Selecting Nuclear-Powered Submarines in Australia: Nuclear Waste Considerations – 14436

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ABSTRACT

A study has been completed that examines the strategic, economic, legal, regulatory and workforce issues in relation to procuring, leasing or assembling a complete military off the shelf (MOTS) nuclear-powered submarine in Australia. In relation to nuclear waste management, the study concludes that all skills and infrastructure needed to support a nuclear naval propulsion economy exist in Australia with the exception of systems for the management of spent fuel. The study also concludes that if the MOTS system were to be obtained from the United States, then it is possible that the US could, under current law and precedent, determine that it is in its national interests to return the spent fuel to the US. Such a possibility could allow Australia to proceed with a naval nuclear propulsion program without having to establish an infrastructure for the management of spent fuel.

INTRODUCTION

Australia is about to embark on a major construction activity to replace its ageing fleet of Collins-class diesel electric submarines. There is current debate in Australia as to whether all or some of the fleet should be nuclear powered. Despite having a quarter of the World's natural resources in uranium, Australia only has a limited indigenous nuclear engineering capability and no nuclear reactors, other than a research and isotope production facility at Lucas Heights in Sydney. So, what would it take to develop such a capability and would one way to facilitate its development be in the operating and maintenance of nuclear-powered submarines?

A study [1] has been completed that considers the strategic, economic, legal, regulatory and workforce issues in relation to procuring, leasing or assembling a complete military off the shelf (MOTS) nuclear-powered submarine in Australia. This scenario would likely require Australia to develop a nuclear-powered submarine operations, maintenance, refuelling, spent-fuel management and possibly decommissioning capability, without presenting Australia with the considerable upfront challenges of developing a nuclear reactor and fuel enrichment supply chain. There may be some legal challenges to overcome, particularly in the international community. These issues relate largely to the transfer of materials under the Non-Proliferation Treaty.

This paper focuses on the radioactive waste management issues that Australia must address in the event that it chooses to pursue a nuclear-powered submarine fleet. Consideration is given to routine operations and maintenance, spent fuel management and fleet decommissioning. Waste disposition, transport and disposal issues are addressed.

WASTE MANAGEMENT FACTORS

If Australia were to operate nuclear-powered submarines, five broad waste management topics must be addressed:

1. Spent fuel management
2. Operating waste management
3. Decommissioning
4. Transportation
5. Regulation

These five factors are addressed below.

Spent Fuel Management

It is accepted that the country that generates nuclear waste is responsible for its management[1]. Given that there are no international repositories, this leads to the conclusion that an Australian nuclear-powered submarine fleet must be accompanied by the development of an Australia repository for the disposal of its spent fuel. This conclusion would add the costs of this activity to a selection decision since Australia otherwise has no need for a repository since, at present, it has no nuclear power program.

There is, however, a possible alternative and very different outcome to this question. Certain aspects of naval nuclear reactor design are classified. This includes details of the nuclear fuel. A country that supplies a naval reactor to Australia could conclude that its national security interest requires that the spent fuel be returned to protect the knowledge of the fuel. There are provisions in US law for this. While motivated by different factors, the return of highly-enriched fuel from the global inventory of test and isotope production reactors utilized US procedures to allow this material to be returned to the US for management. Hence, it is possible to conclude that an Australian decision to obtain nuclear-powered submarines would not necessarily commit Australia to develop a repository.

Because of the classified nature of this type of cooperation, it is difficult to determine whether a nation has returned to the United States nuclear fuel that had been irradiated in another nation's

[1] Australia is a signatory to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management. The Joint Convention affirms that each nation is responsible for its own waste.

nuclear-powered warship. Nonetheless, the United States has entered into bilateral mutual defense agreements with other countries that provide for U.S. assistance in development of nuclear reactors for naval vessels. For example, Article III of the U.S.- UK Mutual Defense Agreement deals with "transfer of submarine nuclear propulsion plant and materials." That article provides for the take-back, by the United States, of nuclear fuel that has been irradiated in another nation's nuclear-powered warship for reprocessing. [2] Section 131 of the Atomic Energy Act (as amended), which was enacted in 1978 as part of the Nuclear Nonproliferation Act (NNPA) may also be relevant to similar return of such irradiated fuel. However, to date, the US Department of Energy's (DOE's) notices of subsequent arrangements pursuant to section 131 have dealt only with peaceful nuclear cooperation, as opposed to mutual defense cooperation. Nevertheless, section 131 could serve as the legal framework for US Executive Branch's evaluation of a foreign government's proposal to return such irradiated fuel to the United States, and potentially allow the DOE to conclude that such take-backs may occur, pursuant to a subsequent arrangement to a preexisting Agreement for Cooperation in the Peaceful Uses of Nuclear Energy, such as the Agreement that is currently in force between the United States and Australia. Although it is unclear whether the United States has taken back fuel that had been irradiated in another nation's nuclear-powered warship, the United States, through the DOE's Reduced Enrichment for Research and Test Reactors program, has entered into agreements with other nations by which the United States has agreed to take back, and has indeed taken back, US-origin high enriched uranium that had been irradiated in other nations' research and test reactors. Extensive research would be required to determine whether the US Executive Branch would carry out a subsequent arrangement or rely on another means of taking back fuel that had been irradiated in another nation's nuclear-powered warship.

