Not Separate And Not Equal: Co-Mingling Defense and Civilian Nuclear Activities

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October 2018

> *The development of atomic energy for peaceful purposes and the development of atomic energy for bombs are in much of their course interchangeable and interdependent.* (Dean Acheson & David Lilienthal, "A Report on the International Control of Atomic Energy," (Washington, DC: U.S. Government Printing Office, March 1946))
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> *The dual use risk of nuclear materials and technology and in civil and military applications cannot be eliminated.* (UK Royal Society, "Fuel cycle stewardship in a nuclear renaissance," (London: Royal Society, October 2011))

A forthright U.S. Department of Energy official once remarked that the only difference between civilian and military applications of nuclear energy was psychological.[1] This stark assessment contravenes the conventional wisdom that the risks of diverting civilian nuclear technology and materials to nuclear weapons can be managed. On the civilian nuclear energy side of the equation, governments and the nuclear industry have invested enormous time and money in distinguishing between peaceful uses of nuclear energy and military uses to help manage public perceptions and expectations. A system of nuclear governance for states with only civilian nuclear sectors has evolved over time to sharpen their boundaries so that non-compliance is easier to discern and can be more quickly addressed. Sharper boundaries will never prevent diversion of civilian nuclear material to military purposes, but they can help strengthen the ability of the multilateral system of checks and balances to respond quickly, effectively, and appropriately.

States with nuclear weapons, however, have largely given themselves a pass on adhering to such boundaries for a variety of economic, political, and technical reasons. This is not simply a historical relic, confined to the Cold War and early years of nuclear weapons programs. There are many reasons for and many different types of co-mingling of civilian and defense nuclear capabilities in states with nuclear weapons, some of which continue today.

From the perspective of nuclear weapon states, this is a non-issue. The "conventional wisdom" arguments hold that material in the military sector is among the best guarded in the world and public accounting measures that would release information about it could decrease, rather than increase

[1] Ben Rusche, then Deputy Assistant Secretary of Energy for Nuclear Energy, when criticized for using the Tennessee Valley Authority's Watts Bar reactors (civilian power reactors) to produce tritium for nuclear weapons and responded thus. Quoted by Victor Gilinsky in his chapter, "Nuclear Weapons, Nuclear Power – Clarifying the Links," in Henry Sokolski, ed.. *Moving Beyond Pretense*, (Carlisle, PA: **The Strategic Studies Institute Publications Office, United States Army War College,** June 2014) p. 130, available at: http://www.npolicy.org/books/Moving_Beyond_Pretense/Ch5_Gilinsky.pdf

security. In this view, efforts to lay the groundwork for treaties to stop producing fissile material for nuclear weapons are unnecessary and perhaps even such a treaty itself is unnecessary since the nuclear weapon states have already stopped producing fissile material for weapons (obviously, this doesn't apply to India, Pakistan and North Korea). Likewise, nuclear disarmament is deemed far off in the future, leaving plenty of time to prepare for it, if it ever comes to pass. The essence of this narrative is "leave well enough alone."

Since the end of the Cold War, however, expectations for greater transparency and accountability have grown. U.S. and Russian progress in arms control and reducing fissile material stockpiles raised expectations for additional progress and the indefinite extension of the Nuclear Nonproliferation Treaty in 1995 raised demands for actions by all nuclear weapon states to meet their Article VI obligation to make progress toward nuclear disarmament. More generally, the amount and kinds of information available to individual citizens about a wide variety of topics through the internet and social media highlights the fact that governments no longer have a monopoly on information, even about nuclear weapons. All of this suggests that it is time for states with nuclear weapons to improve the accountability of their nuclear activities. Beyond refraining from co-mingling civilian and defense capabilities, states with nuclear weapons should consider placing all fissile material production facilities under International Atomic Energy Agency (IAEA) safeguards and refraining from producing HEU or separating plutonium.

Types of Co-mingling

There are several ways in which states with nuclear weapons have co-mingled material, technologies, facilities and sites for defense and civilian purposes. Four particular examples have been common:

- Military facilities providing civilian services, such as military production reactors providing heat and/or electricity to local communities or enrichment plants producing for weapons and for commercial fuel;
- "Conversion" of military facilities to primarily civilian use without application of international safeguards;
- Civilian facilities providing military products such as tritium for weapons; and
- Civilian facilities providing fissile material for nuclear weapons (i.e., reactors, uranium enrichment or spent fuel reprocessing plants) or fissile material for military purposes.

