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The role of the civil nuclear industry in preventing proliferation and in managing the second nuclear age

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EXECUTIVE SUMMARY

The changing nuclear landscape and the integrated nature of the world's nuclear industry strengthen the case for a concerted effort by industry and government to develop jointly a new set of understandings of what the future nuclear proliferation dangers are, and to work closely together in the design and implementation of measures to prevent such proliferation.

Industry and governments have generally considered the issue of nuclear nonproliferation a political and security matter for government. Industry's view - broadly shared by most governments, but contested by some aspects of civil society - is that the nuclear power industry has no direct responsibility for nuclear weapons proliferation. Industry feels it is already highly controlled and regulated, and that abuses are largely the consequences of actions by rogue states and associated networks determined to develop a nuclear weapons program.

Yet sensitive nuclear technology, including technology ostensibly for peaceful purposes, has found its way into nuclear weapons programs since the 70s (into the Indian, Iraqi and now Iranian nuclear weapons programs to name a few) and industry was involved in many cases. These are significant examples of where equipment and material designated for peaceful purposes can, even inadvertently, be misused for non-peaceful purposes. States have in the past responded to these events, and to the failure of the international community to detect in a timely manner the weapons programs in a number of states, by taking remedial action such as the establishment of export control mechanisms in the Nuclear Suppliers Group (NSG), starting in 1978, the conclusion of an Additional Protocol to states' safeguards agreement with the IAEA in 1997 to assist with early detection of undeclared activities and, more recently, counterproliferation actions through the Proliferation Security Initiative (with around 90 participants) and actions pursuant to April 2004 Security Council Resolution 1540. Membership of and adherence to these measures, guidelines and actions are not universal and many are still voluntary.

The global nuclear landscape is continually changing and never more so than in recent years. This is likely to put an even greater strain on efforts to contain nuclear proliferation. Climate change and rapidly increasing global energy needs have dramatically increased the attractiveness of nuclear energy as a known provider of base load power with a very low carbon footprint. We now face what some have called a 'nuclear renaissance', or a 'second nuclear age'. The challenge for the world is to ensure that this renaissance continues to be managed safely and securely at a time when nuclear proliferation pressures are on the increase. Importantly, we know that sensitive nuclear technologies, to which all NPT members believe they have a treaty-given right, can be diverted to non-peaceful use with relative ease by determined proliferators and that we need to find ways of better controlling them, perhaps through multilateral mechanisms. This will have an impact on industry interests and actions.

The ICNND's brief is broad, strategic and seeks to shape the future international nuclear order. Its aim is to add value to the sum total of efforts currently underway all over the world to manage the large and growing nuclear challenges we face. Examining the role of industry in this context is one area where the ICNND will be able to add value. Under 'Peaceful Uses of Nuclear Energy', the ICNND lists four objectives for further examination by the Commission:

- *Establishment of a global understanding that ensuring 3S (safeguards, safety and security) are indispensable for peaceful uses of nuclear energy.*
- *Development of internationally agreed arrangements for effective control of sensitive*

nuclear technology (enrichment and reprocessing)

- *Development of mechanisms for ensuring long-term supply of nuclear fuel and fuel management services so that states will not feel compelled to develop national fuel-cycle capabilities.*
- *Development by the nuclear industry of a comprehensive ‘Code of Conduct’ ranging from responsible uranium supply to support for the development of proliferation-resistant fuel cycle technologies*

There is an opportunity for industry to become a more active partner with governments to shape the world’s nuclear future, to get on the front foot and to take a more proactive and less defensive approach.

Much of the world’s nuclear industry is multinational, with significant public/private cross-ownership where commercial interests, nonproliferation interests and national strategic interests can overlap or collide. Yet governments have tended to manage proliferation as a political issue with virtually no industry involvement other than an expectation that it comply with directives which themselves can be difficult to follow or implement. Industry surveys in the US have shown that industry assesses its own performance in meeting export controls requirements as less than perfect.¹ At the same time, some governments and states have found it convenient to ignore or tolerate proliferation where it suited their strategic or security positions.

Governments rarely include industry representatives in proliferation information exchanges or policy discussions in groups such as the Nuclear Suppliers Group (NSG) except through the occasional outreach activity. Yet industry is at the front line of the development and spread of dual-use nuclear technology and has the capacity to prevent, limit or place conditions upon the spread of that technology, as well as report it, and to influence the type of nuclear technology that is developed in the future.

Industry should be an active partner with Governments in the drafting of regulations and treaties that affect their activities, to ensure that they create a level playing field for all industry players and make operational sense to encourage compliance.

However optimistic the outlook is for the future of nuclear energy (and the global financial crisis may slow things in the short to medium term), the fact remains that in the eyes of the public, it remains a high-risk industry where a major incident can have disastrous consequences. Governments also consider that the rise in nuclear power worldwide does increase the risk of proliferation, even if they understand that value of nuclear energy as a provider of energy with a low carbon footprint. An aggressive growth program risks accentuating those fears. We know that in many parts of the world, the public remains opposed to the introduction of nuclear energy, even if attitudes are starting to shift.

Being politically more proactive does not mean that industry has to abandon its evidence-based approach to risk. It can, however, help industry in its ambition to ‘strengthen and sustain public confidence, both in the reliability of nuclear technology and in the people and institutions responsible for its use.’²

¹ Richard T. Cupitt. *Survey on U.S. industry compliance and export controls: executive summary*. University of Georgia, Center for International Trade & Security 2000: http://www.uga.edu/cits/documents/html/us_industry_compliance.htm.

² WNA Charter of Ethics, p 9, Annex 1, in World Nuclear Association. *Sustaining global best practices in uranium mining and processing: principles for managing radiation, health and safety, waste and the environment*. World Nuclear Association 2008: <http://www.world-nuclear.org/reference/reports.html>.

Moreover, governments have under active consideration the development of new rules of the game which may have real impact on the development of the industry, most notable among them proposals: to multilateralise the nuclear fuel cycle; to limit the spread of sensitive nuclear technologies; and to change NSG rules to insist that countries not exercise the right to develop sensitive technology as a condition of supply, as well as making the adoption of the Additional Protocol a mandatory condition of supply.

In the nuclear industry, commercial interests are tightly woven into national interests, especially when it comes to the right to develop sensitive nuclear technologies such as enrichment. The controversial two-tier system enshrined in the Nuclear Nonproliferation Treaty (NPT) between nuclear weapon states and non-nuclear weapon states spills over into the peaceful uses domain. Initiatives to limit the possession and use of sensitive nuclear technologies to those who have them now for good nonproliferation reasons is currently opposed by emerging nuclear powers which will not, on understandable equity grounds, accept the perpetuation of a two-tier system in the nuclear power industry.

There is no chance these states will even consider foregoing the right to develop sensitive aspects of the nuclear fuel cycle, or see them centralised or regionalised under multinational control, in the absence of a solid commitment from the nuclear armed states to achieving a world without nuclear weapons.

In this context, a global call for disarmament might also become the business of industry. It may be worth exploring whether industry is prepared to make a public commitment to the goals of disarmament and nonproliferation as a sign of good faith and in the interests of the future bona fides of the business as well as a contribution to dismantling the two-tier system.

The world's chemical industry certainly understood (eventually) the advantage of demonstrating to shareholders and to the public its commitment to chemical disarmament and nonproliferation, especially in light of its inadvertent contribution to Iraq's chemical weapons program. The industry understood that if it was going to be regulated intensively and obtrusively, there were distinct advantages to industry being an active collaborator in ensuring that its business did not contribute to chemical proliferation, while at the same time having a direct say in how commercial confidentiality could be preserved through the Chemical Weapons Treaty. The 1989 Government-Industry Conference Against Chemical Weapons provided a useful vehicle to publicly set the basis for a successful government-industry partnership for this purpose.

Without the chemical industry's active support and collaboration, that treaty could most probably not have come into existence. It is, however, the case that GICCW took place in the context of the emerging global consensus among states that chemical weapons should be abolished altogether. No such consensus exists for nuclear weapons, other than the aspiration to general and complete disarmament in the NPT. Yet the global, integrated nature of the nuclear business, its very close connection to government and a changing nuclear policy landscape, including the renewed push towards progress in nuclear disarmament, argue strongly in favour of more regular government-industry collaboration, including through joint monitoring, reporting and enforcement of the rules and export controls. A jointly negotiated declaration as to how that could be done would add a new dimension to the global nuclear conversation.

Initial signs are that some industry players see opportunities and advantages to becoming more engaged in the global nonproliferation agenda. An increasingly globally integrated industry needs to take a global view and be more globally engaged. The CEO of AREVA has agreed to become a member of the ICNND's Advisory Board. Members of industry are now active participants in second-track discussions about the future role of nuclear industry in a

growing nuclear power market. The 2008 WNA policy documents and its Charter of Ethics and Principles of Uranium Stewardship spell out clearly industry responsibilities in ensuring 3S (safeguards, safety and security) are indispensable for peaceful uses of nuclear energy.³ The Australian Uranium Association has begun to advocate for best practice in support of nonproliferation and its uranium stewardship principles support broader engagement to bring that about.⁴

Conclusion

The engagement of industry as a whole will require intense diplomatic effort and will have to be managed adroitly. Large commercial interests are at stake and if there are to be additional standards, they will need to be universally applied.

More information is needed about industry's views on these matters, and, given the very close relationship between much of the world's established nuclear industry and government, government views are also important.

What is set in train today, given the complexity of the issues and the relatively long lead time involved in the nuclear business, will play out over the decades to come.

The paper takes the long view and argues for a more concerted partnership approach between governments and industry which will set benchmarks for the joint management of this enterprise over time.

³ Ibid.

