

Dependant on the categories there are requirements on maximum and minimum operating temperatures and pressures, maximum radiation levels and containment of radioactive contents. The World Nuclear Transport Institute have summarised these requirements in their publications (2). For further details on the requirements there is the "Safe Transport of Radioactive material" code written by the Australian government which takes excerpts from the International Atomic Energy Agencies publications.

There is a vast selection of vessels/containers that could be manufactured, maintained and serviced by local Defence Industry companies.

11. Case Study: Road Transport

South Australia has a number of transport related companies that also provide support for the Defence Industry. Whether this is logistical support of materials or equipment, repair/refurbishment or even new builds of part or whole equipment. The Defence Industry is only one of many industries which the transport industries service, with this added diversity and sustainability allows these industries to strive and provide support to the Defence Industry when required. For example RGM Maintenance who has a workshop located in Regency Park provides services direct to the Australian Defence Force (ADF) and major primes. Items like mechanical maintenance of vehicles and equipment, painting facilities, repair facilities, testing and compliance certifications. (2)

12. Case Study: Sea Transport

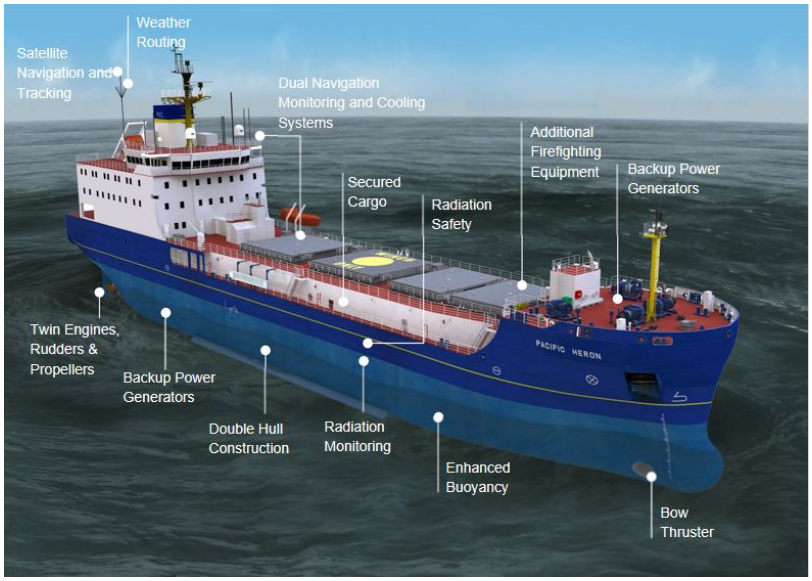
If Australia was to be receiving nuclear waste from other countries there is the requirement for this material to be transported over the sea into Australian ports, which must comply with the International Code for the Safe Carriage of Packaged Irradiated Nuclear Fuel, Plutonium and High-Level Radioactive Waste on Board Ships, issued in 2001.

There is also a requirement for the vessels to have naval guns for defence against threats and to prevent nuclear proliferation.

With the Common User Facility (CUF) at Techport there is the potential that new or retrofitted ships could be designed, built or modified to transport these transport casks, there is also the potential to service and maintain these vessels in the facility.

The wharf at Techport has dimensions of 213 meters long, 25 meters wide, with a depth alongside of 10.5m. The ship lift dimensions are 156m long, 34m wide and with a lift capacity of 9,300 tonnes (or 130 tonnes per metre) these facilities are world class. (3)

The vessels requirements are in regards to the following: damage stability, fire safety measures, temperature control of cargo spaces, structural considerations, cargo securing arrangements, electrical power supplies, radiological protection. A diagram shown below is an example of one vessel.



Source: http://www.pntl.co.uk/our-fleet/pntl-ship-tour/

7. Overarching Defence Industry Capabilities

In large Defence construction projects there are requirements for skilled welders, pipe- fitters, electricians, automation experts. Many qualities and skills can easily be transferred to a nuclear industry and support infrastructure and equipment.

Despite Defence Industry capability being demonstrated in various relevant ways, the aim is to ensure all businesses share language, policy and intent whilst providing relevant practical skills to the common project.

Two Adelaide based businesses below have provided relevant case studies.

1. Case Study: Tactical Training

Tactical Training is a Recognised Training Organisation (RTO) that meets civilian needs through education applicable to various businesses in specialised security, risk management, asset protection and firearms.

Tactical Training's Business Development Manager has also created a second tier in post-Tactical Training for ex-Defence personnel in the Duty Ready Group.

Tactical Training is run independent of government funding and its income is estimated at 5-10% from the ADF. The economic advantage often stays in South Australia either in the ADF or associated Defence Industry. Many personnel train post-ADF career and return as a contractor to Defence as security trainers or guards. Examples of this return on economic contribution post-training can be seen through businesses such as BAE Systems and Lockheed Martin.

Training touches on effective management of radioactive substances and medical alert team training. The result is an increase in sensitivity and ability to effectively manage risk that is easily translated to the Nuclear Fuel Cycle.

Mr Turner believes this business would enjoy significant growth if nuclear industry developed. Tactical Training is building Australia's armed forces capability; skills would be transferable to managing terrorism

risk at nuclear waste sites, transfer of materials to airports and ports and to act as ready-made, trained support for the ADF if called to arms.

Mr Turner sees potential to add units of competency to the RTO associated with CBRN (chemical biological radiological and nuclear) and notes that public perception will also require effective management.