Military production facilities have provided civilian services in all of the five nuclear weapon states at one time or another. The most common example is plutonium production reactors providing electricity and/or heat to local communities, and dedicated military enrichment plants providing low enriched uranium (LEU) for commercial power reactors. Some separation plants have additionally co-mingled defense and civilian materials by processing defense and civilian fuel either together or blending it and then using it in civilian reactors (e.g., breeder cores). In general, this kind of co-mingling raises few external transparency concerns but may generate internal governance and transparency concerns for the citizens that receive such services. For example, how are liability issues handled in the event of incidents or accidents? Would citizens be better or worse off if the

facility is owned and operated by the military, the government more broadly, or the private sector?[2] In the five countries recognized under the NPT as nuclear weapon states, many military production facilities have been shut down, making this issue of historical interest only. However, together more than half of all designated military production reactors in the five nuclear weapon states were used (or designated as dual-use) for some civilian purposes. In many cases, this made a virtue out of necessity, taking advantage of an existing asset to provide a public good or to help defray the costs of the military investment in the plants.

The second case involves the *conversion of former defense facilities to civilian purposes.* Defense facilities are sometimes converted for economic reasons, primarily to utilize the existing life out of a facility, to avoid costs of separate construction, or even to push costs onto the private sector. Sometimes conversion can result in greater transparency, if the facilities are then made eligible for international safeguards. For reactors, conversion from purely plutonium production to electricity production may entail adding steam generation and operating the reactor for longer periods of time to burn up more of the fuel. For some enrichment plants, conversion may mean limiting production to certain cascades or reconfiguring cascades; for reprocessing plants, no changes would be required since the difference between weapons-grade and weapons-usable or reactor grade occurs in the reactor. In the case of Russian enrichment plants, the United States required some transparency measures under the Megaton to Megawatts HEU blend-down agreement, but Russia has not placed those facilities under international safeguards and the transparency measures were limited to verifying the bilateral agreement.

A gray area for some countries has been *production of nuclear-weapons-related materials in civilian facilities.* The most important one for nuclear weapons is tritium.
Most of the nuclear weapon states used dedicated production reactors for tritium. In the United States, reactors at Hanford and at the Savannah River Site produced tritium for many years. In Russia, the Chelyabinsk-65 site had five tritium production reactors; currently two reactors at the Mayak site (Ruslan and Lyudmila) produce isotopes but maintain a tritium production capability. The UK produced tritium at the Chapelcross reactors, which were unsafeguarded, but separation of spent fuel from defense reactors at Chapelcross was under EURATOM safeguards and made eligible for IAEA inspection. France produced tritium in the dedicated Celestin reactors (shut down in 2009) but also at civilian reactors owned by Electricite de France (EDF).

CIVILIAN PRODUCTION OF BOMB INGREDIENTS: *Tritium and deuterium gases are used in fusion-boosted fission devices and in thermonuclear weapons. Tritium is rare in nature and therefore must be produced. Its half-life of about 12.4 years means it must be replenished. Tritium can be produced in many kinds of nuclear reactors by inserting targets (lithium-6) into the core, replacing some of the fuel rods. It can also be produced in particle accelerators.*

[2] Of course, there are hybrid approaches that muddy the waters, like U.S. facilities that are government-owned and contractor-operated, or even corporate agencies like the Tennessee Valley Authority which gets no funding from taxpayers but has a Board of Directors appointed by the President and confirmed by the Senate. Here, the term private sector connotes commercial ownership, operation and management.

The fourth case is *civilian facilities producing fissile material for nuclear weapons or for defense purposes* (such as fuel for naval reactors). Historically, some states have allowed plutonium produced in civilian reactors to find its way into military stockpiles. For example, small amounts of civilian plutonium reportedly were used in British nuclear weapons in the early days when the reach of the UK Atomic Energy Authority spanned both civilian and military programs. A few experts have suggested that France took civilian spent fuel from the unsafeguarded Vandellos reactor in Spain (which operated from 1972 to 1989), reprocessed it, and used it in the French weapons program.[3] And, some material in the United States from non-defense reactors wound up in DoE's weapons-grade plutonium inventory, although presumably not in weapons.