⁴ Australian Uranium Association. *Uranium stewardship principles*:
<http://www.auran.org.au/page.php?pid=393>.

RECOMMENDATIONS

The ICNND agree to the following steps to be reported on ahead of its June 2009 Moscow meeting:

1. Commission an industry-wide survey to gauge industry attitudes to nonproliferation threats and industry's future role (A draft survey is at **Annex B**).
 - Invite one of the designated research centres to conduct a survey on its behalf.
2. Commission further research into the need for an additional industry Code of Conduct, based on an assessment of current codes in the nuclear domain.
 - Invite one of the designated research centres to conduct this research.
3. Meet with a selection of industry representatives in Moscow in June 2009 to gauge views on codes of conduct and a government-industry conference in 2010. Discuss other steps for government-industry partnership in managing the 'second nuclear age' with minimal proliferation risks.
4. Designate a national industry association and an interested government to act as a ginger group to canvass support for a government-industry conference and to design an agenda for that conference, using the 1989 Government-Industry Conference Against Chemical Weapons as a model.

The role of the civil nuclear industry in preventing proliferation and in managing the second nuclear age

SCOPE

This paper examines the opportunities and constraints relating to intensified government-industry cooperation in light of increased global interests in nuclear energy, while mitigating the attendant risks.

Key industry players and the current state of the nuclear industry are identified. The paper then examines the ‘nuclear renaissance’ and its implications for additional proliferation risks. It looks at the case for greater nuclear industry engagement in nonproliferation, incentives and disciplines, as well as possible disincentives for industry to take a more active role in nonproliferation and in the limitation of the pursuit of sensitive technologies which give rise to proliferation concerns.

Some preliminary thoughts are advanced as to how such a process might yield more concerted and regular government-industry collaboration in a way which is effective, sustainable and can generate the confidence of government, the public and industry. This includes a brief exploration of the value of a Code of Conduct or other arrangements for the effective management of future nuclear proliferation risks

Finally, the paper will examine the possibility of convening a nuclear government–industry conference or summit similar to the Australian sponsored government–industry conference against Chemical Weapons in 1989, which would discuss these issues, perhaps agree on a joint strategy for intensified collaboration in nonproliferation, or at least make recommendations in this regard.

1. The nuclear industry

Scope of activities

Nuclear power industry activities can be broadly divided into fuel cycle activities, reactor activities and support activities. Fuel cycle activities include uranium mining and milling to produce ore concentrates, conversion of uranium ore concentrates into uranium hexafluoride or uranium dioxide, uranium enrichment, fuel fabrication, spent fuel reprocessing and nuclear waste management, and the design and construction of fuel cycle facilities. Reactor activities include reactor design and construction, reactor operation, maintenance and decommissioning. Both reactor and fuel cycle services rely upon a number of support activities, including consulting, legal services, parts manufacturing, fuel transportation and fuel supply brokers, research and development (R&D) institutions (government, enterprise or university-based) and industry bodies.

The industry activities of most proliferation interest are the fuel cycle activities, and reactor design, which determines the physical and isotopic nature of the irradiated fuel.

Key players

The nuclear industry is dominated by three companies that engage in fuel cycle, reactor and support activities. The French company AREVA holds the largest market share in the global

nuclear market, (25-30%)⁵ and is developing reactors in a joint venture with Mitsubishi Heavy Industries, followed by General Electric-Hitachi, and Westinghouse (77% owned by Toshiba). Russia's Atomstroyexport and the China National Nuclear Corporation are positioning themselves to challenge the market dominance of these three Western-Japanese nuclear companies in turnkey reactor sales.⁶ Six companies operate commercial enrichment facilities, the China National Nuclear Corporation (2); Eurodif (1); Rosatom (4); Japan Nuclear Fuel Limited (1); Urenco (3) and the United States Enrichment Corporation (1).⁷ Three additional multinational enrichment facilities are being planned for construction in the United States.⁸ The only two commercial reprocessing plants are operated by AREVA (La Hague, France) and Sellafield Ltd (Sellafield, UK). The eight largest uranium ore producers were responsible for approximately 85% of global production in 2008, and include Cameco, Rio Tinto, Areva, Kazatomprom, Rosatom, BHP Billiton, Navoi, Uranium One and General Atomics.⁹ The largest reactor operator in the industry is Electricité de France (59 reactors).

Present capacity

As of June 2008, 439 operational nuclear reactors account for 16% of world electricity production, and 57% of global nuclear generating capacity is situated in the United States, France and Japan.¹⁰ 34 new reactors are under construction¹¹ in China (7); Russia (7); India (6); South Korea (3); Canada (2); Slovakia (2); Japan (2); Argentina (1); France (1); Finland (1); Iran (1) and Pakistan (1). The first two Generation III+ reactors, both European Pressurized Reactor (EPR) designs, are presently under construction at Flammaville, France and Olkiluoto, Finland.

2. The nuclear renaissance

Drivers of an expansion in nuclear energy

Governments are reconsidering the role of nuclear power within their power generation capacity because of increasing energy demand, pressure to reduce greenhouse gas emissions, rising fossil fuel prices, the improving economics of nuclear power and the pursuit of security of energy supply. (A more detailed description of these drivers can be found at **Annex A.**)

Public opposition to nuclear power is significant, but changing

The public aversion to nuclear power that peaked during the 1990s is diminishing. The World Nuclear Association attributes this to the impeccable safety record of the nuclear industry after the Three-Mile Island and Chernobyl accidents, the fact that the health effects of Chernobyl were less severe than expected, and community acceptance of nuclear waste

⁵ AREVA, *AREVA Business Strategy and Overview*. Paris, 2008, p 6.

⁶ Atomstroyexport hopes to win 20-25% of reactor construction contracts within the next 20 to 30 years: Mukhatzhanova. Gaukhar Mukhatzhanova. *Russian nuclear industry reforms: consolidation and expansion*. James Martin Center for Nonproliferation Studies 2007: <http://cns.miis.edu/stories/070522.htm>.

⁷ BBC News. *Q&A: Uranium enrichment* September 1 2006: http://news.bbc.co.uk/2/hi/middle_east/5278806.stmBBC.

⁸ James E. Goodby. *Internationalizing the nuclear fuel cycle*. Hoover Institution, Stanford University May 2008: <http://web.mit.edu/stgs/pdfs/Goodby--Internationalizing%20the%20Nuclear%20Fuel%20Cycle.pdf>.

⁹ Cameco demand and supply estimates: Cameco. *Uranium 101: markets*. 2008: http://www.cameco.com/uranium_101/markets/.

¹⁰ Nuclear Energy Agency, *Nuclear energy outlook 2008*. Paris, OECD, 2008, p 44.

¹¹ Under construction is defined as 'first concrete for reactor poured, or major refurbishment under way': Ibid.

repositories.¹² Nevertheless, nuclear phase-out plans or de facto moratoriums on nuclear build are in place in Switzerland, Sweden, Spain, Germany and Belgium, often in response to public aversion to nuclear power.¹³

Even in Japan, where nuclear power is well established, the public remains wary of its dangers, especially following significant incidents at nuclear power plants such as the earthquake damage in July 2007 to parts of the Kashiwazaki-Kariwa Nuclear Power Plant.¹⁴

That said, the potential of nuclear power to combat climate change may be a decisive factor in changing public attitudes to nuclear power. A poll taken in Europe in 2008 reports a decline in European hostility to nuclear power, as that hostility has yielded to the more pressing concern of global warming. According to that poll, 44% of people in the European Union support nuclear energy, up from 37% in 2005, and 45% oppose it, down from 55% four years ago. In Australia, where a majority of Australians remains opposed to nuclear energy, recent polling suggest that Australians are increasingly attuned to the argument that nuclear energy needs to be part of the future energy mix.¹⁵

Constraints on the expansion of nuclear energy

The capacity of the global nuclear industry is the major constraint upon a rapid expansion in nuclear energy. Supply bottlenecks in human resources, heavy forgings and other reactor parts are likely to worsen as demand increases.¹⁶ Other key components such as reactor cooling pumps, diesel generators, and control and instrumentation equipment have long lead times, requiring up to six years to procure and manufacture.¹⁷ Personnel qualified to design, construct and operate nuclear facilities are increasingly difficult to employ as present employees approach retiring age, and a decreasing number of university degrees are awarded in nuclear relevant fields.¹⁸ Governments and intergovernmental nuclear agencies have put in

¹² World Nuclear Association. *The nuclear renaissance*. 2007: www.world-nuclear.org/info/inf104.html.

¹³ Mycle Schneider. *2008 world nuclear industry status report: Western Europe*. Bulletin of Atomic Scientists September 19 2008: <http://www.thebulletin.org/web-edition/reports/2008-world-nuclear-industry-status-report/2008-world-nuclear-industry-status-re-1>.

¹⁴ This plant is the largest nuclear generating station in the world by net electrical power rating. The earthquake forced it to shut down operations for inspection and some repairs. Exhaustive inspections and safety checks, including three separate visits and reports by the IAEA have confirmed the safe performance of the plant during the quake. However the reactor remains closed and it is understood that public concerns are the main reason for this. International Atomic Energy Agency. *Follow-up IAEA mission in relation to the findings and lessons learned from the 16 July 2007 earthquake at Kashiwazaki-Kariwa NPP: report to the Government of Japan*. IAEA 2008: <http://www.iaea.org/NewsCenter/News/2008/kashiwazaki260208.html>; International Atomic Energy Agency. *Preliminary findings and lessons learned from the 16 July earthquake at Kashiwazaki-Kariwa NPP: report to the Government of Japan*. IAEA 2007: <http://www.iaea.org/NewsCenter/News/2008/kashiwazaki260208.html>.

