Coming to Grips with Plutonium Growth: A Roadmap for Expanding Collaboration

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Introduction

Plutonium is the difficult offspring of the marriage of military and civilian uses of nuclear energy – the problem child with tremendous potential that refuses to be constrained or categorized. Originally produced for weapons, plutonium is used by some countries as civilian nuclear fuel today and features in plans for fueling advanced reactors in the future. Almost seventy-five years after its birth, however, plutonium continues to evade international governance. Three generations have now struggled to handle plutonium safely and securely but all have failed so far to agree to limit its growth.

Two examples from the early years illustrate how national and international perspectives failed to find common footing. In 1957, the U.S. National Academy of Sciences published its first report (the price was $1) on the disposal of nuclear waste on land. Scientists assumed nuclear fuel would be reprocessed, probably because reprocessing was familiar from its use in defense programs or because reprocessing was considered necessary to help the new industry to be a “good neighbor” in terms of radiation safety. Another assumption was that plutonium would be needed to sustain nuclear energy growth because uranium was thought to be a scarce commodity. The National Academy of Sciences estimated every ten nuclear power plants would require one reprocessing plant (which today would equal 10 reprocessing plants in the United States). Eventually, reprocessing was rejected in the United States as costly for the industry and risky for the future nonproliferation regime, but only after two decades and significant cases of proliferation abroad.

The United States was not alone in anticipating widespread civilian reprocessing. The statute of the newly established International Atomic Energy Agency (IAEA) in 1957

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1 The conferences that supported the NAS 1957 findings also considered disposing of nuclear waste at sea, but the NAS report focused on land options. See National Academy of Sciences, “The Disposal of Radioactive Waste on Land,” A Report of the Committee on Waste Disposal of the Division of Earth Sciences, Washington, DC, September 1957, available at: https://www.nap.edu/catalog/10294/the-disposal-of-radioactive-waste-on-land

2 Reprocessing separates plutonium and uranium from other highly radioactive elements in spent fuel. PUREX, the most widely commercialized process, separates plutonium and uranium from each other, whereas COEX leaves plutonium with uranium and pyroprocessing leaves plutonium with fission products. For simplicity sake, the reader may equate the use of “reprocessing” with PUREX.

3 In reality, two large reprocessing plants with enough surge storage (800t capacity) could handle the approximately 2000 tons of spent fuel produced annually.
foresaw the potential need to address the stockpiling of materials that might result. Article XII, paragraph 5 stated that one of the Agency’s safeguards rights and responsibilities, to the extent relevant, would be:

To approve the means to be used for the chemical processing of irradiated materials solely to ensure that this chemical processing will not lend itself to diversion of materials for military purposes and will comply with applicable health and safety standards; to require that special fissionable materials recovered or produced as a by-product be used for peaceful purposes under continuing Agency safeguards for research or in reactors, existing or under construction, specified by the member or members concerned; and to require deposit with the Agency of any excess of any special fissionable materials recovered or produced as a by-product over what is needed for the above-stated uses in order to prevent stockpiling of these materials, provided that thereafter at the request of the member or members concerned special fissionable materials so deposited with the Agency shall be returned promptly to the member or members concerned for use under the same provisions as stated above. (emphasis added)4

Of course, this envisioned future also did not come to pass, despite the IAEA’s involvement in projects and studies that attempted to come to address risks from plutonium growth, such as the International Nuclear Fuel Cycle Evaluation and the International Plutonium Storage talks. Other countries, fearing scarce uranium, pursued spent fuel reprocessing, and accumulated stockpiles of separated plutonium over time. Meanwhile, plutonium stockpiles outside of the nonproliferation regime – in Pakistan, India and North Korea – continue to grow.

Plutonium Management Guidelines: A Brief History5

Ironically, the end of the Cold War in the early 1990s and the withdrawal of tons of material from military stockpiles in the US and Russia provided another impetus for governance efforts on plutonium. The then-Director General of the International Atomic Energy Agency (IAEA) Hans Blix engaged the nuclear weapon states along with Japan and Germany in informal talks on the prospects for increasing not just transparency regarding growing stockpiles of civil plutonium but also surplus plutonium from weapons

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States with plutonium balances sought to avoid potentially divisive and unproductive discussions in a wider forum and therefore agreed among themselves to draft guidelines for plutonium management. By 1997, stockpiles of separated civilian plutonium had risen to approximately 219 metric tons (MT).

