MAPW - Health Professionals Promoting Peace

Committee Secretary
Joint Standing Committee on Treaties
PO Box 6021
Parliament House
Canberra ACT 2600

30th April 2017

To the Secretary

Re: Generation IV Nuclear Energy – Accession

Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems, as extended by the *Agreement Extending the Framework Agreement for International Collaboration on Research and Development of Generation IV Nuclear Energy Systems* (Washington, 28 February 2005)

Please find attached the submission regarding the above agreement from the Medical Association for Prevention of War. If you have any questions, please feel free to contact us.

Yours sincerely

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Executive Summary

MAPW recommends strongly against Australia becoming a party to this agreement. There is no proposal for Australia to get a nuclear power program.

This framework agreement applies to technologies that are economically, socially, environmentally, and from a nuclear security perspective, very dubious. Generation IV reactors are an assortment of proposed technologies that have been put forward over the last 70 years, tried and failed.

ANSTO is already very heavily subsidised by the Australian government, and extending its operations into this research sphere will require further scientific effort, expertise and funding. This is highly inappropriate given the current major constraints on government spending, and the urgent need to focus research energies on realistic, financially viable and proven measures to contain emissions from electricity generation. Collaboration would mean taxpayer subsidies would go to an industry which has already wasted many billions in public funds and resulted in major adverse legacies. No private industry is prepared to invest in this research without large government subsidies because none are prepared to lose so much money.

It is also clear that Australia has no policy to use these long promised and never commercially delivered reactors. Therefore any involvement just subsidises those who hope to use them. If Australia wishes to expand its nuclear expertise, then research into “non nuclear waste” generating technologies (such as those to produce medical isotopes) would be much more productive and also be of positive benefit to the Australian population.

Background

Objectives of GIF Framework Agreement

1)The objective of this Framework Agreement is to establish a framework for international collaboration to foster and facilitate achievement of the purpose and vision of the GIF: the development of concepts for one or more Generation IV Systems that can be licensed, constructed, and operated in a manner that will provide a competitively-priced and reliable supply of energy to the country(ies) where such systems may be deployed, while satisfactorily addressing nuclear safety, waste, proliferation and public perception concerns.

2) Collaboration under this Framework Agreement shall be conducted only for peaceful purposes and in accordance with non-proliferation objectives and the Parties’ international obligations relating thereto; and on the basis of equality, mutual benefit, and reciprocity.

The Generation IV International Forum notes in its introduction:
For more than a decade, GIF has led international collaborative efforts to develop next generation nuclear energy systems that can help meet the world’s future energy needs. Generation IV designs will use fuel more efficiently, reduce waste production, be economically competitive and meet stringent standards of safety and proliferation resistance.

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The Gen IV International Forum guidelines aim for a lifecycle cost advantage over other energy sources and to have a level of financial risk comparable to other energy projects.

However the reality is dismal track record for both objectives. Fast neutron reactors providing easy access to plutonium for weapons.[1] Statements that collaboration under the agreement will "only be used for peaceful purposes" clearly ignore the evidence from past use of this technology. An estimated $100 billion has been spent on development over more than six decades, with no commercially viable model found.[2]

Justifications for Generation IV systems

In the 1960's there was concern was that global uranium supplies were limited. At this stage generation IV reactors were described as "breeder" reactors, aiming to solve long term energy supply problems by requiring much less uranium. But exploration since then has shown there are ample reserves of uranium globally. Russia and India have been two of the nations most concerned about uranium supply in the past, and continue to be among the nations most heavily subsidising these systems, despite changes in global availability of cheap uranium ore.

The next justification given for generation IV research was the difficulties arising from storing and disposing of spent fuel wastes from standard light-water reactors. The storage issues could be partially ameliorated by reprocessing, which separates out the one percent plutonium in the spent fuel. This does not remove the problem of ultimate disposal, but does provide a short term measure and defers the very difficult issue of how to safely dispose of spent nuclear fuel.

It was planned that the plutonium separated out could then be used as fuel for fast neutron reactors. However the increase in spent fuel reprocessing has significantly increased stockpiles of weapons grade plutonium.[1] This clearly represents an increase in risk of proliferation of nuclear weapons.

The latest reason for generation IV reactors centres on the unsolved problem of how to safely dispose of spent nuclear fuel. The proposition is that plutonium and other long lived transuranics in reactor fuel (that like plutonium also create a disposal problem) could be used up in so called "burner" reactors. These would hypothetically leave behind mostly shorter lived isotopes that would be much less of a disposal problem.