¹⁵ Martine Letts. *Cross-pollination: Australia's nuclear futures*. Lowy Institute for International Policy January 2009: <http://www.lowyinterpreter.org/post/2009/01/Cross-pollination-Australia-nuclear-futures.aspx>.

¹⁶ The ultra-heavy forgings required for large Generation III+ reactors are only being produced by Japan Steel Works (JSW), which is booked out until 2010, though JSW recently announced plans to triple its capacity by 2012. Areva, China and Russia operate forging facilities capable of producing forgings for smaller reactors. *Japan Steel Works to triple capacity*. World nuclear news December 3 2008: http://www.world-nuclear-news.org/C-Japan_Steel_Works_to_triple_capacity-0312085.html; Nuclear Energy Agency, *Nuclear energy outlook 2008*.

¹⁷ Keystone Center, *Nuclear Power Joint Fact-Finding*, 2007, p 35.

¹⁸ Mycle Schneider and Antony Froggatt, *World nuclear industry status report 2007*. Paris, London, Brussels, Greens-EFA Group in the European Parliament, 2008, p 13; Sharon Squassoni, *Nuclear renaissance: is it coming? Should it?* Policy brief, Carnegie Endowment for International Peace, 2008,

place measures to encourage students to enter the nuclear field and support nuclear R&D, however the maintenance of power reactor skills and competence has been largely left to industry.¹⁹

The OECD Nuclear Energy Agency estimates that, based upon historical experience in the 1980s and the expansion in global industrial capacity since, nuclear industry capacity may feasibly increase to meet projected demand, as additional capacity would not be required until after 2020, from bringing 10 reactors online per year up to 2020, to 40-50 per year in the 2030s and 50-60 in the 2040s.²⁰ These figures suggest that the long lead times for nuclear projects will allow industry sufficient time to rebuild and expand capacity such that construction schedules and reactor safety are not compromised in the coming nuclear renaissance. The disadvantage of long lead times is that they limit the contribution that nuclear energy may make to reducing carbon emissions.²¹

Assessing the proliferation risk of nuclear energy expansion

The proliferation risk of the second nuclear age is determined by three principal factors: whether the expansion takes place in existing nuclear power states or new nuclear power states; the geostrategic contexts of countries acquiring nuclear technology for the first time; and the nature of the nuclear technology acquired.

Eighty per cent of the expansion in nuclear power is forecast in countries already using nuclear power.²² Newly-minted nuclear countries are likely to account for only 5% of global nuclear capacity by 2020.²³ China, Russia and India will account for the largest increases in new nuclear generating capacity by 2020, though the United States, France and Japan will retain their dominant position, producing 50% of global generating capacity.²⁴ The non-nuclear power countries which have planned or approved nuclear power generation are Vietnam, Turkey, Iran, Indonesia, Belarus and the United Arab Emirates (UAE), although in Indonesia popular opposition may yet prevent plans going ahead.²⁵ Countries without a present nuclear power capacity which have proposed or intend to use nuclear power are Thailand, Bangladesh, Bahrain, Egypt, Ghana, Georgia, Israel, Jordan, Kazakhstan, Kuwait, Libya, Malaysia, Namibia, Nigeria, Oman, the Philippines, Qatar, Saudi Arabia, Uganda, Venezuela²⁶ and Yemen.²⁷

The states seeking nuclear power for the first time are concentrated in Africa, the Middle East and Southeast Asia. All are zones of varying degrees of domestic political instability. The

pp 2-3; Sharon Squassoni, Charles D. Ferguson and Alan Hanson, *Nuclear energy, nonproliferation and arms control in the next administration: is nuclear energy the answer?* (Washington, D.C., 29 October 2008); Nuclear Energy Agency, *Nuclear energy outlook 2008*, pp 322-324.

¹⁹ Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 324.

²⁰ *Ibid.*, p 318.

²¹ In order to make up Stephen Pacala and Robert Socolow's nuclear 'wedge' as an option to mitigate climate change, 700 1000MWe reactors would have to come online by 2050, in addition to maintaining the present share of nuclear energy in the global mix, requiring two reactors to come online every month for the next 40 years. This is unlikely to be a sustainable growth rate: see Charles D. Ferguson, *Nuclear energy: balancing benefits and risks*. CSR no 28. New York, Council on Foreign Relations, 2007, p 13.

²² World Nuclear Association. *The nuclear renaissance*.

²³ Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 60.

²⁴ Down slightly from 57% in 2004: *Ibid.*, p 84.

²⁵ Jay Solomon, U.S. and U.A.E. to sign nuclear-cooperation pact. *Wall Street Journal*, 15 January 2009.

²⁶ Nina Gerami and Sharon Squassoni, *Venezuela: a nuclear profile*. Proliferation Analysis. Washington, D.C., Carnegie Endowment for International Peace, 2008.

²⁷ Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 75.

Middle East is strategically unstable and directly affected by the Iranian enrichment program. While Southeast Asian countries are not directly in the line of North Korean nuclear threats, their security would nonetheless be affected by a deteriorating East Asian strategic environment were Pyongyang's nuclear ambitions to be unchecked. In all three regions, states have genuine reasons for wanting to develop nuclear power, including growing energy demand²⁸ and the desire to preserve fossil fuels for export,²⁹ and in many cases had been interested in acquiring nuclear power prior to the Iranian and North Korean proliferation crises. Significantly, Vietnam and Indonesia have signaled their intent not to develop an enrichment capacity, as have Bahrain and the UAE.³⁰

While no other state with recent nuclear energy ambitions has expressed intent to develop enrichment or reprocessing capabilities, Egypt has refused to rule out its acquisition of such technologies on equity grounds.³¹ Such attitudes do not allay suspicions that the renewed interest in nuclear power in the Middle East is at least in part a hedging strategy in response to Iran's nuclear program.³² Some analysts have expressed concern over the proliferation risks posed by the lack of regulatory competence in the region.³³ No new plans for enrichment or reprocessing have been advanced in Africa or South East Asia, though fuel preparation may become economically viable as more plants come online in the region.³⁴

Important factors in the realisation of these nuclear energy ambitions are whether these states will be able to pay for their nuclear energy plans and whether they can develop and finance the necessary regulatory and technical bases to realise them safely. They do suggest fertile ground for increased assistance from established nuclear powers and industry to help them develop competence in regulation and effective export controls. In the present economic climate, the ability to finance these costly projects, however, is far from assured.

Nuclear **power** reactors themselves, in particular the standard light water reactors (LWRs), are not considered a high proliferation risk because the isotopic content of the spent fuel and the difficulty of separating plutonium from the spent fuel assembly mean that they are not effective producers of fissile material.³⁵ No additional states currently have plans to construct commercial enrichment plants, though Argentina, Brazil and South Africa have the capacity and so far insist on the right to do so in future. No state currently has firm plans to construct a

²⁸ Andrew Symon, *Nuclear power in Southeast Asia: implications for Australia and non-proliferation*. Lowy Institute Analysis. Sydney, Lowy Institute for International Policy, 2008.

²⁹ David Albright and Andrea Scheel, *Unprecedented projected nuclear growth in the Middle East: now is the time to create effective barriers to proliferation*. ISIS Report. Washington, D.C., 2008.

³⁰ Peter Crail and Jessica Lasky-Fink. *Middle East states seeking nuclear power*. Arms Control Association 2008: http://www.armscontrol.org/act/2008_05/MiddleEastEnergy; Solomon, U.S. and U.A.E. to sign nuclear-cooperation pact .

³¹ Crail and Lasky-Fink. *Middle East states seeking nuclear power*.

³² Ibid.; Albright and Scheel, *Unprecedented projected nuclear growth in the Middle East: now is the time to create effective barriers to proliferation*, , William J. Broad and David E. Sanger, With eye on Iran, rivals also want nuclear power. *New York Times*, 15 April 2007.; and Sanger, *IISS Nuclear energy expansion in the Middle East: reactions to Iran?* IISS Strategic Comments. London, Institute for International and Strategic Studies, 2006.

³³ Crail and Lasky-Fink. *Middle East states seeking nuclear power*. For an assessment of the regulatory capacity of Egypt, Saudi Arabia and Turkey, see James M. Acton and Wyn Q. Bowen, *Atoms for Peace in the Middle East: the technical and regulatory requirements*. NPEC Working Paper Series. Washington, D.C., 2008.

³⁴ Symon, *Nuclear power in Southeast Asia: implications for Australia and non-proliferation*, pp 14-15.

³⁵ Some argue that LWR fuel may still be useful for producing fissile material if the state in control of the reactor is 'bent on making bombs': see Victor Gilinsky, A fresh examination of the proliferation dangers of light water reactors, in *Taming the next set of strategic weapons threats*. Ed. Henry Sokolski. Carlisle, PA, Army War College Strategic Studies Institute, 2006.

commercial reprocessing plant.³⁶ Renewed US support for reprocessing as a method of dealing with the waste disposal problems has led to R&D cooperation with South Korea on pyroprocessing techniques, a reprocessing technique that present research shows to be more 'proliferation safe' than the PUREX process presently used, but is by no means 'proliferation resistant'.³⁷

Nuclear energy ambitions among states without an existing nuclear power capability are not of direct proliferation concern, especially if sensitive technologies are not pursued.