In addition to the five nuclear weapon states – China, France, the UK, Russia and the United States – Germany, Japan, Belgium and Switzerland joined the talks in 1997. Several countries already had been publishing information individually on their national energy strategies and stocks of fissile material. For example, the UK established a policy in the mid-1980s to publish statistics on plutonium movements, production and stocks, as well as information on exports and imports of unseparated plutonium in irradiated fuel and separated plutonium products, including mixed oxide fuels. The United States, as part of a broad declassification effort enabled by the end of the Cold War, had released major government reports on HEU and plutonium in the military stockpiles a few years earlier. The nine countries communicated the guidelines to the IAEA through Notes Verbale, and the IAEA published them as INFCIRC/549 in March 1998.

In their communications with the IAEA, the nine countries all expressed the hope that other states that “separate, hold, process or use plutonium in their civil nuclear activities will adopt similar policies.” All but Russia and China also agreed that highly enriched uranium (HEU) should be subject to similar guidelines.

The guidelines initially had four goals:

• underscore the commitment of each state to existing standards of security and safeguards;
• spur strategic management of plutonium;
• improve transparency; and
• enhance controls on international transfers (for example, implementing end-user certificates).

The guidelines are concise: three and one-half pages define the material that is covered, the application of international standards of physical protection and nuclear material accountancy and control and the necessity of formal assurances in the case of international transfers. The countries committed to sharing annual reports on separated plutonium holdings; annual statements on plutonium estimated to be contained in spent civil reactor fuel and occasional statements explaining national strategies for nuclear power and the nuclear fuel cycle. China specifically did not agree to share information

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on plutonium contained in spent nuclear fuel (Annex C) and never has shared such information.

With respect to strategies for managing plutonium, the guidelines are suggestive rather than prescriptive. Although the United States reportedly pushed to include a goal of reducing plutonium stocks, the guidelines instead state that such policies should take into account the need to avoid contributing to nuclear proliferation, to protect the environment, workers and the public, to account for the resource value of the material and finally, the importance of balancing supply and demand as soon as possible. In practice, the national strategies published over the years, with the exception of those of France and Japan, reveal very little about attempts to minimize plutonium stockpiles to meet nonproliferation or security goals. France, like China and the UK, shared a single national strategy with its initial submission in 1997. In that strategy, officials described the “equal flows” approach, wherein “the plutonium is recycled as a function of the number of reactors capable of operating with MOX fuel and the excess spent fuel is stored temporarily. France’s report also described the need for 20 metric tons of separated plutonium as inventory for the La Hague reprocessing plant.

Japan has published national strategies as INFCIRC/549 reports three times -- in 1997, 2014 and 2018. However, its Atomic Energy Commission has published an annual report since 1994 on the location of plutonium according to types of facilities. In 2014, Japan released its report presumably to account for the upheaval in its nuclear energy program following the Fukushima disaster. In 2018, Japan shared its July 31, 2018 statement by the Japan Atomic Energy Commission regarding Japan’s intention to reduce the size of its plutonium stockpile. In that statement, Japan committed to five specific steps to keeping its stockpile from increasing, which are worth repeating verbatim here:

1. Approve reprocessing plans under the Spent Nuclear Fuel Reprocessing Implementation Act so that reprocessing is to be carried out only to an extent necessary for steady pluthermal power generation, reflecting the operational situation of the Rokkasho Reprocessing Plant (RRP), the MOX Fuel Fabrication Plant,* and MOX-burning reactors; Instruct the operators and confirm that the produced MOX fuel is to be fully consumed in a timely manner;

2. Instruct the operators so as to secure a balance between demand and supply of plutonium, minimize the feedstock throughout the process between reprocessing and irradiation, and reduce the feedstock to a level necessary for proper operation of the RRP and other facilities;