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[1] Cochran, T. B. et al. Fast Breeder Reactor Programs: History and Status February 2010 https://www.google.com.au/search?q=Cochran%2C+T.+B.+et+al.++Fast+Breeder+Reactor+Programs%3A+History+and+Status+&ie=utf-8&oe=utf-8&client=firefox-b&gfe_rd=cr&ei=HNr-WPOTEqHM8gf_3YH4Ag accessed 22 April 2017

[2] Cochran, T.B. et al. It's Time to Give Up on Breeder Reactors Bulletin of Atomic Scientists http://thebulletin.org/2010/may/its-time-give-breeder-reactors accessed 22 April 2017

Analysis by the US National Academy of Sciences found this proposal to have such very high cost and so little benefit that it would take hundreds of years of recycling to reduce most of the global inventory.[3] In addition an economic analysis of reprocessing versus direct disposal of spent nuclear fuel found uranium found that uranium would need to cost more than $340 /kg to favour the use of fast reactors on a financial basis[3]. The current price of uranium (March 2017) is $54/kg.

Generation IV reactors - a track record of repeated failure and massive cost

The unbridled optimism and powerful lobbying of the nuclear industry have been sadly let down over the many decades of investment in research in this area. Promises of electricity that was "too cheap to meter" have failed to materialise. Global nuclear capacity is one tenth of what was projected in the early 1970s. As can be seen from the 2010 table below, the vast majority of fast reactors have been shut down.[4]

	MWe	MWt	Operation
France			
Rapsodie		40	1967–83
Phénix	250		1973–2009
Superphénix	1240		1985–98
India			
FBTR		40	1985–
PFBR	500		2010?
Japan			
Joyo		140	1977–
Monju	280		1994–95, 2010?
USSR/Russia			
BR-5		5	1959–2004
BOR-60	12		1969–
USSR/Russia (cont.)			
BN-350 (Kazakhstan)	350		1972–99
BN-600	600		1980–
BN-800	800		2014?
United Kingdom			
DFR	15		1959–77
PFR	250		1974–94
United States			
EBR-I	0.2		1951–63
EBR-II	20		1963–94
Fermi 1	66		1963–72
SEFOR		20	1969–72
Fast Flux Test Facility		400	1980–93

Table 1.1 **Major experimental, pilot and demonstration fast breeder reactors.**[1]

[3] Bunn, M. et al. The economics of reprocessing vs. direct disposal of spent nuclear fuel January 2005 Nuclear Technology 150 https://www.researchgate.net/publication/237772055_The_economics_of_reprocessing_vs_direct_disposal_of_spent_nuclear_fuel accessed 25th April 2017

[4] Cochran, T. B. et al. Fast Breeder Reactor Programs: History and Status February 2010 https://www.google.com.au/search?q=Cochran%2C+T.+B.+et+al.++Fast+Breeder+Reactor+Programs%3A+History+and+Status+&ie=utf-8&oe=utf-8&client=firefox-b&gfe_rd=cr&ei=HNr-WPOTEqHM8gf_3YH4Ag accessed 22 April 2017

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Since this table was published:

In September 2016 the Japanese government abandoned plans to restart the Monju fast breeder reactor, due to many failures. These include sodium coolant leakage and fires, accidents and failure to conduct safety inspections on safety critical equipment. The Japanese government had spent US$12 billion, and in 2012 it was estimated decommissioning would cost US$3 billion.[5][6]

India's Department of Atomic Energy has promised construction of hundreds of fast neutron reactors, yet its test reactor (FBTR) took 26 years from planning approval to operation, and design work for a larger prototype (PFBR) started in 1985 and construction started in 2004. It has yet to start operating.

China has an experimental 20Mwe fast reactor, which has operated for less than one month in the 63 months from start up in 2010 to October 2015. Plans for a 600MWe and a 1000Mwe reactors have yet to be approved. According to the World Nuclear Association, at best China may have one commercial scale reactor by 2034.[7]

Russia has three fast reactors in operation and has announced plans for 11 reactors in the next 14 years, but their nuclear program (like India) has a history of very ambitious projections that fail to materialise. The current economic crisis in Russia means it is likely most new reactors will be cancelled.[8]

Germany, the UK and the US have all cancelled their prototype fast reactors, and France is considering a fast reactor but will not decide until the end of the decade.

Cost Issues

Economists classify costs as direct and indirect.