The case of civilian facilities producing material for defense purposes – such as enrichment of uranium for defense nuclear reactors – may be a future problem if the five nuclear weapon states forego building new defense enrichment plants. Three of the five nuclear weapon states (the US, UK and Russia) use HEU for their naval reactors. A significant question for them will be whether new HEU production will be needed to sustain naval fuel in the future or whether they can switch to high-assay LEU fuels (enriched to between 5 and 20% in U-235). In the recent past, additional material has been created by blending down HEU rather than producing up to particular enrichment levels because commercial enrichers today only produce at levels hovering around 5%. As military production assets dwindle, combining former military material and civilian material may become more attractive.

All four cases of co-mingling reduce discrimination between the two sectors but those that involve the use of civilian facilities for military purposes can have damaging repercussions for the nonproliferation regime by demonstrating lack of restraint and highlighting the discriminatory nature of obligations that states undertake under the NPT. This amounts to a "Do as I say, not as I do" approach to nuclear safeguards by the nuclear weapon states. If nuclear weapon states are serious about deterring other states from acquiring nuclear weapons, a better approach would be to demonstrate the enormous costs of dedicated military programs.

The accompanying table gives a rough comparison of the state of separation of military nuclear production facilities from civilian nuclear energy activities in the five nuclear weapon states under the NPT plus India, Pakistan, Israel and North Korea. The table divides production facilities into three types (although there clearly are many more facilities involved in the nuclear fuel cycle and nuclear weapons programs): reactors, reprocessing and uranium enrichment. It uses four separate criteria: a) whether the facilities were used for dual military and civilian production; b) whether they were physically separated from civilian sites; c) whether there was administrative separation; and d) whether international safeguards have ever been applied at the site. Sites are considered physically separate when military sites do not contain civilian facilities on-site. They are considered administratively separate when budgets, personnel and programs are kept separate, minimizing the potential for material or facilities to fluidly shift from one to the other.

[3] David Albright, Frans Berkhout, William Walker, *World Inventory of Plutonium and Highly Enriched Uranium 1992*, (United Kingdom: Oxford University Press, 1992), p. 86. See also David Albright, "French Military Plans for SuperPhenix?" *Bulletin of Atomic Scientists,* November 1984, pp. 30-34.

TABLE 1: HOW SEPARATE ARE DEFENSE AND CIVILIAN NUCLEAR FACILITIES IN NUCLEAR WEAPON STATES?

TYPE OF FACILITY	US	UK	FRANCE	RUSSIA	CHINA	INDIA	PAKISTAN	ISRAEL	NORTH KOREA
PRODUCTION REACTORS: Dual civilian uses?	✔	✔	✔	✔	X	✔	X	X	X
Physical separation?	✔	X	X	✔	X	X	✔	✔	X
Administrative separation?	>1974	> 1973	X	✔	X	?	For safety	✔	X
International safeguards on converted reactors?	X	?	X	X	X	Some	X	None	None
REPROCESSING: Dual civilian processing?	X	<1969	✔	✔	✔	✔	X	X	X
Physical separation?	✔	Some	X		X	X	X	✔	X
Administrative separation?	> 1974	Some	X	X	X	X	> 2001	✔	X
International safeguards?	NA	Some	Some	X	X	Some	X	X	X
ENRICHMENT: Dual civilian uses?	Converted	✔	✔	Converted	Converted	X	X	X	X
Physical separation?	✔	X	X	X	X	✔	X	✔	X
Administrative separation?	> 1974	> 1993	X	X	X	✔	X	✔	X
International safeguards?	Some	Some	Some	X	Some	X	X	X	X

Source: Author's estimates

Why Co-Mingling Matters Today

Several developments may make co-mingling a relevant issue for nuclear weapon states in the coming years. First, the need to maintain nuclear weapons even as infrastructure and facilities age will require policy decisions that may not reflect a clean separation of military and civilian sites. For example, the United States considered multiple options to produce tritium before choosing existing commercial civilian reactors in 1998 to save money.[4] On the other hand, uncertainty about future nuclear weapons reductions could increase pressure to build new, dedicated military production facilities, potentially complicating a future treaty on halting production of fissile material for nuclear weapons. Unlike twenty years ago, the United States now has peaceful nuclear cooperation agreements with Russia, China, and India, none of which has truly separated their military and civilian nuclear sectors. In particular, this raises questions about how well the United States can ensure that its technology does not find its way into military uses in those countries. Finally, separation allows for greater transparency, which will be needed in preparation for a future fissile material production cutoff treaty (FMCT).[5]