3. Work on reducing Japan’s plutonium stockpile stored overseas through measures including promoting collaboration and cooperation among the operators;
4. Examine all options such as use and disposal of plutonium that is associated with research and development purposes, if there is no concrete plan for its immediate use, while ensuring flexibility depending on the situations; and

5. Steadily promote efforts toward expanding storage capacity for spent fuel. In addition, in order to enhance transparency, electric utilities and Japan Atomic Energy Agency (JAEA) are expected to develop plutonium utilization plans anew, which describes owners, the amount of plutonium in possession and the purposes of plutonium utilization, and then release them every fiscal year.7

Japan, which has a strong incentive to build trust in its intentions as the only non-nuclear weapon state with reprocessing facilities, has clearly taken extra steps to promote transparency in its plans and programs.

China’s single national strategy report in 1997 described the laws for regulating and protecting plutonium, but lacked any reference to balancing supply and demand. This may reflect that China had no separated plutonium at the time, but China has since developed a small inventory, evident in reports beginning in 2010. Russia, which has accrued substantial inventories of separated plutonium and plutonium contained in spent fuel, published five national strategies from 1998 to 2002 that referred mostly to “maximum use,” but not to any need to balance supply and demand.

Lastly, the UK has by far accumulated the largest stockpile of separated plutonium of any country, estimated at the end of 2016 to be 133.5 MT of separated Pu (including 23.2 MT belonging to foreign bodies) and 29 MT of plutonium contained in spent nuclear fuel or at reprocessing plants. While the UK has released significant amounts of information, both about its civilian nuclear energy program and production of fissile material for nuclear weapons (notably the 2000 report, Plutonium & Aldermaston), it has not shared any significant information through INFCIRC/549 about its plans for minimizing stockpiles.

Despite the past twenty years of reporting on plutonium management, the current civilian separated plutonium stockpile worldwide has grown to 290 MT, led by the UK with 110.3 MT, France with 65.4 MT, Russia with 57.2 MT, and Japan with 47 MT.8

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7 The July 31 2018 policy can be found at [http://www.aec.go.jp/jicst/NC/iinkai/teirei/3-3set.pdf](http://www.aec.go.jp/jicst/NC/iinkai/teirei/3-3set.pdf)

Role of Plutonium Management Guidelines

Compared to other governmental channels that have been established to address plutonium management, INFCIRC/549 is a modest measure. It is clear that where there are substantial issues surrounding separated plutonium, smaller groupings of states with similar problems or capabilities or objectives may be necessary to implement specific steps. For example, the US, UK, France and Japan convene regular roundtables on plutonium that address lessons learned at least every two years. The United States conducts bilateral meetings with Japan and with the UK on plutonium management and the United States signed a plutonium management and disposition agreement with Russia in 2000 to address material deemed excess to their weapons programs.

Nonetheless, states drafting the plutonium management guidelines clearly intended that their information would be shared with all IAEA member states in expressing their hope that other states would adopt similar policies. The UK noted in its first report that it had a policy of publishing substantial information on plutonium since 1986, but that publishing information in the format of INFCIRC/549 appendices offered an opportunity to facilitate comparisons with other participating countries’ holdings of plutonium.

In addition, all but Russia and China also expressed the belief in 1997 that “the management of highly enriched uranium “should be subject to similar guidelines.” The five nuclear weapon states all committed to placing plutonium transferred from military to peaceful uses under IAEA safeguards, and China, the US and Russia also agreed to report on that material under INFCIRC/549.

The annual reports represent a baseline of sorts on material growth and disposition but cannot truly be used to judge the effectiveness of efforts to manage civilian nuclear material stockpiles. First, information is not completely consistent across the board, as evident in the discussion above. For example, the UK, France and China have each provided only one national strategy report while the US has periodically reported (six times over 20 years), as has Russia (from 1998 to 2002). In addition, China has never committed to providing information on its plutonium contained in spent nuclear fuel (Annex C). On the positive side, some countries have included information on HEU in their reports, beginning in 1997 with the UK, and then with France and Germany joining a little later.