However, views on whether an increase in the number of power reactors around the world poses an increase in nuclear proliferation dangers differ. John Ritch, who was President Clinton's Ambassador to the IAEA in the 1990s and is current Director General of the World Nuclear Association (WNA), is not convinced that even a tenfold increase in power reactors in the world would have a significant impact on nuclear proliferation. He believes that by far the greatest problem is rogues states determined to develop a nuclear weapons program and their number has not significantly increased in the last 10-15 years.³⁸ This is in contrast with the views in the 2008 report of the International Security Advisory board of the U.S. Department of State that 'the rise in nuclear power worldwide, and particularly within Third World countries, inevitably increases the risks of proliferation.'³⁹

There is always a risk that the establishment of even the most basic nuclear infrastructure and expertise can presage later pursuit of a full nuclear fuel cycle. At the very least, it gives such countries that option. Under cover of their rights to develop such technology, the examples of Iran and the DPRK have presented great challenges to the international community in managing future nuclear ambitions by new states under the current international rules, which have not deterred a determined proliferating state.

Mitigating the proliferation risk

Three strategies suggest themselves to policymakers and industry to mitigate the proliferation risks of the second nuclear age: technical solutions, commercial solutions and political solutions. Technical solutions would include making fissile material more technically difficult to produce, and include the development of nuclear reactors that produce less or no fissile material and/or make any fissile material more difficult to extract. Commercial solutions might include replacing turnkey reactor sales contracts to build-own-operate contracts,⁴⁰ or inserting minimum nonproliferation requirement provisions into supply contracts.⁴¹ Political solutions would include placing the nuclear fuel cycle under multilateral control and restricting supply to those states with an Additional Protocol in place with the IAEA. Industry is a necessary partner in all three approaches.

3. The case for greater industry involvement in support of nonproliferation

³⁶ The US has expressed interest through its GNEP proposal, but has yet to make a firm decision on the matter.

³⁷ See Edwin Lyman and Frank von Hippel. *Reprocessing revisited: the international dimensions of the Global Nuclear Energy Partnership*. Arms Control Association 2008: http://www.armscontrol.org/act/2008_04/LymanVonHippel. The authors also express concern about the wisdom of such R&D cooperation given South Korea's suspicion and envy of the Japanese reprocessing capability.

³⁸ Conversation between Letts and John Ritch on 23 December 2008.

³⁹ International Security Advisory Board. *Report on proliferation implications of the global expansion of civilian nuclear power*. United States Department of State 7 April 2008: <http://2001-2009.state.gov/documents/organization/105587.pdf>.

⁴⁰ Alan Hanson in Squassoni, Ferguson and Hanson, *Nuclear energy, nonproliferation and arms control in the next administration: is nuclear energy the answer?*

⁴¹ Squassoni, *Nuclear renaissance: is it coming? Should it?*, p 6.

Industry generally abides by the international nonproliferation regime, in most instances cooperating with national safeguards obligations, physical protection of nuclear materials and export controls.⁴² Industry must, in partnership with government and the IAEA, manage the unique threats of nuclear accident, nuclear terrorism and nuclear proliferation, all of which have significant public policy implications. The industry does not actively promote nonproliferation, though it actively manages and mitigates the threats of nuclear accident and, to a lesser degree, nuclear terrorism, at both the industry-wide and company level.⁴³

The lack of active industry engagement in nonproliferation advocacy does not necessarily increase the risk of proliferation. That said, a more active partnership on nonproliferation may well be needed for the future, as the world's nuclear industry grows, and where, as a consequence of growing demand, governments look to tighten the nonproliferation regime.

The nuclear industry, fairly or unfairly, continues to suffer public image problems and must be, like Caesar's wife 'above suspicion'. The slightest misstep is likely to have far graver consequences for the industry than for other industries utilising different sources for energy production. The Chernobyl and Three Mile Island incidents and their effect on the acceptability of nuclear power were dramatic enough. (If another country were to acquire nuclear weapons using technology sold by a particular company, its corporate image and the image of the industry as a whole would be tarnished.⁴⁴ Were a nuclear weapon detonated, either by a state or non-state actor, then the nuclear power industry would come under massive public and governmental pressure to demonstrate that it posed a zero proliferation risk.) This could badly damage the industry's prospects and perhaps even its survival.⁴⁵ So industry has a strong impetus to support nonproliferation.

The proposition that an active nonproliferation stance by industry could be a public confidence-building tool and even a commercial imperative rather than primarily a box to tick should at least be tested.

Obstacles and incentives to greater industry involvement in nonproliferation

Depending on one's perspective, obstacles and incentives for greater industry involvement in nonproliferation are two sides of the same coin, given the high degree of public/private and cross-border ownership in the industry. It is not so easy to determine where private interests end and public interest starts. As many nuclear companies are wholly or partially government-owned, or enjoy close links with government, this should augur well for tighter government-industry cooperation in nonproliferation, provided there is a commitment to this by both government and industry.

That said, a strong perception persists within the nuclear industry that nonproliferation is a government responsibility and is adequately managed by governments.⁴⁶ Governments tend to

⁴² Companies involved in the nuclear black market run by A.Q. Khan during the 1990s were an exception to general industry compliance.

⁴³ An example of industry-wide efforts to improve nuclear safety is the World Association of Nuclear Operators established in the wake of the Chernobyl accident in 1986, which conducts peer reviews of reactor safety and shares best practices. The recently-established World Institute of Nuclear Security will operate along similar lines, but to share best practices in nuclear security.

⁴⁴ This 'ripple effect' was a driver of self-regulation in other industries, but did not eventuate from sales to the A.Q. Khan network.

⁴⁵ Personal communication from the Australian Safeguards and Nonproliferation Office, 4 December 2008; Personal communication from the Australian Uranium Association.

⁴⁶ See Alan Hanson of AREVA's comments in Squassoni, Ferguson and Hanson, *Nuclear energy, nonproliferation and arms control in the next administration: is nuclear energy the answer?*; Gretchen

see proliferation as a political issue which is not the domain of industry. On the other hand companies are concerned that recognising a link between their activities and weapons proliferation could tarnish their corporate image and damage business.⁴⁷ There is also a common perception that the nuclear industry is already overregulated and does not require any additional regulatory burden to address proliferation. In particular, industry is concerned by additional costs that may be incurred in actively preventing proliferation.⁴⁸

On the face of it, the disincentives for industry to get ahead of government are wide-ranging, from loss of profits, to corporate image concerns, to loss of competitiveness within the industry. Companies fear that if they tighten their conditions of sale to prevent proliferation, they will be undercut by less scrupulous suppliers seeking to improve their market share, resulting in a loss of competitiveness and profits. They are also wary of the effect nonproliferation cooperation would have on their image of independence from government.⁴⁹ Companies are rightly concerned that information sharing resulting from any increased cooperation with government raises the issue of the protection of proprietary information.⁵⁰ Companies offering products or services that are more proliferation prone than others on the market will suffer a loss of sales and profits and may go out of business if they act in furtherance of nonproliferation.⁵¹

The nonproliferation rules and treaties are drafted by government and governments are responsible for ensuring they are implemented through domestic legislation. Governments rarely include industry representatives in proliferation information exchanges or policy discussions in groups such as the Nuclear Suppliers Group (NSG), except through the occasional outreach activity. Another obstacle arises from differing levels of support for the nonproliferation regime among governments and divergent attitudes towards the acquisition of enrichment and reprocessing technology by states not already possessing them. It may be the case that were industry to be more supportive of the nonproliferation regime than governments, corporate interests and national interests might also diverge.⁵²

The close relationship between government and the nuclear industry does not guarantee that nonproliferation commitments will take precedence. Nuclear cooperation agreements continue to be pursued between advanced nuclear states and countries in all regions of the world, apparently without real concern about the possible proliferation dangers that such assistance might give rise to.⁵³ There are instances where governments have not acted in the interests of nonproliferation first, and where they have been swayed by the commercial interests of their nuclear industry or by overriding strategic and security concerns.⁵⁴

Hund and Amy Seward, *Broadening industry governance to include nonproliferation*. Pacific Northwest Center for Global Security Publication. Richland, Washington, 2008, pp 19-20.

⁴⁷ Gretchen Hund. *Nonproliferation promoted by industry self-regulation*. Pacific Northwest Center for Global Security 2006: <http://pnwccgs.pnl.gov/pdfs/INMM-Hund6-14-06REV.pdf>.

⁴⁸ See Gretchen Hund, Carol Kessler, Heidi Mahy, Fred McGoldrick and Amy Seward, *Cradle-to-grave nuclear fuel supply workshop: industry's potential role*. Richland, Washington, Pacific Northwest Center for Global Security, 2007; Hund and Seward, *Broadening industry governance to include nonproliferation*,

⁴⁹ See Elizabeth Turpen's comments in Hund and Seward, *Broadening industry governance to include nonproliferation*, pp 19-20.

⁵⁰ *Ibid.*, p 14.

⁵¹ Atomic Energy of Canada Limited's CANDU reactors may face this problem in the future.

⁵² The divergence of commercial and national interests is already a source of tension between companies and governments in the global nuclear market: see Michelle M. Smith and Charles D. Ferguson, France's nuclear diplomacy. *International Herald Tribune*, 12 March 2008.

⁵³ Squassoni, *Nuclear renaissance: is it coming? Should it?*, p 5

⁵⁴ Matthew Fuhrmann. *Taking a walk on the supply side: the determinants of civilian nuclear cooperation*. Belfer Center for Science and International Affairs 2008:

Industry surveys in the US have shown that industry assesses its own performance in meeting export controls requirements as less than perfect.⁵⁵

What this suggests is the need for a concerted effort by industry and government to develop jointly a new set of understandings of what the future proliferation dangers are as well as a demonstrable commitment to nonproliferation, which can also be as good for business as they are for security. To be really effective, this probably needs to be at the global level.