A relatively recent example of the U.S. government's efforts to grapple with co-mingling arose as the Department of Energy (DoE) identified options to manage its tritium and enriched uranium needs. DoE's October 2015 report to Congress, "Tritium and Enriched Uranium Management Plan Through 2060" illustrated how carefully the U.S. government navigates requirements for "unobligated enriched uranium" for defense purposes. These requirements arise, according to the DoE, from "U.S. nuclear nonproliferation policy and U.S. international agreements for peaceful uses of nuclear materials [which] require that any nuclear weapon material be produced using resources, technologies, production equipment, and infrastructure that are free of peaceful use restrictions." In other words, the U.S. needs to avoid using material to which its allies attach conditions that it only be used for peaceful purposes. The report goes on to state that these "restrictions affect all conversion, enrichment, fuel fabrication, and commercial power reactors being employed for defense purposes."

In the 2015 assessment of requirements for tritium, highly enriched uranium for defense purposes, and unencumbered low enriched uranium out to 2060, the Department of Energy concluded that it will need to start making tritium in a second TVA reactor beginning in 2020 and that tritium production in TVA reactors appears to be the lowest cost, quickest and least risky of alternative options. DoE also concluded that it will eventually need an enrichment facility "without peaceful use restrictions" to produce HEU for naval reactor fuel and high-assay LEU for research reactor fuel, somewhere between 2020 and 2060.[6] The Department of Energy may go so far as to subsidize U.S. uranium enrichment to ensure that it is meeting a self-imposed "no foreign encumbrances" policy for

[4] See, for example, "Report of the Defense Science Board Task Force on Tritium Production Technology Options," (Washington, DC: Office of the Under Secretary of Defense for Acquisition and Technology, 1999), available at http://www.dtic.mil/dtic/tr/fulltext/u2/a433325.pdf

[5] A fissile material production cutoff treaty (FMCT) would halt the production of fissile material for weapons. The U.S. has supported negotiations of such a treaty for decades.

[6] U.S. Department of Energy, "Tritium and Enriched Uranium Management Plan Through 2060," Report to Congress, October 2015. Available at: http://fissilematerials.org/library/doe15b.pdf

domestically produced low enriched uranium fuel for the Watts Bar reactors that will produce additional tritium for U.S. nuclear weapons. The 2015 consolidated appropriations bill (P.L. 113-235) required DoE to conduct a cost-benefit analysis of options available for supplying enriched uranium for defense purposes, including a "preliminary cost and schedule estimate to build a national security train."[7]

In addition, DoE suggested in its October 2015 report that "the design, size, and operation of an unencumbered enrichment facility that could accommodate naval fuel HEU requirements, research reactor high-assay LEU fuel needs, and LEU fuel for tritium production ***could consider leveraging commercial demand for enrichment services for LEU power reactor fuel from such a facility*** (emphasis added). Such a strategy could minimize the additional investment required by the U.S. Government to satisfy all of its needs for enriched uranium."[8] In assessing its options for building a national security enrichment plant, DoE estimated a cost of between $3.1 and $11.3 billion for a plant based on AC-100 technology, which would become operational by 2025.

Leaving aside specific questions about how DoE conducted its evaluations, several elements of DoE's approach to the separation of civilian and defense nuclear assets are deeply flawed. DoE suggests it will need unrestricted uranium enrichment to meet both defense-related and non-defense national priority missions. The 2014 and 2015 appropriations bills, however, only required the DoE to assess national security purposes and/or defense needs, not "non-defense national priority missions." The inclusion of non-defense national priority missions, and the suggestion that the United States will need HEU specifically for medical radioisotope production and research reactor fuel, conflicts with the U.S. policy to minimize, and where possible, eliminate the use of HEU in civilian applications. Moreover, a 2016 National Academy of Sciences study concluded that all research reactors could convert to LEU fuel without performance loss in the next 10 to 20 years.[9] The notion that the U.S. needs unsafeguarded enrichment to fuel non-defense national priority missions conflates the need for reliable supply with the need for unencumbered enriched uranium. There is ample reliable supply within U.S. borders from the URENCO enrichment plant in Eunice, New Mexico and outside U.S. borders from URENCO or Orano (formerly Areva) enrichment plants. The notion that the United States must have a U.S.-owned and operated enrichment plant on U.S. soil undermines the basic arguments the United States makes with other countries about relying on the existing market for enriched uranium supply.