Moreover, the information is incomplete. In addition to the nine countries reporting, Israel, Italy, Spain, the Netherlands, India, Pakistan and North Korea have all at one time had or currently have plutonium and HEU. Before the nuclear security summits, Italy reportedly had 120kg HEU (fresh and irradiated) and 10 kg of plutonium (fresh and
irradiated). As of 2016, Italy was reported to have < 1 kg of Pu remaining. Both Spain and Germany also had separated plutonium, but transferred ownership to the British. Dutch separated plutonium may be in either France or the UK. Separated plutonium in both Israel and North Korea is presumed to be in their military programs only. While these countries do not pose a great risk of expanding stockpiles of sensitive materials, India, Pakistan and North Korea do pose that risk, whether in their military or civilian sectors.

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**Expanding the Tent**

There are many reasons to promote greater information sharing about Pu and HEU production and stockpiles, whether the specific mechanism is INFCIRC/549 or some other formulation or forum. Information about energy production could help countries coordinate their climate change mitigation strategies and gauge the potential of nuclear energy to help implement zero net emissions strategies. Greater information from Russia and China on their plans for domestic or international recycling would also help other governments gauge the viability of nuclear energy overall. Since it is crucial that nuclear energy not increase proliferation risks, fuel cycle strategies, particularly for advanced reactors, should be scrutinized for the extent to which they seek to minimize the production and/or use of highly enriched uranium or separated plutonium. In the past, governments addressed fuel cycle issues within the International Framework for Nuclear Energy Cooperation, but the forum itself appears to now focus mostly on supporting nuclear energy rather than helping shape fuel cycle futures.

As the British noted more than twenty years ago, providing consistent data alongside other countries allows a comparison of capabilities, and it stands to reason that expanding adherents to the international guidelines could improve the data set. India and the Netherlands are two examples of countries with separated plutonium that could join INFCIRC/549. Although Italy and Spain once had materials, these have been transferred as a result of the Nuclear Security Summit process. South Korea also might find it useful to join INFCIRC/549 as both a confidence-building measure vis-à-vis North Korea and toward other countries if it intends to move forward on pyroprocessing.

Reporting on HEU has only involved three countries (UK, France, Germany) but should involve more. In general, providing more detailed information on Pu or HEU might also be valuable. Japan, for example, has demonstrated the usefulness of providing more detailed information about plutonium stocks. But there are additional ways in which the guidelines could be improved, such as generating a technical and policy dialogue about

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how supply and demand for plutonium could and should be managed. It would also be useful to revisit countries’ commitments to transparency regarding their nuclear energy plans, material stockpiles and fuel cycle approaches. Finally, other countries that have been separating plutonium, like India, Pakistan, and North Korea.

**Potential New Members inside the NPT (South Korea, the Netherlands)**

Participants in the plutonium guidelines expressed their hopes in 1997 that “other States which separate, hold, process or use plutonium in their civil nuclear activities will adopt similar policies.” Since the guidelines were formed, no additional countries within the NPT have new stockpiles of separated plutonium; some have transferred ownership. South Korea, which does not have stockpiles of separated plutonium, however, might consider it useful to begin adhering to INFCIRC/549 as part of a transparency campaign aimed at gaining confidence in its intentions with respect to pyroprocessing. The Netherlands, which reportedly has a small amount of separated plutonium, might find it useful to adhere to the guidelines to enhance its leadership role in promoting strengthening of nuclear security.

**Potential New Members outside the NPT (Israel, India, Pakistan, North Korea)**

There is no particular reason why states outside of the NPT could not adhere to the international plutonium management guidelines on their own or with explicit or tacit approval of existing members. One potential hurdle is the reference to the NPT in paragraph 5 (Nonproliferation and International Safeguards) of the guidelines, which states:

Plutonium will continue to be handled in accordance with the Government of [“’s obligations under the Treaty on the Non-Proliferation of Nuclear Weapons, [Belgium], (Germany), (France), (UK) its obligations under the Euratom Treaty], its Safeguards Agreement(s) with the IAEA, and its other nuclear non-proliferation commitments.

Countries objecting to the reference to the NPT may be able to finesse this issue in their Notes Verbale by simply referring to their safeguards and other nuclear non-proliferation agreements. Alternatively, they could approach current members to amend the guidelines to omit the single reference to the NPT. Paragraph 5 could be amended to read as follows:

Plutonium will continue to be handled in accordance with the Government of [“’s safeguards obligations under relevant treaties and agreements as well as its other nuclear non-proliferation commitments.