Direct Costs of fast reactors have been outlined, with an estimated over US$100 billion spent over six decades on development with no commercially viable model found.[9]

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[5] Running Monju reactor for 10 years would cost gov't 600 billion yen extra August 29, 2016 Mainichi Japan http://mainichi.jp/english/articles/20160829/p2a/00m/0na/017000c accessed 25th April 2017

[6] Decommissioning of troubled fast-breeder reactor Monju would cost 300 billion yen February 16, 2016 Mainichi Japan http://mainichi.jp/english/articles/20160216/p2a/00m/0na/005000c accessed 25th April 2017

[7] World Nuclear Association, China's Nuclear Fuel Cycle 6th December 2016 http://www.world-nuclear.org/information-library/country-profiles/countries-a-f/china-nuclear-fuel-cycle.aspx accessed 22 April 2017

[8] *Slivyak* , V. Russia is planning new reactors but prospects are murky August 2016 Nuclear Monitor https://www.wiseinternational.org/nuclear-monitor/829/nuclear-monitor-829-24-august-2016 accessed 22nd April 2017

[9] Cochran, T.B. et al. It's Time to Give Up on Breeder Reactors Bulletin of Atomic Scientists http://thebulletin.org/2010/may/its-time-give-breeder-reactors accessed 22 April 2017

In Australia the Australian Nuclear Science and Technology Organisation (ANSTO*)* is a statutory body of the Australian government. It would be the Implementing Agent in the framework agreement. The enthusiasm of this organisation for this agreement needs to be carefully weighed up by looking at cost and benefit.

In the 2015-16 financial reports ANSTO received A$156.7 million from the government in both the 2015 and 2016 financial years, and additionally had deficits of A$56.3 million and A$40.9 million respectively. So in the two most recently reported financial years, the government is already spending A$213 million and A$198 million annually on nuclear issues.[10] Given the current climate of budget deficits and fiscal restraint it seems highly inappropriate to commit further expenditures, especially to an endeavour with such high costs and such a conspicuous lack of success. Interested parties however continue to push for increased role and subsidies, regardless of the likely outcomes.

Should ANSTO propose collaboration can occur without further cost to the taxpayer, then a funding review should be conducted to establish what research is already being done by ANSTO, at what cost, for what purpose and at whose behest. With an average loss of A$200 million annually, ANSTO should be able to provide disaggregated accounts for both transparency and accountability.

Allison MacFarlane, former chair of the US Nuclear Regulatory Commission, recently made this sarcastic assessment of fast reactor technology: “These turn out to be very expensive technologies to build. Many countries have tried over and over. What is truly impressive is that these many governments continue to fund a demonstrably failed technology.”[11]

Even the South Australian Nuclear Fuel Cycle Royal Commission found the outlook for the deployment of fast reactors and other innovative designs had many significant challenges. “Presently there are no operational fast reactors or other innovative designs that can be used to validate their potential for commercial deployment. Several countries have research and development programs for improved fast reactors, with some being in place since the 1950s, with significant challenges still to be overcome before commercial operation is achieved.”[12]

Indirect costs can also be referred to as opportunity costs**.** Any resources put towards this Framework Agreement means those resources cannot be directed to other crucial areas. Given the

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[10] Annual Report of the Australian Nuclear Science and Technology Organisation (ANSTO) for the period 1 July 2015 to 30 June 2016. September 2016 http://www.ansto.gov.au/Resources/Publications/AnnualReports/index.htm accessed 5th March 2017

[11] Stapczynski,S. and Urabe,E. Japan’s Nuclear Holy Grail Slips Away With Operator Elusive 1st June 2016 https://www.bloomberg.com/news/articles/2016-05-31/nuclear-holy-grail-slips-away-from-japan-with-operator-elusive accessed 25th April 2017

[12] South Australian Nuclear Fuel Cycle Royal Commission Report 6th May 2016 South Australian Government http://nuclearrc.sa.gov.au/ accessed 25th April 2017

clear need for emissions reduction in energy production, committing resources to renewable energy and developing energy storage would be far more likely to have a successful commercially viable outcome, without the major safety issues, nuclear proliferation risks and unsolved very long term toxic waste issues inherent in fast reactors. Existing light-water reactors are already too expensive compared with other forms of energy production.[13][14][15] Even if eventually a commercial model was developed, the likelihood of fast reactors providing cheaper electricity than existing reactors is very remote, given their complexity, and major reliability and safety problems.

If the motivation of the government is to be a good global citizen, it could deliver a demonstrable benefit much more cost effectively and safely by subsiding reputable foreign aid organisations to deliver projects such as vaccination of children, or famine relief in East Africa.

Safety issues

Fast reactors have particular safety problems that have been a major factor in why they are so often shut down for long periods. Existing fast reactors use liquid metals such as sodium for coolant, which reacts violently with water and burns if exposed to air. Sodium fires have been responsible for shut downs in a large proportion of countries who have experimented with fast reactors. Indeed, in the 30 years of operating Russia's BN-600, it has had over 30 incidents connected with sodium leaks and fires.[16]

Reliability issues

The vast majority of demonstration fast reactors have been shut down for most of the time that they should have been generating electricity. It is very difficult to maintain and repair equipment that is immersed in sodium, given the already described properties that make sodium likely to explode or catch fire when exposed to water or air. To undertake repairs the fuel has to be removed, the sodium drained and the entire system very carefully flushed to remove any residual sodium. This means repairs can take months or years. The world's only commercial-sized fast reactor, France's