More significantly, the statement that a national security plant "could consider leveraging commercial demand for enrichment services for LEU power reactor fuel" seems to suggest that the plant would enrich material for both defense purposes and commercial fuel. And the statement that this strategy would minimize the additional investment by the U.S. government suggests that commercial sales

[7] Several weapons complex shutdowns eliminated options for using existing facilities, including the shutdown of the K-reactor (which produced tritium) at Savannah River in 1988, and the Paducah gaseous diffusion uranium enrichment plant in 2013.
[8] DoE, "Tritium and Enriched Uranium Plan," p. 31.
[9] National Academy of Sciences, "Reducing the Use of Highly Enriched Uranium in Civilian Research Reactors," (Washington, DC: National Academies Press, February 2016).

would offset costs of U.S. defense production. This would be the culmination of a long chain of decisions and investments that moved AC-100 technology between the defense and civilian sectors for the last fifty years. After all, the U.S. government spent twenty-five years (1960 to 1985) developing centrifuge technology, which US Enrichment Corporation (now Centrus) more recently attempted to commercialize. This approach would turn the program back to DoE, which would then recoup its investments through commercial sales, although it is not clear exactly how DoE would do that. Would DoE itself offer enrichment services as it did in the past? Would the new national security train essentially be a dedicated military plant providing commercial services? Would it be converted to civilian purposes after it fulfills its defense missions? Or would it be a commercial plant essentially performing dual civilian and military roles, perhaps with certain cascades cordoned off for defense purposes?

The DoE analysis seems to bend over backwards in applying its policy of using only unencumbered enriched uranium, particularly for LEU production for tritium production, despite a 2014 GAO report that suggested the Department conduct an updated interagency review "that either reaffirms or supports a change in the current practice," given that the United States no longer has an assured source of unobligated LEU. The GAO suggested such a review "could help address questions about whether using certain other LEU for tritium production is an option for DOE at this time."[10] A footnote in the October 2015 DoE report stated that the U.S. interagency was reviewing alternatives to peaceful use obligations as it applies to tritium production.[11] In 2018, the GAO reported to Congress that NNSA's analysis missed the mark in several respects: it demonstrated a preference for one approach (using enriched uranium) to continue tritium production, it underestimated the full costs of building a new uranium enrichment facility and the scope of the stated mission was too broad.[12]

Implications for Arms Control, Disarmament and Nonproliferation

Most state parties to the NPT – the non-nuclear weapon states – have little need to demonstrably separate civilian and military nuclear activities because they have no military nuclear activities. A few countries are considering naval nuclear programs, which could force the issue of demarcating peaceful from military, non-explosive nuclear activities. Under comprehensive IAEA safeguards agreements, states may request the non-application of safeguards on fissile material when used in military, non-explosive activities. Since no country has yet attempted this, there are no accepted provisions for ensuring that the material is not diverted for explosive purposes. Among the non-

[10] U.S. Government Accountability Office, "Department of Energy: Interagency Review Needed to Update U.S. Position on Enriched Uranium That Can Be Used for Tritium Production, "(Washington, DC: U.S. Government Accountability Office, October 14, 2014), GAO-15-123.
[11] U.S. DoE, "Tritium," See footnote 12, page 11.
[12] U.S. Government Accountability Office, "Nuclear Weapons: NNSA Should Clarify Long-Term Uranium Enrichment Mission Needs and Improve Technology Cost Estimates," (Washington, DC: U.S. Government Accountability Office, February 2018), GAO-18-126.

nuclear weapon states, Brazil's nuclear-powered submarine is furthest along in development, but Argentina, Iran and South Korea have expressed interest in such programs.[13] In most other cases, the exclusively peaceful use of nuclear energy is verified through acceptance of comprehensive International Atomic Energy Agency (IAEA) safeguards – a system of reporting, inspections, sampling and analysis.

But what of the nuclear weapon states? Obviously, NPT nuclear weapon states – the United States, United Kingdom, France, China and Russia – have different obligations. They are not legally bound to prove that their own materials, technologies and processes in the civilian, peaceful sector stay purely peaceful because there are no limits on their nuclear weapons under the NPT.[14] In some nuclear cooperation agreements, nuclear weapon states may be bound by a mutual obligation not to use material or equipment transferred for any military purpose whatsoever. Most, if not all, U.S. nuclear cooperation agreements contain this restriction, but these have not been universally adopted among Nuclear Supplier Group members.