Effort to amend the guidelines should also update paragraph 7 to reflect the most recent revision of the Convention for the Physical Protection of Nuclear Material and perhaps make reference to commitments under INFCIRC/869 (Strengthening Nuclear Security Implementation).
Israel is a member of the IAEA but not a party to the NPT. The International Panel on Fissile Materials, a non-governmental group of scientists that publishes estimates of fissile material stocks, estimates that Israel has .9 tons of plutonium in its military sector (as of 2014, 900 kg +/-130kg). David Albright, president of the Institute for Science and International Security, estimated in 2015 that Israel had produced 660kg +/- 115kg in its Dimona research reactor, based on a somewhat lower estimate of the maximum power level of the reactor. It is not known whether that material is entirely in nuclear weapons or whether some of it is held as stocks outside of weapons. Many experts believe that Israel has stopped producing fissile material for nuclear weapons. Unless Israel declared some of its military plutonium as excess (or potentially HEU that might have come from the NUMEC plant in Apollo, Pennsylvania), it would be an unlikely candidate to participate in the plutonium management guidelines because it has no civilian facilities producing HEU or plutonium.

Nonetheless, participation by Israel in the INFCIRC/549 guidelines would likely require the following steps:

a. Declaring some material (plutonium or HEU) as requiring IAEA safeguards. Since Israel does not explicitly admit it has a military nuclear program, declaring material excess to defense needs is not politically possible. Options might include exporting such material to another country and then requesting that IAEA safeguards be applied to it, or requesting the IAEA to apply safeguards to the material under an INFCIRC/66 agreement.

b. Issuing a Note Verbale to the IAEA Director General expressing intention to adhere to the guidelines. The Note Verbale would likely be tailored, highlighting which portions of the guidelines Israel would apply to its management of the material in question. The Note Verbale would omit any mention of the NPT, but could mention Israel’s safeguards and other safety and security obligations.

c. Providing a national fuel cycle strategy statement and declaration of plutonium stocks (separated and/or in irradiated fuel).

Obviously, any of these actions for Israel would require an enormous shift in policies. However, Israel has indicated support for a treaty that would ban fissile material production for nuclear weapons and while not declaring a moratorium itself, is widely believed to have stopped producing fissile material for any purpose. Providing a fuel cycle strategy presumes that Israel plans to pursue civilian nuclear energy, and declaring plutonium stocks but there is otherwise little incentive for Israel to do anything in the sphere at all.
India is also a member of the IAEA but not a party to the NPT. It has a significant civilian nuclear research and energy program in addition to its defense capabilities.

India has roughly 400 kg of separated civilian plutonium under IAEA safeguards and an additional 6 MT (± 3.5) of reactor-grade separated plutonium outside of international safeguards that has been categorized as “strategic” material. India’s weapons-grade plutonium stockpile for military use is estimated between 0.58 ± 0.15 MT. India also has stocks of highly enriched uranium from three enrichment plants (a pilot plant at Bhaba Atomic Research Center, the Rare Materials Plant in Ratehalli and the so-called Special Material Enrichment Facility at Challakere in the Chitradurga district of Karnataka). If enriched to a level of 30% U-235, the stocks could equal about 4.0±1.4 MT of HEU, according to the International Panel on Fissile Materials.10

Reportedly, Indian adherence to INFCIRC/549 was an early requirement during discussions about how India might join the Nuclear Suppliers Group. India has adhered to NSG guidelines in exchange for the United States brokering an exemption for India from NSG requirements in 2008. As part of the U.S.-India nuclear deal, India placed additional facilities under IAEA safeguards, the so-called “separation plan.” India has, in the last ten years, shown its willingness to support other nuclear security and nonproliferation efforts, including the four nuclear security summits held from 2010 to 2016. In particular, India joined 37 other countries in June 2016 to support the Joint Statement on Strengthening Nuclear Security Implementation (INFCIRC/869) and has established a nuclear security support center (a so-called center of excellence).