Active industry support and engagement will be necessary if major changes are made to the international market structure in order to make it more proliferation safe, for example in placing enrichment facilities under multilateral control. Given the high costs of fuel cycle activities, it has been suggested that finding economies of scale through a multinational approach could fulfill the dual role of keeping costs down while helping support nonproliferation policies. For example, companies and states might consider becoming shareholders in multinationally-owned modern centrifuge facilities, using leased centrifuge machines under ‘black box’ conditions as an alternative to investing in their own smaller, high-cost enrichment facilities.⁵⁶ Such facilities would, of course, need to be accessible to nations yet to develop their own fuel cycle facilities, maybe even as joint plant operators as well as consumers.⁵⁷ These facilities would need to develop appropriate rules for the supply of nuclear fuel which not only supports nonproliferation but effectively guarantees security of supply free of capricious political interference.

Industry is also at the front line of the development and spread of dual-use nuclear technology and has the capacity to prevent, limit or place conditions upon the spread of that technology, as well as report it, and to influence the type of nuclear technology that is developed in the future. Industry reporting of sales could assist the IAEA in assessing the completeness of member-state declarations.

Large nuclear companies can exert considerable pressure upon their national governments in their nuclear policy choices. Therefore an industry which makes nonproliferation a priority may also help reinforce the nonproliferation commitments of government. Making a commitment to nonproliferation part of the corporate brand might in fact deliver practical benefits for companies, helping to cultivate better relationships with regulators and nonproliferation advocates, and dispel the poor image created by the anti-nuclear lobby. Of course there are limits to the pressure that even larger nuclear companies can exercise when they are publicly owned and where broader national security and strategic concerns come into play.

Industry-wide initiatives to stem proliferation would require a harmonisation of business practices, ensuring that no company was disadvantaged for being more proactive on proliferation and thereby discouraging the first mover.⁵⁸ More generally, industry should be an active partner with governments in the drafting of regulations and treaties that affect their activities, to ensure that they make operational sense and to encourage compliance.

4. Initiatives to engage industry

http://belfercenter.ksg.harvard.edu/files/uploads/Fuhrmann_Talking_A_Walk%20on_the_Supply_Side.pdf.

⁵⁵ Cupitt. *Survey on U.S. industry compliance and export controls: executive summary*.

⁵⁶ Goodby. *Internationalizing the nuclear fuel cycle*, p 10.

⁵⁷ *Ibid.*, p 10.

⁵⁸ This problem was noted by Ralph Wirtz of Oerlikon Leybold Vacuum, Hund and Seward, *Broadening industry governance to include nonproliferation*, p 4.

The nuclear industry currently cooperates with governments to fulfill their nonproliferation obligations, abiding by export controls and their safeguards inspection and reporting requirements. Industry has been effectively engaged in Generation IV reactor activities under the Advanced Fuel Cycle Initiative of GNEP, to develop proliferation safe reactor designs with US government R&D funding.⁵⁹ Beyond their obligations and R&D cooperation, the industry contribution to nonproliferation is minimal, and advances in nuclear safety and security have little to offer by way of precedent, as they have primarily engaged nuclear operators. Nonproliferation values are, however, contained in the WNA Charter of Ethics and Principles of Uranium Stewardship.⁶⁰

What more can be done?

Not enough is known about how far industry is prepared to go in taking a more prominent stand on nonproliferation. Members of the Australian Uranium Association (AUA) have shown an interest in encouraging industry to become more prominent and confident advocates in favour of nonproliferation because they think, by and large, industry has a good story to tell and because of their commitment to uranium stewardship principles.

We have listed here some general considerations and ideas for designing initiatives to further engage industry on nonproliferation. This includes examining the pros and cons of an industry-wide Code of Conduct and a government-industry conference which might help set the tone for the future management of the ‘second nuclear age’.

More information is needed on how industry would respond to these ideas, or indeed other ideas for how such increased engagement might be effected.

Such information could be obtained in numerous ways. One way would be a survey which could be put to a selection of key industry representatives on which a future government-industry dialogue might be based.

The Commission could consider asking the ICNND Secretariat or one of the participating research centres to design and send a survey to the key industry players and perhaps also to IAEA member states to assist in shaping the ICNND’s own recommendations about greater industry engagement in nonproliferation.

Whom to engage

The answer to this question will depend upon the type of initiative and desired outcome of any industry engagement. There are two broad options for whom to engage: key companies supplying sensitive nuclear technology, or as many nuclear industry companies as possible.

Targeting the suppliers of sensitive nuclear technology would engage those whose conduct will bear most directly upon the future of the nonproliferation regime. Stemming the expansion of enrichment and reprocessing capabilities and/or multilateralising those existing facilities will require the direct cooperation of those companies. Companies to be engaged on this matter should include Areva, Rosatom, Urenco, Eurodif, China National Nuclear Corporation, Japan Nuclear Fuel Limited, Westinghouse, GE Electric, Silex, Industreas Nucleares do Brasil, BNFL, Cameco, the Pakistan Atomic Energy Corporation, Nuclear Fuel Complex (India), the Nuclear Energy Corporation of South Africa and any other company with control of enrichment or reprocessing facilities and technology.

⁵⁹ See U.S. Department of Energy. *Global Nuclear Energy Partnership: Industry involvement*. 2008: <http://www.gnep.energy.gov/afciparticipants/industryinvolvement.html>.

⁶⁰ World Nuclear Association. *WNA Charter of Ethics*. World Nuclear Association 2008: <http://www.world-nuclear.org/uploadedFiles/org/about/pdf/WNA%20Charter%20of%20Ethics.pdf>.

Another possibility is to engage as many nuclear industry companies as possible, whether they engage in fuel cycle, reactor or support activities, in order to create an industry-wide norm and momentum in favour of nonproliferation. This broader strategy would ensure that smaller companies were as committed to nonproliferation as the market leaders, and that industry leader commitment to nonproliferation would not be undermined by other companies who had not been similarly engaged by government. It also addresses the concern that a large number of nuclear activities have the potential to contribute to a weapons capability by building up the necessary infrastructure and expertise.

Whether done sequentially or at the same time, targeting the key industry players in sensitive nuclear technology and engaging the wider industry will be necessary to achieve an industry-wide commitment to nonproliferation that is also capable of delivering practical results. It is likely that the companies dealing with sensitive nuclear technology will not commit to nonproliferation without an assurance that the rest of the industry will support rather than undercut them, while the industry as a whole is unlikely to commit to nonproliferation without the leadership of the major companies.

This might be a role for an industry peak body such as the WNA, which could begin by engaging the suppliers of sensitive nuclear technology with the intention of associating a commitment to nonproliferation with leadership of the industry, as well as encouraging smaller companies to comply with new standards of appropriate industry behaviour.

Outcomes

Two types of outcomes may result from industry engagement – symbolic outcomes, in which industry declares its support for preventing proliferation as an exercise in public diplomacy, and practical outcomes, in which companies take active measures in order to prevent proliferation. Both types of outcomes are desirable and mutually reinforcing. A symbolic commitment would raise awareness of the role of industry in facilitating or preventing proliferation and provide a standard against which industry could be held responsible for the proliferation implications of its conduct, while generating a positive public image for the industry.

Practical outcomes could fill some of the gaps in the nonproliferation regime and contribute to the overall strengthening of the regime. Examples include:

- Industry collaboration in the establishment of multilateral fuel cycle services;
- Making minimum nonproliferation standards a condition of supply of nuclear technology written into contracts e.g. requiring that states purchasing nuclear reactors have an Additional Protocol (or equivalent safeguards agreement) in place with the IAEA;
- Reporting suspicious procurement efforts to national authorities or the IAEA;
- Disclosing sales information to assist the IAEA in verifying the completeness of state nuclear declarations;
- Developing technologies with a lower proliferation risk and ceasing sales of products that pose an unacceptable proliferation risk;
- Government-industry-IAEA consultation in the drafting of any new regulations, treaties or protocols, or in updating existing instruments to ensure that they are as effective as possible;
- Mechanisms for sharing nonproliferation best practices, and for enforcing compliance with such measures;
- Assisting states with fledgling nuclear power programs to develop or strengthen their competence in regulation, safety and effective export controls.

These outcomes may be achieved through industry self-regulation or through cooperative action between government and industry. They are more likely to be successful if done collaboratively with government and agencies like the IAEA.

5. Code of Conduct

Industry Codes of Conduct are a form of business self-regulation⁶¹ and may be divided into three main types of codes, those with an aspirational purpose (a code of ethics), an educational or advisory purpose (a code of conduct) or a restrictive purpose (an enforceable code of practice).⁶² The Biological Weapons Convention experience with codes of conduct is not entirely applicable to the nuclear industry,⁶³ yet the Biological Weapons Convention experience highlights some important questions that any nuclear industry code of conduct would need to respond to, including the need to clearly define the purpose, audience and function of the code of conduct.

The WNA has a series of principles and codes it has developed over time, the latest iteration of which was published in January 2008 called the 'New WNA Policy'. These policies include the WNA Charter of Ethics, the WNA Principles of Uranium Stewardship and Principles for Managing Radiation, Health and Safety, Waste and the Environment and the International Council of Mining and Metals (ICMM) Sustainable Development Principles. These policies have, according to the WNA, been developed by industry leaders with the support of the full WNA membership and key organisations such as the IAEA and the ICMM. According to the WNA, these codes 'hold the status of a policy and ethical declaration by the full WNA membership, which encompass most of the wide range of enterprises that comprise the global nuclear industry-from uranium miners, to equipment suppliers, service providers, and generators of electricity.'⁶⁴

With around 180 members, the WNA represents 90% of worldwide uranium production and of nuclear power generation. The WNA has pledged to obtain, from all relevant enterprises, formal commitment to a Code of Practice that translates its principles into worldwide industry performance; to conduct periodic audits, peer reviews and public information activities. The WNA does not have a mandate to enforce any of the provisions of its code of practice and ethics. These codes and principles are ultimately enforceable through national legislation and regulation in accordance with a number of international treaties and statutes covering the range of peaceful nuclear activities.