[13] Sophie Vorrath & Giles Parkinson 26 November 2015 Nuclear priced out of Australia's future energy equation in new report **Renew Economy** http://reneweconomy.com.au/nuclear-priced-out-of-australias-future-energy-equation-in-new-report-67465/ Accessed 25th April 2017

[14] Nuclear power The dream that failed 12 march 2012 *The Economist* http://www.economist.com/node/21549936 accessed 28th April 2017

[15] Next-Generation Nuclear Reactors Stalled by Costly Delays February 2nd 2017 *Bloomberg Markets* https://www.bloomberg.com/news/articles/2017-02-02/costly-delays-upset-reactor-renaissance-keeping-nuclear-at-bay accessed 28th April 2017

[16] Galina Raguzina August 4th 2014 Holy grail or epic fail? Russia readies to commission first plutonium breeder against uninspiring global track record http://bellona.org/news/nuclear-issues/nuclear-russia/2014-08-holy-grail-epic-fail-russia-readies-commission-first-plutonium-breeder-uninspiring-global-track-record accessed 25th April 2017

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Superphenix, was famous for its lengthy shutdowns. Its lifetime capacity factor (from time of grid connection in January 1986 to shut down in December 1996) was less than 7 % of what is would have been had it operated at full capacity. Japan's *Monju,* the UK *Dounreay* and *Prototype Fast Reactors* and the US *Enrico Fermi 1* Demonstration reactors similarly had very extensive shutdowns. Russia's smaller *BN-600* has done better, but only because of a willingness to continue to operate despite multiple sodium fires.

Proliferation risk

Fast reactors require the separation of plutonium from spent fuel. Any increase in this process increases access for creation of nuclear weapons, by both state and non-state actors. Indeed, India used plutonium from its fast reactor program to create its first nuclear weapon. This happened despite signed undertakings that India's reactor technology would only be used for peaceful purposes. India continues to refuse to put its fast reactors under international safeguards so that plutonium production cannot be monitored.[17] The significance of keeping their fast reactor outside of the safeguards regime has not been lost, especially on Pakistan. France used its Phenix fast reactor to make weapons grade plutonium.

Australia's position on nuclear energy

The recent South Australian Nuclear Fuel Cycle Royal Commission made a detailed exploration of the prospects of Australia commencing a nuclear power program.[12] The Royal Commission found:

"Taking into account the South Australian energy market characteristics and the cost of building and operating a range of nuclear power plants, the Commission has found it would not be commercially viable to develop a nuclear power plant in South Australia beyond 2030 under current market rules.

Given the prospect that new reactor designs, and in particular smaller reactors, might be viably integrated in the Australian electricity network, the Commission recommends that the South Australian Government also collaborate with the Australian Government to commission expert monitoring and reporting on the commercialisation of new nuclear reactor designs that may offer economic value for nuclear power generation."

It is of note that the Royal Commission proposed "monitoring and reporting" of new designs, not participation in research and active subsidization. The Royal Commission also places emphasis on economic value for nuclear power generation, which is clearly entirely absent from fast reactor operations.

[17] Ramana, M.V. A fast reactor at any cost: The perverse pursuit of breeder reactors in India 3rd November 2016 http://thebulletin.org/fast-reactor-any-cost-perverse-pursuit-breeder-reactors-india10124 accessed 25th April 2017

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Research is open access

The hypothesis that being a party to this Framework Agreement would keep Australia “in the loop” and on top of the science is deeply flawed. This is publicly funded civilian nuclear research which is published in peer reviewed articles, so any interested party can get access to the science. If it is not accessible then we have to assume a) it involves weapons research; or b) it is unlikely to withstand peer scrutiny. Either way, as an important member of the IAEA, Australia can avail itself of the evolving research without participation - the two are not contingent.

Should Australia wish to increase its expertise in the nuclear research field, it would be of much greater benefit to research into “non nuclear waste” generating technologies (such as those to produce medical isotopes). Cyclotron manufacture of isotopes is the fastest growing branch of nuclear medicine. Such research would lend itself to international collaboration and most importantly have outcomes that are much more achievable and would actually be of benefit to the Australian population.

Conclusion

With any proposal, it is always worthwhile to closely examine the underlying motivation of the parties advocating for change, and who exactly is likely to benefit. Given Australia has no plans to have a nuclear reactor, and that all legitimate research in this area will be publicly accessible, it is difficult to see any community benefit in Australia participating. After 60 years of research there is still no commercially viable fast reactor, and these reactors pose major nuclear proliferation and safety hazards. No matter how elegant the physics behind the process, the outcomes have been very poor.

In an era of fiscal restraint, subsidising research on clearly failed, expensive and dangerous technologies is not in the public interest. Australian scientific effort, expertise and funding would be much better focused on areas where there will be a real benefit to the Australian community.

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