In the 1985 NPT Review Conference Final Document, the Conference recommended the continued pursuit of applying IAEA safeguards to all peaceful nuclear activities in all states, and recommended consideration of the separation of civil and military facilities in nuclear weapon states. At the 1990 NPT Review Conference, draft recommendations called for substantial progress towards the separation of the peaceful and military nuclear facilities in the nuclear-weapon states, but the parties failed to adopt a consensus document that year. [15] In 2010, as described below, NPT parties committed to apply the principles of irreversibility, verifiability and transparency in implementing their treaty obligations.

Yet if the future holds specific nuclear weapons limits for all nuclear weapon states, or a ban on fissile material production for weapons or even elimination of nuclear weapons entirely, stricter accounting of peaceful uses will be necessary. In the meantime, there is little reason to check for diversion of material in countries that have tons of materials in their weapons programs.

Nuclear weapon states have progressively allowed for safeguards inspections on their territory, and these safeguards have helped to separate their civilian and military nuclear sectors in limited ways. Under the so-called "voluntary offer" safeguards agreements, the nuclear weapon states give the IAEA a list of facilities and/or material that are *eligible* for inspections. The IAEA may from time to time choose facilities and conduct inspections. More recently, the IAEA has applied safeguards in nuclear weapon states at the request of cooperating partners. So, for example, Russia requested safeguards

[13] See essays in the Institute for International Science & Technology Policy *Occasional Papers Volume I*, October 2018, for analyses of the legal, technical and policy challenges surrounding naval nuclear fuel and nonproliferation.

[14] Article VI of the NPT calls for each of the parties to the treaty to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament, and on a treaty on general and complete disarmament under strict and effective international control.

[15] https://unoda-web.s3.amazonaws.com/wp-content/uploads/assets/WMD/Nuclear/pdf/finaldocs/1991%20-%20Geneva%20-%20NPT%20Review%20Conference%20-%20Final%20Document%20Part%20%20II.pdf Final Document, Part II, Report of Main Committee II, NPT/CONF.IV/MC.II/1, p. 9, Review of Article II, paragraph 6.A.25.

on the centrifuge plant it supplied to China (at Hanzhong), URENCO has required safeguards on plants it has supplied to the United States and France, and Australia has required the United States to make

SAFEGUARDS AND TRANSPARENCY AT THE WEST VALLEY REPROCESSING PLANT
During negotiations of the Nuclear Nonproliferation Treaty (NPT), states poised to sign the treaty as non-nuclear weapon states noted the commercial disadvantages they might experience relative to nuclear weapon states without inspections at their facilities. To allay these concerns, President Lyndon Johnson announced on December 2, 1967 that the United States would permit the IAEA to apply safeguards to all nuclear activities in the United States, excluding only those with direct national security significance. The idea for confidence-building safeguards, however, dated back to a 1957 U.S. National Security Council document on the Peaceful Uses of Atomic Energy. Although the U.S. safeguards agreement was not ratified until 1980, the United States early on offered the commercial Nuclear Fuel Services reprocessing plant at West Valley, New York as a test-site for safeguards approaches at reprocessing plants. U.S. officials suggested that the IAEA follow some reactor cores through fabrication, irradiation and reprocessing. The first "inspection" was held in 1969 at West Valley, which operated between 1966 and 1972. After the plant closed in 1976, the General Electric plant at Barnwell, South Carolina, also welcomed IAEA inspectors to test safeguards techniques; its reprocessing operations were halted in 1977, but it continued safeguards work through 1983. Today, the United States has over 260 facilities on its eligible list, but the IAEA has selected only four and is actively inspecting only one facility, which is a vault containing plutonium at the Savannah River site.

any plant using SILEX laser enrichment technology eligible for IAEA safeguards. Applying safeguards would ensure that material produced in those facilities is not available to nuclear weapons programs. In many respects, this is unnecessary, given that the five nuclear weapon states long ago stopped producing enriched uranium for weapons, but it has set an important precedent. Another important precedent has been the declarations by Russia, the United States and the United Kingdom of material excess to defense needs, which in some cases have become eligible for IAEA safeguards. [16] While the IAEA has, in fact, conducted inspections in all five nuclear weapon states, those inspections have never reached the level anticipated.[17]