Self-regulation

In the nuclear industry there are also two examples of more elaborated processes for sharing and disseminating best practice and information, one of which is still under development:

The World Association of Nuclear Operators (WANO), formed in May 1989 in response to the Chernobyl accident to improve safety standards at nuclear power plants worldwide such that a repeat accident would never occur, provides a forum for the exchange of operating experience in a 'culture of openness' amongst various nuclear operators. WANO conducts voluntary peer reviews of nuclear safety at another member's plant and provides a report on

⁶¹ For more on business self-regulation, see Virginia Haufler, *Beyond government: business self-regulation in international affairs*. Study Group on the role of the Private Sector, 1998.

⁶² Brian Rappert, *Towards a life sciences code: countering the threats from biological weapons*. Strengthening the Biological Weapons Convention Briefing Paper, 2005, p 17.

⁶³ Codes of Conduct have become the alternative to a protocol to strengthen the BWC, where the protocol was defeated by industry opposition. Life sciences Codes of Conduct are thus directed at scientists and formulated by the scientific community and its stakeholders, not industry, nor is the regulation of industry behaviour the object of life sciences codes of conduct. See *Ibid.*, pp 3-12.

⁶⁴ World Nuclear Association. *Sustaining global best practices in uranium mining and processing: principles for managing radiation, health and safety, waste and the environment*.

that plant based on safety criteria and quantitative performance indicators, in addition to providing workshops and seminars and technical support and exchange.⁶⁵

The effectiveness of WANO is attributed to the fact that 'the nuclear industry perceived them as its own ideas, operating to serve the industry's own interest. These organizations also had direct access to the utility CEOs, who could bring powerful peer pressure to bear on any CEO whose utility was lagging behind.'⁶⁶

The recently-established World Institute for Nuclear Security (WINS), a joint initiative of NTI and the Institute of Nuclear Materials Management, intends to bring together representatives from government, industry, academia and think tanks in an effort to share best practices on nuclear security, in a similar model to WANO.⁶⁷

WANO (and possibly WINS also, in the future) provides an example of how industry initiatives to improve the safety record of nuclear operators have surpassed the minimum safety standards imposed by national legislation and have facilitated more uniform safety standards internationally. A commitment to nuclear safety is a very common corporate social responsibility principle for companies operating nuclear reactors. The sharing of best practices, performance indicators and peer reviews are mechanisms that could be transposed into the nonproliferation arena, as WINS is attempting to do for nuclear security.

What could a global code on nonproliferation add?

Nonproliferation involves a broad and complex network of treaties, rules, and actions in multiple locations using open-source and classified information. It does not seem to lend itself to location-specific safety and security codes of conduct. The question must therefore be asked whether any kind of code of conduct can add anything to practical nonproliferation efforts. It might be said that any code of conduct is no replacement for rules and regulations pursuant to international treaty obligations and export control legislation and that in fact it may be inimical to nonproliferation to settle for a 'Code of Conduct' in lieu of legal obligations.

While codes of conduct may be implemented at many different levels (company, national, regional, universal), a nuclear industry code of conduct would also be ineffective if it were not universal in application. As noted, codes of ethics relating to nonproliferation already exist in the industry⁶⁸ and have probably done little to deter those entities determined to sell equipment to sensitive locations, as the most recent information about Chinese sales of dual-use equipment to Iran would suggest.⁶⁹

A new code of conduct would be either advisory or enforceable, and draw lessons from the lack of success of present codes of conduct. The difficulty of devising international industrial enforcement mechanisms (especially if customer/government complicity is involved)

⁶⁵ World Association of Nuclear Operators. *What is WANO?*:

http://www.wano.org.uk/WANO_Documents/What_is_Wano.asp.

⁶⁶ Matthew Bunn. *Securing the bomb 2008*. Project on Managing the Atom, Harvard University, and Nuclear Threat Initiative November 2008: http://www.nti.org/e_research/Securing_the_bomb08.pdf.

⁶⁷ World Threat Initiative. *World Institute for Nuclear Security (WINS) is launched in Vienna: NTI press release*. 29 September 2008: http://www.nti.org/c_press/release_WINS_092908.pdf.; World Institute for Nuclear Security. <http://www.wins.org>.

⁶⁸ For example, the WNA Charter of Ethics and AUA Stewardship Principles. IAEA Codes of Conduct, such as the Code of Conduct on the Safety and Security of Radioactive Sources and Code of Conduct on the International Transboundary Movement of Radioactive Waste, are directed at IAEA member-states rather than companies.

⁶⁹ Glenn R. Simpson and Jay Solomon, Fresh clues of Iranian nuclear intrigue. *Wall Street Journal*, 16 January 2009.

suggests that an advisory code of conduct would be the most achievable for the nuclear industry at present.

An industry code of conduct would need to be drafted by industry representatives in consultation with government regulators, nonproliferation experts and representatives of intergovernmental nuclear agencies to ensure that all stakeholders are included in the drafting stage and are more likely to accept the finished product. The process of drafting a code of conduct could be beneficial in raising awareness of issues and facilitating debate about appropriate conduct, and should entail provisions for review and revision in order to 'keep the conversation going'.⁷⁰ A provisional code of conduct could be drafted by a ginger group of companies, or a working group of WNA members, which would then seek the input of governments, international agencies and other companies. The draft code of conduct could then be presented to an industry conference,⁷¹ or at a special conference called for the purpose of improving industry contribution to nuclear nonproliferation (this need not necessarily be the government-industry conference discussed below). The code of conduct would be implemented by companies, but could benefit from government and industry body promotion.

This could be a lengthy process, and seen to be duplicating obligations which government and industry already have under existing legal regimes. It could be difficult to enforce. However, we were encouraged to hear from some industry representatives that they viewed the process itself as part of the answer, as it would highlight engagement which, properly managed, would eventually lead to the right result.

An interim step would be to encourage nuclear industry companies to include a commitment to nonproliferation in their corporate social responsibility statements, alongside commitments to sustainable development, nuclear safety and security.⁷²

6. A government-industry conference

Government-Industry Conference against Chemical Weapons (GICCW)

The idea of a government-industry conference is drawn from the experience of the Chemical Weapons Convention, in which a Government-Industry Conference against Chemical Weapons in 1989 played an important role in the conclusion of the treaty in 1993 after more than twenty years of negotiation. GICCW was the culmination of four to five years of intensive consultation and diplomatic activity between government and the chemical industry. It started with the establishment of the Australia Group in 1985 when Australia brought together representatives of industrial nations which exported certain relevant chemicals to ensure that their industries were not associated with the production of chemical weapons. Australia also launched in 1988 an Asia-Pacific regional initiative to work cooperatively with neighboring countries to prevent chemical proliferation in the Asia-Pacific region.

As leader of the Australia Group, Australian officials had also started to engage with government and leading chemical industry representatives in capitals on how best to advance the objective of preventing the spread of chemical weapons, while not impeding the legitimate activities of the civil chemical industry and protecting their commercial interests. In the absence of a peak body for the chemical industry, Australian diplomats worked with

⁷⁰ Rappert, *Towards a life sciences code: countering the threats from biological weapons*, p 21.

⁷¹ Possible conferences include the World Nuclear Association annual fuel cycle conference or the Institute of Nuclear Materials Management Annual Meeting.

⁷² Hund and Seward, *Broadening industry governance to include nonproliferation*, pp 2-3.

key industry players, such as Hoechst, Bayer and Monsanto, to form a spearhead group to bring other industry players on board.⁷³

Strong support from one of the two principal chemical weapons possessors, the United States, provided important political impetus. Then US Secretary of State James Baker and then Australian Foreign Minister Gareth Evans had discussed how to build on the momentum of the Paris Conference on Chemical Weapons in January 1989. What followed was a joint announcement on 7 March 1989 that Australia would host a government-industry conference. Baker made the announcement in Vienna at a meeting of foreign ministers of countries participating in the talks on Conventional Forces in Europe.⁷⁴

Political backing was also important from the members of the Conference on Disarmament (CD) who were negotiating the Chemical Weapons Treaty. They needed to be assured that the government-industry conference was not an attempt to open up a second negotiating forum. In an address to the CD in June 1989, then Australian Foreign Minister Gareth Evans sought to provide such assurances.

By the time GICCW took place in Canberra in September 1989, most of the essential groundwork for a joint approach had been laid. At the conclusion of the conference, chemical industry representatives released a statement, '(1) express[ing] their willingness to work for an early conclusion of a global chemical weapons ban; (2) oppos[ing] misuse of industrial products for the dangerous proliferation of CW; (3) commit[ting] industry to continue its dialogue with governments on ways to implement a CW convention; and (4) accept[ing] a self-policing role.'⁷⁵

The world's chemical industry certainly understood (eventually) the advantage of demonstrating to shareholders and to the public its commitment to chemical disarmament and nonproliferation, especially in light of its inadvertent contribution to Iraq's chemical weapons program. The industry knew that if it was going to be regulated intensively and obtrusively, there were distinct advantages to industry being an active collaborator in ensuring that their business did not contribute to chemical weapons proliferation, while at the same time having a direct say in how commercial confidentiality could be preserved through the Chemical Weapons Treaty. The 1989 Government-Industry Conference Against Chemical Weapons provided a useful vehicle to publicly set the basis for a successful government-industry partnership for this purpose.