Tactical Training has the capacity for changing the business model and would consider "training the trainers" rather than individuals, if the need arose.

When asked what set-backs may be felt in growing this business, Mr Turner expressed the need for improved State and Federal Firearms legislation to support training for, and actualisation of, appropriate protection of Nuclear Fuel Cycle product and assets. Emergency response plans would likely require updating, with a described lack of detail in the "Guide to Safe Transport of Uranium Oxide Concentrate" (2012) which has been noted by the Adelaide Hills climate action group (4) on page eight of their submission to the Royal Commission. There is a valid point that the current guide does not go into adequate detail to protect others if there was to be a containment issue.

2. Case Study: Human Performance

Mr David Olney is a Human Performance Consultant with expertise in Civil-Military Relations. Among other things, David runs Applied Thinking for Complex Problems Courses with the University of Adelaide and his independent consultancy work aligns with various organisations including the ADF.

His courses encourage development of cohesive pathways between Military and Civilian Industry in areas such as policy, compliance, safety and public perception.

The difference in communication and action seen between Military and Civil units may be a challenge, there is no common language. Compounding this is a difference in working style where the Military typically "have no choice but to get on with it" whilst civilians "put it off until they have more information". A Marriage of these two worlds will require appreciation of skills and contributions to create the forward momentum required for high reliability organisations.

To achieve this, the ground rules within the organisations are re-established which often this means a change from typical power based structure to influence structure. This allows people with technical skills to add maximum value to management teams. The success of this approach was clearly demonstrated recently where 27 different groups including special operations engineers, came together with the charter to provide solutions centred around analysing problems and dealing with differences. The success of the venture was made obvious through ongoing demand for this work.

If the work gained through ADF continues to grow at the current rate, it is likely that in 2-3 years Mr Olney's consultancy business will have limited opportunities to work with other clients.

This type of overarching training should not be limited to Military – Civilian applications. It can also assist alignment of Federal and State political parties where policy changes will be required for the Nuclear Industry to be successful. Managing civilian perception is a significant challenge of the Nuclear Fuel industry, where a long history of negative media has led to the current climate of anxiety and negativity. Mr Olney believes careful management of the media will be critical in the industries success and that his courses will be relevant to encourage smooth progress.

In summary, where there is any common cause, training to bridge the gap for essentials including common language, thinking tools, planning, analysis and ways to effectively criticise and question each other is invaluable. If the Nuclear Fuel Industry were to develop, the demand for this type of Human Performance training could be mind-blowing.

8. Challenges

If the Defence Industry were to extend its capability and engage in supporting the development of other areas of the Nuclear Fuel Cycle, various challenges would be introduced. Below is a representation of some the challenges that may be encountered:

- Training and Education
    - There would need to be introduction of specific nuclear related courses into Universities (such as Nuclear Engineering), however there would also be a need to modify already existing courses such Electrical and Mechanical engineering to ensure that they introduce a nuclear flavour to ensure a minimum level of understanding is achieved in areas such as understanding the fuel cycle, reactor operation, nuclear safety and public awareness.
    - It would be envisaged that these skill developments would, in the short term, be developed through international markets until such time they are available locally.
- Nuclear Governance
    - The nuclear industry is a very heavily regulated industry and rightly so. Currently ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) is the organisation which regulates use of radiation in Commonwealth entities. ARPANSA would need to further develop its regulatory framework with respect to Construction and monitoring of nuclear facilities, provide public assurance on health, safety and environmental matters and compliancy with safeguards.
- Testing and Certification
    - The nuclear industry is big on ensuring their equipment functions the way it should with built in redundancies. This could impact local Defence companies to upgrade their products to ensure they meet capability required for support of a nuclear industry.
- Initial investment:
    - Cost could be deterrent for some small defence companies trying to break into the nuclear industry, if educating and conforming to nuclear requirements are required
- Risk Aversion
    - Lowered Tier Defence companies may not want to be involved in a nuclear industry because of its potential for high risk consequences in the event of a nuclear incident. They may not wish to expose themselves to any negative press related to these types of incidences.

9. Conclusion

Beyond serving as a demand leveller for the Defence Industry, participation in the Nuclear Fuel Cycle would offer companies many spill-over benefits, and could usher in the next era of Australian advanced manufacturing and technology. There are clear parallels between the Defence and nuclear industry, such as high tech, high precision, safety critical and regulatory requirements. These synergies can be easily transitioned between the industries with some minor upskilling required. It is clear from details in this paper

that the Defence Industry has the expertise and capacity to involve itself is the development of the Nuclear Fuel Cycle.

10. Recommendations

Our recommendation is that a clear leadership body needs to be established for Defence Industry to be successful in its contribution to the Nuclear Fuel Cycle. We recommend this body has significant Industry representation. It should deliver balanced perspectives and addresses following areas:

1. Clarity of the desired Nuclear Fuel Cycle outcomes and deliverables
2. Preparation and guidance of individual industries including confirmation of key roles and responsibilities.
3. Education – This includes upskilling and also the management of public perceptions.

It appears obvious that initial guidance will be sought from outside of Australia however the clear intent should be to develop a pathway to transfer existing global knowledge to local industry. In this way Australian businesses may be able to move from initial involvement at the Tier 3 and 4 levels, toward contributing as a system or functioning as a prime.

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