India’s participation in the INFCIRC/549 guidelines would likely require the following steps:

a. Issuing a Note Verbale to the IAEA Director General expressing its intention to adhere to the guidelines. The Note Verbale would likely be tailored, highlighting which portions of the guidelines India would apply to its management of the material in question. The Note Verbale would omit any mention of the NPT, but could mention India’s safeguards agreement, Additional Protocol and other nuclear nonproliferation commitments.

b. Providing a national fuel cycle strategy statement and declaration of plutonium stocks (separated and/or in irradiated fuel).

c. Providing information about its HEU production and/or stockpiles.

In informal discussions, Indian nuclear and foreign policy experts have suggested there are few incentives for India to open up about its fissile material production and stocks.

Becoming a member of the Nuclear Suppliers Group, in their view does not require further *bona fides* beyond what India has already produced. However, since India has always supported a fissile material production cutoff treaty, one way in which it could contribute to progress toward negotiating a treaty would be to provide information on civilian production of Pu and HEU. Former Chairman of India’s Atomic Energy Commission described the Chitradurga plant as engaging in strategic and civilian enrichment, and therefore not subject to IAEA safeguards, but these kinds of distinctions will not be tolerable under a future fissile material production cutoff treaty.\(^{11}\) There are many actions India could take to build confidence about the Chitradurga plant but these could test India’s threshold for intrusiveness and may be physically complicated, since the plant was not designed to separate strategic and civilian activities. Providing data on materials could be much easier. However, India may also be wary of providing data on HEU unless China also does.

**Pakistan** is also a member of the IAEA but not a party to the NPT. Pakistan has no declared separated civilian plutonium, but reportedly has 280 kg of separated military plutonium.\(^{12}\) Recent estimates put Pakistan’s irradiated plutonium in spent nuclear fuel at 2.17 tonnes.\(^{13}\) An expansion of civilian nuclear energy, as Pakistan intends, could change the situation dramatically. Whether or not Pakistan joins the Nuclear Suppliers Group, China clearly will continue to supply Pakistan with civilian nuclear power reactors. Pakistan’s engagement through INFCIRC/549 could help dampen security concerns in India and bolster Pakistan’s nonproliferation credentials in the international community. Adhering to plutonium management guidelines could begin to build trust in Pakistan’s intentions.

Participation by Pakistan in the INFCIRC/549 guidelines would likely require the following steps:

a. Issuing a Note Verbale to the IAEA Director General expressing its intention to adhere to the guidelines. The Note Verbale would likely be tailored, highlighting which portions of the guidelines Pakistan would apply to its management of the material in question. The Note Verbale would omit any mention of the NPT, but could mention Pakistan’s safeguards obligations.


b. Providing a national fuel cycle strategy statement and declaration of plutonium stocks (separated and/or in irradiated fuel).

c. Providing information about its HEU production and/or stockpiles.

Pakistani officials reportedly have offered to adhere to INFCIRC/549 to provide incentives for other countries to consider their membership in the Nuclear Suppliers Group but so far have been unable to overcome the reluctance of many states to this idea. There are no details about what such an offer might have entailed but any information about plutonium would likely cover material in irradiated fuel. Reporting on HEU would be a welcome, if far-reaching step. However, Pakistan may not declare HEU information because China has not done and India may not do so.

The participation of North Korea in the guidelines for plutonium management could present interesting dilemmas. Many analysts assume that a final agreement with North Korea will include its denuclearization, eventually with a return of North Korea to the Nuclear Nonproliferation Treaty as a non-nuclear-weapon state. They might also assume that this would mean a complete clean-out of weapons-usable material from North Korea, including HEU and separated plutonium. Even such a rosy scenario might leave plutonium in spent nuclear fuel on-site for practical reasons, such as cost of packaging or transportation, or for environmental radiation exposure. It is also possible that a reintegration of North Korea via denuclearization would convert existing facilities to peaceful, civilian uses. In this case, North Korea’s capabilities could either mirror South Korea’s (e.g., reactors, research capabilities and fuel fabrication) or Japan’s (enrichment and reprocessing under IAEA safeguards). Even in this unlikely scenario, it could be valuable to have North Korea adhere to the plutonium management guidelines.