If Australia decided to pursue naval nuclear reactors, it could establish, up front, that the spent fuel would return to the supplying country. It could also establish that the waste from these reactors could return to Australia if a repository were to exist at the time. Monetary concessions could also be established within the origination process to reflect the possible movements of spent fuel.

Another approach exists to address this challenge. Australia has established contracts in the UK and France to reprocess its HIFAR fuel. (HIFAR was a research and isotope production reactor that has now been shut down.) Broadly, these agreements call for the resulting wastes to be returned to Australia in a form that might allow for future disposal in a near-surface repository. The contracts require that intermediate-level waste (ILW) be returned to Australia in lieu of high-level waste (HLW); i.e., Australia receives the radiological equivalent to the HLW that would derived from reprocessing the HIFAR fuel, but it receives it in the form of ILW. This approach could be mirrored in negotiations for naval nuclear reactors. In turn, this might obviate the need for a deep geological repository.

To conclude, spent fuel wastes from Australian nuclear-powered submarines could be managed in one of three manners:

1. Disposal in an Australian repository
2. Return to the supplying country
3. Disposal of residual wastes in an Australian near-surface facility

Operating Waste Management

There are two broad types of operating wastes produced by naval nuclear reactors:

1. Routine operations wastes
2. Wastes from failed fuel incidents

Routine operating wastes are similar to those produced at any nuclear reactor. The wastes are produced on board and off loaded regularly at port. An Australian reactor shipyard would have to build facilities and systems to safely receive, process, package and store these wastes. All of these systems exist elsewhere and can be commercially obtained.

Australia produces low-level wastes as part of its medical and industrial isotope system and has an established nuclear regulatory structure. It is engaged in a consent-based process to site a new near-surface disposal facility. The wastes from routine submarine operations are of a similar nature to other low-level wastes that are presently stored but ultimately destined for management at this new facility. Hence, Australian radioactive wastes from nuclear-powered submarines could be managed in the systems now under development.

When a fuel failure incident occurs, the wastes may contain small quantities of long-lived isotopes. As noted in the previous section, Australian standards address this by specifying the characteristics of wastes that can be disposed of in a near-surface facility. The reactor shipyard would have to strictly adhere to these standards in processing these wastes to ensure that new surface disposal can occur.

Decommissioning

At the end of the life of nuclear-powered submarines, they must be decommissioned. Radioactive waste results from the decommissioning of the reactor and associated systems in the nuclear island. It is possible that the supplying country may demand that it undertake the reactor decommissioning for national security reasons. In this circumstance, decommissioning wastes may reside with the supplying country.

Alternatively, either the wastes from decommissioning done elsewhere or in Australia may have to be managed within Australia. Broadly, such wastes are anticipated to be entirely consistent with Australia standards for near-surface disposal in facilities presently under development.

Transportation

Three types of waste-related transportation can be anticipated from an Australian nuclear-powered submarine fleet:

1. Spent fuel shipment
2. Ground transport of wastes
3. Ocean transport of wastes

Each of these activities has been and continues to be done throughout the world. Systems and services for these activities can be commercially obtained. Global standards exist that are protective of the public, workers and the environment. Hence, transporting nuclear wastes from an Australian nuclear-powered submarine fleet would not create a new challenge.

Regulation

Australia possesses a regulatory infrastructure for overseeing the production, management, transportation and disposal of radioactive material. When the HIFAR experience is included, the Australian regulatory system has addressed almost every challenge that would be associated with the development and operation of a naval-reactor fleet.

The principal exception to this conclusion would be a decision to proceed with the development of a repository for the disposal of long-lived wastes. The technical challenges of this activity are within the experience of Australia, particularly when the management of uranium mining and milling wastes is considered.

Clearly, the nuclear waste regulatory demand in Australia is quite small compared to a country with an active nuclear power program. Hence, the pursuit of naval nuclear reactors would add stress to this system. This stress would require an increase in staffing and skill acquisition. Nonetheless, the regulatory demands associated with a new nuclear-powered submarine fleet are within the broad experience of the Australian system.

CONCLUSIONS

If Australia selects to acquire nuclear-powered submarines, it must make provisions for the management of all radioactive wastes. The low-level radioactive wastes that come from routine operations and decommissioning are manageable within Australia utilizing commercially available technologies and within facilities now in development in Australia. This includes transporting the nuclear wastes.

The Australian structure of regulation of nuclear materials is already established for most of the activities anticipated by the establishment of a naval nuclear power program. The regulation of

a repository, if required, is within the broad scientific experience of the Australian nuclear regulatory system.

Management of spent fuel from naval reactors is a more complex matter. It is possible that this fuel, or the residual wastes from its management, would have to be managed in a repository. Alternatively, it is possible that the country that supplies the naval reactor could agree to receive the fuel at the end of its life on security grounds. Also, it is possible that, following the precedent for management of Australia's HIFAR spent fuel, residual wastes from the management of naval reactor fuels could be disposed of in near-surface facilities, provided that the wastes meet Australian standards for this activity.

REFERENCES

[1] Could Australia's Future Submarines be Nuclear-Powered? UCL International Policy Institute, Adelaide, Australia, August 2013. http://www.ucl.ac.uk/australia/ucl-australia-news/nuclear-powered-submarines-do-able-for-australia

[2] See Article III.B of the "Agreement Between the Government of the United Kingdom of Great Britain and Northern Ireland and the Government of the United States of America for Co-operation on the Uses of Atomic Energy for Mutual Defence Purposes (July 3, 1958)."