Through the conference and by participating as advisers to the negotiations at the CD in Geneva, industry developed confidence in the process which helped developed a level playing field with an equal impact on all companies, while ensuring that commercial and technological confidentiality was maintained.⁷⁶

The situation of the chemical industry differs from that of the nuclear industry as the Nuclear Nonproliferation Treaty (NPT) is already in existence, political support for complete nuclear

⁷³ Personal communication from Paul O'Sullivan, Director-General of Security, Australian Intelligence Security Organisation (ASIO), former Director of the Chemical and Biological Disarmament Section, Department of Foreign Affairs and Trade in the mid 1980s and Ambassador for Disarmament 1989-1992).

⁷⁴ *Government-industry conference on chemical weapons proliferation: Minister for Foreign Affairs and Trade news release M40*, 6 March 1989.

⁷⁵ Nuclear Threat Initiative. *WMD 411 Chronology -- 1989*. 2008: http://www.nti.org/f_wmd411/1989.html.

⁷⁶ Personal communication from Tom Reynolds, former President of the Chemical Confederation of Australia and Chairman of the 1989 GICCW Industry Forum.

disarmament is not as strong as it was for chemical weapons⁷⁷ other than the aspiration to general and complete disarmament in the NPT and inspections of nuclear facilities are already in place, which was not the case for chemical weapons.

GICCW took place in the context of the emerging global consensus that chemical weapons should be abolished altogether. However, without the chemical industry's active support and collaboration, that treaty could not have come into existence.

The Biological Weapons Convention

Efforts to engage industry in the negotiation of a Verification Protocol to the Biological Weapons Convention were not successful. There was neither the political nor the business support among the key players for this. Diplomats who participated in these negotiations report that it was widely perceived that the reason the US withdrew from the Protocol negotiations in 2001, causing them to come to a halt, was because of pressure from Pharma, their peak pharmaceutical/biotechnology body. Similar views were voiced by European pharmaceutical enterprises. Their main concern was a perception that the CWC regime was too intrusive and thus highly threatening to commercial confidentiality. There is also strong scepticism about the verifiability of BW proliferation. Indeed there was a strong view that the BW verification regime under development would be expensive to comply with and trivially cheap to evade.⁷⁸

Towards a government-industry conference against nuclear proliferation

The global, integrated nature of the nuclear business, its very close connection to government and a changing nuclear policy landscape, including the renewed push towards progress in nuclear disarmament, argue strongly in favour of more regular government-industry collaboration, including through joint monitoring, reporting, and enforcement of the rules and export controls. A jointly negotiated declaration as to how that would be done would add a new dimension to the global nuclear conversation.

As for the prospect of a conference modelled on the GICCW, a similar intensive diplomatic effort would be required in preparation for any nuclear industry-government conference, and the effort would require an agent with strong government backing. In a similar fashion to the GICCW, a ginger group comprising some of the key companies outlined earlier in this section should be formed, and a conference should include as many industry players as possible.

Possible outcomes of a government-industry conference

Outcomes of the conference could include a declaration of the type resulting from GICCW, approval of a Code of Conduct or code of practice, or scheduling of regular government-industry consultation meetings on the margins of NSG meetings, and/or in parallel with the NPT Preparatory Conferences or Review Conferences, industry body conferences or IAEA meetings.

New, groundbreaking announcements are also possible, given that supplier governments have under active consideration the development of new rules of the game which may have real impact on the development of the industry. These include proposals to multilateralise the nuclear fuel cycle; to limit the spread of sensitive nuclear technologies; to change NSG rules to insist that countries not exercise the right to develop sensitive technology as a condition of

⁷⁷ President H.W. Bush had declared that he wanted to be remembered as the president who had rid the world of chemical weapons.

⁷⁸ Personal communication from ASNO.

supply, as well as making the adoption of the Additional Protocol a mandatory condition of supply.

This might be overly ambitious, given how tightly commercial interests are woven into national interests, especially when it comes to the right to develop sensitive nuclear technologies such as enrichment. It must be remembered that the controversial ‘two-tier’ system enshrined in the NPT between nuclear weapon states and non-nuclear weapon states could also spill over into the peaceful uses domain. Initiatives to limit the possession and use of sensitive nuclear technologies to those who already have them now-albeit for good nonproliferation reasons-is opposed by emerging nuclear industry powers who will not accept the perpetuation of a two-tier system in the nuclear power industry.⁷⁹ There is also virtually no chance states will even consider foregoing the right to develop sensitive aspects of the nuclear fuel cycle, or see them centralised or regionalised under multinational control, in the absence of a solid commitment from the nuclear armed states to achieving a world without nuclear weapons.

In this context, a global call for disarmament might also become the business of industry. It may be worth exploring whether industry is prepared to make a public commitment to the goals of both disarmament and nonproliferation as a sign of good faith, in the interests of the future bona fides of the business and as a contribution to dismantling the two-tier system.

Being politically more proactive does not mean that industry has to abandon its evidence-based approach to risk. The international community will need to be confident that growth in nuclear energy will be managed responsibly. Being proactive can help industry in its ambition to ‘strengthen and sustain public confidence, both in the reliability of nuclear technology and in the people and institutions responsible for its use.’⁸⁰

With this in mind, there may be a case for involving global stakeholders from civil society in the global conversation, something a government-industry conference might include in its final declaration.

Participants, location and timing of conference

Logistics, timing and location of such a conference are details that can be elaborated on in the event the ICNND supports the idea. The chemical industry is much larger than the nuclear industry, so it should not be difficult to put together a representative group for the nuclear industry. From government, a good starting point would be members of the Board of Governors of the IAEA and all states with plans to establish nuclear power in the foreseeable future. The conference could be hosted by one of the co-chairs’ countries (Australia or Japan); or in a host nation with a major interest in the future development of nuclear energy or in an established international location such as Vienna. Whichever country hosts it would need to work closely with a supportive industry body. As to timing, given the organisational challenges and the need to canvass widely industry and government views before holding a conference, it might be best to hold the meeting after the May 2010 NPT Review Conference.

7. Prospects

The changing nuclear landscape and the integrated nature of the world’s nuclear industry strengthen the case for a concerted effort by industry and government to develop jointly a new

⁷⁹ Goodby. *Internationalizing the nuclear fuel cycle*.

⁸⁰ World Nuclear Association. *Sustaining global best practices in uranium mining and processing: principles for managing radiation, health and safety, waste and the environment*. WNA Charter of Ethics, Annex 1, p 9.

set of understandings of future nuclear proliferation dangers, and to work closely together in the design and implementation of measures to prevent such proliferation.

Initial signs are that some industry players see opportunities and advantages to becoming more engaged in the global nonproliferation agenda. An increasingly globally integrated industry needs to take a global view and be more globally engaged. The CEO of AREVA has agreed to become a member of the ICNND's Advisory Board. Members of industry are now active participants in second-track discussions about the future role of nuclear industry in a growing nuclear power market.⁸¹ The industry is represented by the WNA and could be engaged as an active partner. The 2008 WNA policy documents, and its Charter of Ethics and Principles of Uranium Stewardship spell out industry responsibilities to ensure the 3S (safeguards, safety and security) are indispensable for peaceful uses of nuclear energy.⁸²

The engagement of industry as a whole will require intense diplomatic effort and will have to be managed adroitly. Large commercial and national security interests are at stake and if there are to be additional standards, they will need to be universally applied.

More information is needed about industry's views on these matters, and, given the very close relationship between much of the world's established nuclear industry and government, government views are also critical.

As a first step, a smaller industry group could be engaged to conduct the initial consultations with industry in collaboration with a supportive government. The Australian Uranium Association might be a candidate for such a role, given its strong public support for the principles of uranium stewardship.

8. Recommendations

The ICNND agree to the following steps to be reported on ahead of its June Moscow meeting:

1. Commission an industry-wide survey to gauge industry attitudes to nonproliferation threats and industry's future role (a draft list of elements for a survey is at **Annex B**). This could also include industry trade associations and professional associations of nuclear industry employees which might be keen to encourage industry to increase its commitment to nonproliferation and disarmament.

- Invite one of the designated research centres to conduct a survey on its behalf

2. Commission further research into the need for an additional industry Code of Conduct or other effective arrangements, based on an assessment of current codes and activities in the nuclear domain.

- Invite one of the designated research centres to conduct this research.

3. Meet with a selection of industry representatives in Moscow in June 2009 to gauge views on codes of conduct and a government-industry conference in 2010. Discuss other steps for government-industry partnership in managing the 'second nuclear age' with minimal proliferation risks.

⁸¹ Squassoni, Ferguson and Hanson, *Nuclear energy, nonproliferation and arms control in the next administration: is nuclear energy the answer?*

⁸² World Nuclear Association. *Sustaining global best practices in uranium mining and processing: principles for managing radiation, health and safety, waste and the environment.*

4. Designate a national industry association and an interested government to act as a ginger group to canvass support for a government-industry conference and to design an agenda for that conference, using the 1989 Government-Industry Conference Against Chemical Weapons as a model.

Annex A: Drivers of expansion in nuclear energy

Increasing energy demand

Global population growth, and economic growth in developing countries, resulting in higher per capita energy consumption, are projected to increase primary energy demand by a factor of approximately 2.5 by 2050 if present policies remain unchanged, and electricity demand by a factor of 1.8 to 3.7.⁸³ In most countries that produce nuclear energy, present generating capacity will also need to be renewed, including the 342 reactors (of 439 globally) currently aged 20 years or older.⁸⁴ Increased demand for fresh water will also increase demand for desalination plants that are increasingly likely to be powered by nuclear energy.⁸⁵ If present nuclear power capacity and the share of nuclear in the total energy production mix are to be maintained, then more power reactors will be needed.