A less rosy scenario – or at least one in which denuclearization comes at the end of decades of small steps to reduce risks and build confidence – could include North Korea’s participation in the plutonium management guidelines. For example, North Korea could declare some plutonium as excess to its defense program. This might not be the complete stockpile, but an amount perhaps sufficient for 10-20 bombs (80-150kg). One potential perceived advantage for North Korea to make such a declaration within INFCIRC/549 is that it would be tied less to US-DPRK relations and the state of bilateral negotiations and more to reintegration of North Korea into a community of countries dedicated to reducing nuclear risks. INFCIRC/549 could also cover North Korea’s HEU.  

If North Korea did adhere to the plutonium management guidelines, what steps would be necessary? A first step would be for North Korea to rejoin the International Atomic

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14 This may be very difficult because not all current INFCIRC/549 members comply with it, and North Korea may have to hold onto the information about its HEU (growing) stock as its leverage for denuclearization talks.
Energy Agency, which it left in 1994, by submitting a Note Verbale to the Director General. The IAEA Secretariat would transmit the application to the Board of Governors, which would then transmit it to the General Conference for approval. The process of adhering to INFCIRC/549 would be much less formal, but would also require submitting a Note Verbale to the IAEA Director General. In all likelihood, participating states would probably gather to consider North Korean adherence. In the present environment, where steps to build confidence in its intentions tend to be welcomed by North Korea’s neighbors and other stakeholders, rejoining the IAEA may not be so far-fetched. Although North Korea’s antipathy to the IAEA is well-known, rejoining the organization would allow North Korea to potentially engage in technical cooperation projects, which would have to be limited in the short term to safety-related projects. North Korea could then submit a Note Verbale to the IAEA Director General indicating its intention to adhere to INFCIRC/549 guidelines. The content of its declaration would depend very much on where North Korea was in the process of denuclearization.

Obviously, goals for North Korea’s denuclearization are far more ambitious than North Korea issuing a non-legally binding declaration regarding stocks of fissile material. But such declarations could have a role in the denuclearization process and should be assessed for their utility.

Roadmap for implementation

Expanding INFCIRC/549’s “tent” could take several pathways. Adhering countries could choose to reinvigorate the guidelines by focusing additional attention upon and elevating the guidelines’ priority. This might or might not involve attracting new members. The guidelines could be promoted at the NPT 2020 Review Conference or other international fora such as the February 2020 ministerial meeting on nuclear security. Core concepts of the guidelines could be promoted by existing members of the Nuclear Suppliers Group in their supply agreements or adherence to INFCIRC/549 could become a prerequisite for new members of the Nuclear Suppliers Group. Finally, North Korea’s adherence to INFCIRC/549 could occur on the margins of or within denuclearization negotiations.

1. **INFCIRC/549 reinvigoration:** At present, the group of states that implements INFCIRC/549 meets briefly on the margins of the annual IAEA General Conference. One or more of the 9 countries could choose to expand that meeting to include substantive discussions. Potential topics could include balancing supply and demand of plutonium, national fuel cycle strategies, briefings of bilateral and multilateral discussions or new membership outreach.

2. **2020 NPT Review Conference:** The 2020 NPT Review Conference may be contentious for several reasons, including the failure of efforts to secure a WMD-free
zone in the Middle East, North Korea’s continuing nuclear threat, and, most importantly, the failure of U.S.-Russian arms control. Although nuclear weapon states will try to keep discussion of the nuclear weapons ban treaty out of the forum, they are unlikely to be successful. The U.S. emphasis on “creating the environment for nuclear disarmament,” at best, could include some small steps on transparency. The expansion of INFCIRC/549 would contribute to transparency and would underscore states’ willingness to promote nuclear energy expansion. Within the NPT, countries such as Spain, Netherlands, and South Korea could join. Although South Korea currently has no separated plutonium, it still harbors hopes of engaging in pyroprocessing, which several other members of INFCIRC/549 have experimented with. Moreover, South Korea’s participation could pave the way for North Korea eventually to participate in the process. The best option would be for Japan and China to encourage South Korea to join as part of a regional effort to enhance transparency on fuel cycle activities.