While separation of military and civilian programs for nuclear weapon states inside the NPT has been voluntary and paid relatively little attention, co-mingling in states with nuclear weapons outside the NPT -- India, Pakistan, Israel and now North Korea -- has come under increasing scrutiny. These states have had to meet requirements imposed upon them by cooperating partners.[18] From the

[16] For a concise description of all of these, see Pavel Podvig, "Disposition of Excess Military Nuclear Material," UNIDIR report, February 2012, available at http://www.unidir.org/files/publications/pdfs/disposition-of-excess-military-nuclear-material-388.pdf

[17] According to John Carlson, the IAEA initially expected to spend between 20 and 30% of its total inspection effort in the nuclear weapon states, but the reality is closer to 5%. John Carlson, "Expanding Safeguards in Nuclear Weapon States," NTI Paper, expansion of a paper for INMM, July 17-21, 2011, http://www.nti.org/media/pdfs/NWS_safeguards_carlson_fin.pdf?_=1337718775

[18] Since the demise of the 1994 Agreed Framework in 2002, cooperation with North Korea in constructing a light water reactor under the KEDO agreement has halted. Since 1992, nuclear trade with Israel has been banned and although

inception of the Nuclear Suppliers Group (NSG) in 1974, suppliers required IAEA safeguards on materials and equipment transferred, adopting a policy of restraint especially for uranium enrichment and spent fuel reprocessing equipment. In 1992, however, the NSG recognized that safeguarding materials and equipment transferred was insufficient to prevent diversion and therefore required comprehensive safeguards (that is, safeguards on all nuclear material in a state). In effect, the NSG banned nuclear trade with states outside of the NPT. This lasted almost twenty years, until the George W. Bush administration lobbied for an exception to the NSG rules for India, a non-party to the NPT.

Under the terms of the US-India deal, India was required to separate its civilian from its military nuclear program as a prerequisite for both U.S. nuclear cooperation and a lifting of the NSG ban. But the Bush administration failed to get India to abandon dual uses of certain facilities (such as the PREFRE reprocessing plant) and failed to get India to place legitimately civilian facilities under safeguards.[19] Although physical and administrative separation of military and civilian nuclear assets could have facilitated the application of international safeguards to civilian assets and provided barriers to comingling between the two sectors, India was pressed to do neither.

Role of Transparency

If safeguards are applied to obviously civilian facilities and materials, then the role of transparency is reserved for the military side of the equation. Transparency is certainly a tough sell for nuclear weapons holders outside the NPT, but for nuclear weapons states inside the NPT, it has become hard to avoid. In the last twenty years, there have been increasing calls for the nuclear weapon states to be more transparent across a range of nuclear issues. In 1995 and 1996, the United States declassified significant information regarding fissile material production and also declared hundreds of tons of HEU and PU excess to defense needs. In the ensuing twenty years, both France and the UK have also made significant strides in transparency, but China and Russia have done less.[20]

More recently, all state parties to the NPT committed in 2010 to apply the principles of irreversibility, verifiability and transparency in implementing their treaty obligations. As a result, the nuclear weapon states reported, as a confidence-building measure, on their efforts related to NPT

Pakistan should also be subject to that ban, China has been a supplier of light water reactors to Pakistan, requiring IAEA safeguards on them.

[19]As a result, India's new safeguards agreement with the IAEA placed only 14 of its 22 nuclear power reactors under safeguards and left off enrichment and spent fuel reprocessing facilities (except as currently safeguarded), military production reactors and other military nuclear plants and three heavy water plants. For its part, the U.S. nuclear cooperation agreement stipulated that India could only receive advance consent for enrichment or reprocessing if it built new, civilian (safeguarded) enrichment and reprocessing plants.

[20] In 2000, as part of the 1998 Strategic Defense Review, the UK began "a process of declassification and historical accounting" that produced a report on defense fissile material production since the 1940s. "Plutonium and Aldermaston – an Historical Account." See http://fas.org/news/uk/000414-uk2.htm

implementation in 2014.[21] These reports covered a wide range of issues, including disarmament, nonproliferation and peaceful uses of nuclear energy. However, the responses were uneven. For example, Russia's report noted that Russia stopped producing HEU and plutonium for weapons in the 1980s, but was silent on the implementation of safeguards in Russia[22]. China's report detailed implementation of safeguards but not the status of its fissile material production for weapons. France and the UK have gone the furthest in terms of drawing clear distinctions between civilian and military production, although only portions of the French reprocessing plant at La Hague and of the British THORP plant are under safeguards. The French approach, similar to that of the United States, has been to decommission and close down former military production sites. The UK has placed all civil material under EURATOM/IAEA safeguards, including some plutonium stores at Sellafield. Following the 1998 Strategic Defense Review, the UK went further and stated that any future withdrawals from safeguards "would be limited to small quantities of nuclear materials not suitable for explosive purposes," and promised to publish information on any such withdrawals. The UK report, however, made no mention of the status of its fissile material production for weapons. Of the five reports, only the U.S. touched upon developments in its weapons complex, particularly the streamlining and shutting down of facilities.