Climate change

Nuclear power is the only mature base load electricity production method that does not burn fossil fuels and is a relatively low emitter of greenhouse gases, making it an attractive alternative to fossil fuels to governments seeking to reduce their carbon emissions.⁸⁶ Yet the contribution that nuclear power can make to mitigating climate change is limited by the long lead times required to bring nuclear power plants online, the present lack of capacity to respond to a rapid increase in demand for nuclear power,⁸⁷ and the fact that electricity accounts for only 27% of greenhouse gas emissions.⁸⁸ Nuclear power will still have to compete against renewable energy in the future as those technologies mature.

Rising fossil fuel prices

Large increases and volatility in fossil fuel prices in recent years make nuclear energy a more attractive option because fuel prices account for a relatively small proportion of the total cost of nuclear power generation (the majority of the cost being the plant itself), protecting electricity production costs from fluctuations in uranium prices to an extent unparalleled with coal, natural gas or oil.⁸⁹

Economics of nuclear power

Increases in the price of fossil fuels and the anticipated pricing of carbon emissions in many Western countries are expected to improve the economics of nuclear power vis-à-vis other base load power generation options.⁹⁰ Where nuclear power remains at a disadvantage is in the sizeable construction costs incurred prior to the reactor producing electricity for sale, as

⁸³ Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 90.

⁸⁴ *Ibid.*, p 49, most reactor licences are issued for 40 years, though present licence extensions have increased reactor retirement ages to 60 years in the United States: Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 44.

⁸⁵ World Nuclear Association. *The nuclear renaissance*. . Interest in nuclear desalination is particularly strong in the Middle East and North Africa.

⁸⁶ See Nuclear Energy Agency, *Nuclear energy outlook 2008*, p 100 and ch 4; World Nuclear Association. *The nuclear renaissance*.

⁸⁷ Ferguson, *Nuclear energy: balancing benefits and risks*, p 16, see the following section on the constraints on the expansion of nuclear power.

⁸⁸ This figure is, however, growing, and an expanded uptake of electricity-fuelled (instead of fossil fuelled) transportation in the future may alter the contribution that nuclear power is able to make: see Alan Hanson's comments in Squassoni, Ferguson and Hanson, *Nuclear energy, nonproliferation and arms control in the next administration: is nuclear energy the answer?* .

⁸⁹ World Nuclear Association. *The nuclear renaissance*.

⁹⁰ *Ibid.*; Squassoni, *Nuclear renaissance: is it coming? Should it?*

well as reactor decommissioning and waste disposal costs.⁹¹ The slow in construction of nuclear reactors in the West in recent years means that cost estimates are uncertain,⁹² and the viability of nuclear power constructed without government assistance in deregulated electricity markets is questionable,⁹³ especially in light of the recent credit crunch.⁹⁴

Energy security

Concerns about reliability of oil and natural gas supplies in recent decades stem from rising prices and fears of political interference in supply. Governments have considered including or increasing the share of nuclear power in their energy generation mix in order to reduce dependence on fossil fuels. Major uranium producers such as Canada and Australia are viewed as reliable energy suppliers due to their stable domestic political environments. This strategy should not, however, be understood as seeking energy 'independence'. Given the internationalised nature of the nuclear fuel cycle, the process is rather one of diversification. Further, France and Japan have not been able to reduce their dependence upon imported oil by expanding nuclear energy production, as oil constitutes a very small part of total electricity generation in those two countries.⁹⁵

⁹¹ Ferguson, *Nuclear energy: balancing benefits and risks*, p 6.

⁹² Squassoni, *Nuclear renaissance: is it coming? Should it?*, p 3.

⁹³ On the UK energy market, see Deloitte, *Running the risk: structuring investment for new nuclear build*. Nuclear discussion series. London, Deloitte Touche Tohmatsu, 2005 and Deloitte, *The power to deliver: is current market design supportive of nuclear power generation*. Nuclear discussion series. London, Deloitte Touche Tohmatsu, 2005. The US Energy Policy Act 2005 has provided incentives and a streamlined licensing process in order to overcome the difficulties of reactor construction costs: see Ferguson, *Nuclear energy: balancing benefits and risks*, p 8.

⁹⁴ Sharon Squassoni, Stephen Goldberg and Stephen Maloney, *Financial crisis: impact on new nuclear reactors* (Washington, D.C., 13 November 2008).

⁹⁵ Squassoni, *Nuclear renaissance: is it coming? Should it?*, p 2.

Annex B: Elements for a survey of industry on its role in nonproliferation

Nuclear proliferation risks

1. How important is a well functioning non-proliferation regime to the nuclear industry?
2. How would a breakdown in the non-proliferation regime affect the nuclear industry?
3. What do you believe are the greatest proliferation risks associated with the nuclear industry?
4. Do you think nuclear proliferation risk is largely
 - a. Politically driven by the geostrategic interests of governments
 - b. Technologically driven, related to the spread of nuclear technology and know-how
 - c. both

Industry policy on nonproliferation

5. What does your company do to mitigate proliferation risks?
6. What additional measures might your company take in the future?
7. Would you consider including nuclear nonproliferation in your corporate social responsibility principles?

Industry leaders

8. Who are the present industry leaders in nonproliferation? What activities make them the industry leaders?
9. How might industry best practices be shared and implemented?

Government/ Industry role in nonproliferation

10. What do you see as the balance of responsibility between government and industry on nuclear nonproliferation?
11. Please describe the nature of your present engagement with national governments and international organisations on nonproliferation issues.
12. Should government consult industry more in shaping nonproliferation policy and regimes?

Effectiveness of current nonproliferation regulations

13. Do you consider government-imposed regulations in support of nonproliferation
 - a) Over-regulation
 - b) Sufficient
 - c) A minimum standard upon which your company should build
14. Are current international regulations effective in preventing nuclear proliferation? If not, why not?
15. How might regulations be improved while ensuring minimal disruption to legitimate commercial activities?

Future actions

16. What should be the focus of future action on nonproliferation?
 - a) Export controls
 - b) Reactor design and other proliferation safe technologies eg Generation IV reactors
 - c) Reactor operations
 - d) Physical protection of nuclear material
 - e) Multilateralisation of the nuclear fuel cycle
17. What are the disincentives for greater industry activity in support of nonproliferation?
 - a) For your company
 - b) For the nuclear industry in general
18. What are the incentives needed for greater industry activity in support of nonproliferation?
19. Would you consider cooperating with government and international organisations on nonproliferation by:
 - a) Reporting suspicious procurement efforts to national regulators or the IAEA
 - b) Consulting more regularly and openly with government on strengthening nonproliferation efforts
 - c) Strengthening export control regimes in consultation with the Nuclear Suppliers Group

A regional or multilateral fuel cycle

20. Will placing the nuclear fuel cycle under multilateral or regional control help stem proliferation?
21. Which of the proposals in the attached **Annex C** do you consider most promising from a commercial perspective?
22. Would you be willing to participate in a multilateral fuel cycle regime?

Code of Conduct

23. What are your views on an industry-wide Code of Conduct as an effective tool to harmonise industry practices on nonproliferation?
24. Do you believe the current WNA Code of Ethics and associated industry guidelines are as much as can be realistically achieved?
25. Are sector specific self-regulatory mechanisms such as for the World Association of Nuclear Operators (WANO) more effective?
26. Is it possible to measure and enforce compliance with an industry Code of Conduct?
If not why not?

Government-Industry Conference

27. Do you believe that a Government-Industry conference would provide a forum for clear industry input into government deliberations?

28. What would you like to see on the agenda of such a conference?
29. What outcomes from such a conference would you support (or reject)?
- a) A joint declaration in support of nonproliferation
 - b) A joint declaration in support of nonproliferation and disarmament
 - d) A list of additional steps for government-industry coordination to prevent proliferation including:
 - o steps to place more aspects of the nuclear fuel cycle under regional or multilateral control
 - o a more regular government-industry dialogue e.g. on the margins of the NSG
30. Do you have any suggestions for other ways in which industry can contribute to the nonproliferation regime?

Annex C: Multilateral fuel cycle initiatives

Global Nuclear Power Infrastructure – A Russian proposal to develop global infrastructure ensuring access to nuclear energy supplies. The International Uranium Enrichment Centre at Angarsk was established as part of the proposal, and international reprocessing and storage facilities are also envisaged. Fuel supply contracts would be guaranteed by the IAEA, and the stocks of fuel placed under IAEA control.

Global Nuclear Energy Partnership (GNEP) – A US proposal to develop proliferation-resistant technologies and limit the number of enrichment and reprocessing facilities to those already in existence, in order to facilitate an economically viable and proliferation-safe expansion in nuclear energy. The partnership includes 21 countries and industry, national laboratories, universities and local business in the USA.

Six-Country Proposal – The Multilateral Mechanism for Reliable Access to Nuclear Fuel is a system of enriched uranium supply assurances, proposed by the six countries with commercial enrichment facilities (France, Germany, the Netherlands, Russia, the United Kingdom and United States). Recipients of the assurances would be required to forego enrichment and reprocessing capabilities.

Fuel Suppliers' Registry – Japan proposed the IAEA Standby Arrangements System for the Assurance of Nuclear Fuel Supply, a registry of uranium and enriched uranium suppliers disseminated by the IAEA to assist in the prevention of fuel supply disruptions. The system would complement the Six-Country Proposal.

US HEU Proposal – The United States offered to set aside excess HEU, which would be downblended and available as a strategic reserve for countries foregoing enrichment and reprocessing.

IAEA Fuel Bank Proposal – The Nuclear Threat Initiative (NTI) proposed an international fuel reserve, owned and managed by the IAEA, the fuel to be used in the event of a disruption to the international market. The proposal has received financial support from the United States, European Union, United Arab Emirates and Norway, to match that already provided by NTI.

IAEA Multilateral Enrichment Facility – Germany proposed a multilateral enrichment facility administered by the IAEA but operating on a commercial basis and situated in an extraterritorial or neutral location.

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