3. **Connection to Nuclear Suppliers Group activities:** The Nuclear Suppliers Group restricts trade in sensitive nuclear technologies, including in fuel cycle technologies such as uranium enrichment and spent fuel reprocessing. Initially, the NSG guidelines called for restraint in the transfer of sensitive facilities, technology and weapons-usable materials. NSG guidelines suggested encouraging recipients to accept supplier involvement or multinational participation if such items were to be transferred, and also suggested suppliers should promote multinational regional fuel cycle centers. While suppliers agreed that any transfers of enrichment plants would be subject to ceiling set at 20% enrichment, there was no formal attempt to make the product of reprocessing more proliferation-resistant.

Changes to the NSG guidelines in the mid-2000s focused primarily on adding depth and detail to enrichment restrictions. However, there has been little attempt to coordinate how countries operationalize those restrictions in their national nuclear cooperation agreements. One way in which expansion of INFCIRC/549 might be promoted is through greater coordination of restrictive language in nuclear cooperation agreements. For example, the 2015 U.S.-China nuclear cooperation agreement contained language taken from INFCIRC/549 regarding fuel cycle transparency and balancing supply with demand. States could promote the adoption of such language in all new nuclear supply agreements. Most agreements will not contain consent to reprocess, but even requiring assurances about final disposition of nuclear waste would be a step in the right direction.

With respect to new members of the Nuclear Suppliers Group, both India and Pakistan have been seeking NSG membership for several years. Both have, at different times, suggested adherence to INFCIRC/549 as a sweetener for NSG members to consider their membership. At present, China is blocking India’s membership in the NSG unless there is reciprocal action on Pakistan. Pakistan could unilaterally decide to adhere to INFCIRC/549 to enhance the prospects for approval of its candidacy by other NSG members.
4. North Korean denuclearization negotiations: The adherence of North Korea (and possibly South Korea) might be included in a denuclearization agreement that allowed North Korea to keep some nuclear energy capabilities or as a result of North-South confidence-building measures. Although it would certainly be helpful to get accurate data on North Korea’s fissile material stockpiles, North Korea’s adherence to INFCIRC/549 would be a collateral benefit from other processes and should not be a goal when considering how to strengthen INFCIRC/549. Within a denuclearization process, it would be a minor, complementary step. Obviously, it is not a substitute for verification (and in fact, has no verification inherent in it). However, even a denuclearization process may find less comprehensive and voluntary measures useful.

Conclusions

Obtaining fissile material remains the essential hurdle for those individuals or states seeking to develop nuclear weapons. In the last two decades, increased awareness of the threat of nuclear terrorism has prompted some states to reduce and/or secure stockpiles of weapons-usable materials, particularly through the nuclear security summit process. Overall, however, broader efforts to create an international governance system to restrict the growth of stockpiles or to reduce stockpiles have failed in the face of resistance for technical, political and economic reasons.

It may be that the current INFCIRC/549 has lost its relevance and influence because of declining support for nuclear power in some member states like Germany, Belgium and Switzerland, or because nuclear security has ascended in importance since September 11, 2001. The Fukushima accident on March 11, 2011 caused a significant reevaluation of nuclear safety policies and procedures in many states as well. For INFCIRC/549 to continue to be relevant, it must adapt to new challenges.

A few factors will continue to make consensus difficult on plutonium growth. China is gearing up to open a civilian nuclear spent fuel reprocessing plant, several countries continue their fast reactor programs (nearly all of which will require recycling or conditioning spent fuel), and there is still no consensus on whether irradiated nuclear fuel is an asset or a liability. None of the 31 countries (plus Taiwan) that deploys civilian nuclear power plants has permanently disposed of its nuclear waste from those plants, leaving key political and technical questions open.

It is imperative, therefore, that the international community continues to build on progress to date in illuminating countries’ civil nuclear energy programs, the growth of spent fuel and separated plutonium, and their strategies for mitigating risks. INFCIRC/549 is a small effort but has provided measurable indicators for twenty years on countries
activities and should be strengthened, expanded and adapted to meet a new century’s needs.