Conclusions

When it comes to the separation of military and civilian nuclear energy activities in nuclear weapon states, the strategic nature of nuclear weapons tends to overpower the need to keep the two separate and inhibits transparency. This has certainly been the historical case for all five nuclear weapon states, and to a large extent for India and Pakistan (less so for Israel and North Korea, which have few purely civilian nuclear assets). And while the requirements for keeping military and civilian nuclear assets separate, at least on an international level, were minimal in the past, there are increasing incentives for doing so today.

First, it is in the nuclear weapon states' interest to reduce the perception of discrimination within the Nuclear Nonproliferation Treaty (NPT) and the promotion of safeguards in non-nuclear weapon states, both of which would be aided by expanded application of safeguards at civilian facilities in the nuclear weapon states. Any co-mingling – particularly where civilian facilities are used for military purposes – makes safeguards difficult. Second, all NPT nuclear weapon states support a fissile material production cutoff treaty (FMCT) which would likely require the application of IAEA safeguards at all fissile material production facilities. Third, all NPT parties committed to apply the principles of irreversibility, verifiability and transparency in relation to the implementation of their

[21] These statements reported on those countries' actions to implement Actions 5, 20 and 21 of the final document of the 2010 NPT Review Conference, and are available here: http://www.un.org/disarmament/WMD/Nuclear/Repository/submissions_2014.shtml

[22] Russia halted HEU production in 1989. Although it halted Pu production for weapons in 1984, its plutonium production reactors continued to operate because they provided heat and electricity to surrounding locations. The last of these reactors did not shut down until 2010.

treaty obligations in 2010. Yet, the nuclear weapon states have demonstrated only limited progress in this area. Given their boycott in 2017 of the negotiations on a Treaty on the Prohibition of Nuclear Weapons (so-called "ban treaty"), nuclear weapon states should strongly consider how to best showcase their commitments at the 2020 NPT Review Conference – the fiftieth anniversary of the treaty.

To facilitate transparency, Russia, China and other countries should explore measures for physical and administration separation of their military nuclear programs. China should be encouraged to declare that it has stopped producing fissile material for nuclear weapons. France, Russia and China could report, as have the United States and the United Kingdom on historical fissile material accountancy in their weapons programs. States inside and outside the NPT should place all enrichment facilities under safeguards (and ensuring that safeguards are applied to those facilities). Exploring limits on enrichment levels (for example, keeping enrichment just below 20% or even as low as 10%) could begin to build the norm for restricting the biggest proliferation risks attaching to uranium enrichment. A further step would be to explore options for multinationalizing all enrichment facilities for improved transparency. [23]

Critics may contend that further separation of civilian and defense nuclear activities in the nuclear weapon states and the application of safeguards will do little to reduce perceptions of discrimination under the NPT while imposing significant costs on nuclear weapon states. It is true that the costs of safeguarding big bulk-handling facilities like uranium enrichment and spent fuel reprocessing plants are significant within the realm of IAEA safeguards, but likely cost-effective compared to alternative monitoring schemes under future fissile material control regimes.

Ultimately, if countries are serious about moving towards a world free of nuclear weapons, greater transparency will be needed to create a system of monitoring and verification that future fissile material production facilities are solely for peaceful purposes. Greater emphasis on nuclear governance, especially for states that are considering nuclear power for the first time, has to be matched by greater emphasis on nuclear governance among the states that pioneered nuclear weapons and nuclear energy.

[23] For additional details, see joint report by CSIS and the Nuclear Threat Initiative, authored by Kelsey Hartigan, Corey Hinderstein, Andrew Newman and Sharon Squassoni, *A New Approach to the Nuclear Fuel Cycle,* (Washington, DC: Center for Strategic & International Studies, March 2015)