

Workshop Report

# Fissile Material Restrictions in Nuclear Weapon States: Treaties and Transparency

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*A Report of the CSIS Proliferation Prevention Program*

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## Fissile Material Restrictions in Nuclear Weapon States: Treaties and Transparency Workshop Report

September 19, 2016

The Proliferation Prevention Program at the Center for Strategic and International Studies hosted a workshop exploring fissile material restrictions in nuclear weapon states in June 2016. The meeting addressed the potential for transparency-related measures as well as those covered by a fissile material treaty. It sought to investigate new angles into the existing debate about fissile material production limits in the nuclear weapon states, including those related to restrictions on fuel cycle activities (such as restricting enrichment of uranium above 20% U-235). Drawing upon experts from government, academia, and think tanks, the workshop reviewed the existing state of play on discussions in Geneva on a fissile material production cutoff treaty, some existing political and technical hurdles, and new potential points of entry for further work going forward. This workshop was meant to serve as a foundation for future collaboration among participants, a mechanism to inject new ideas into the FM(C)T discussion, and a venue for cross-fertilization between individuals in and out of government. The appendix to this workshop report lists the participants, the agenda, and the discussion paper prepared for the workshop. The presentations from the workshop are available [here](#).

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<sup>1</sup> There has been a long-standing debate on whether or not a fissile material treaty should include existing stocks. Those in favor of only limiting future production typically have used the acronym FMCT (fissile material production

### Background

Most discussions of restricting fissile material production have focused on the weapons side of the problem – that is, halting fissile material production specifically for weapons. There is a large body of writing devoted to problems (and opportunities) associated with negotiating a legally-binding Fissile Material (Cut-off) Treaty (FM(C)T).<sup>1</sup> First proposed in 1956 by U.S. President Dwight Eisenhower, an FM(C)T has been a long-time fixture of the arms control and disarmament agenda. In 1994, Special Coordinator Gerald Shannon, Canada’s Ambassador to the Conference on Disarmament, recommended establishing an Ad Hoc Committee in Geneva to explore negotiations, leaving open the question of whether such a treaty would cover existing stocks of material or just future production. The Shannon Mandate was adopted briefly in 1995 and the Ad Hoc Committee completed two weeks of work in 1998, but actual negotiations have never proceeded at the Conference on Disarmament. A few draft treaty texts have been floated over the years without results.

On the civilian side of the issue, efforts to restrict fissile material production have largely focused on dampening proliferation – that is, attempts to restrict the further spread of uranium enrichment and spent

cutoff treaty) to describe a treaty that simply cuts off production and does not touch existing stocks. This report places the “C” in FMCT in parentheses to avoid prejudice regarding scope of the treaty, since the acronym FMT (fissile material treaty) is not widely accepted.

fuel reprocessing technology. Nonetheless, the four nuclear security summits held since 2010 have drawn attention to the risks of stockpiles of highly enriched uranium (HEU) and plutonium in the civilian and, to a lesser extent, military sectors. As part of the Nuclear Security Summit process, participating states have agreed to minimize the use of HEU in the civilian sector where possible. Many research reactors that use HEU fuel have been converted to low-enriched uranium (LEU) fuel. Existing military materials and future enrichment and reprocessing activities were excluded from summit discussions, though the United States made a unilateral declaration of its HEU inventory.

In her opening remarks, Ms. Sharon Squassoni noted the incongruity of the stalled FM(C)T negotiations with the *de facto* production moratoria of the five nuclear weapon states under the Nonproliferation Treaty (NPT). She suggested that it may be time for a wholesale reconsideration of a treaty to restrict fissile material based on three significant developments: increased awareness of fissile material security and proliferation risks as a result of the Nuclear Security Summits; an increased focus on transparency in the Nuclear Nonproliferation Treaty Review Conference process; and the conclusion of the Iran nuclear deal (the Joint Comprehensive Plan of Action), which suggested that reducing the risks from fissile material production and stockpiles may require greater restrictions than the current nonproliferation regime entails. Ms. Squassoni encouraged participants to consider issues beyond traditional treaty considerations (e.g., scope, verification)

with an eye towards how transparency measures might play a meaningful role, even in the civilian nuclear fuel cycle arena.

### **Current Status of Negotiations**

The first session explored current thinking specifically on the FM(C)T, including the formal process in Geneva, the Group of Governmental Experts, and France's recent proposed draft treaty. Ambassador Paul Meyer detailed the many years of blocked negotiations at the Conference on Disarmament (CD) and the major obstacles to breaking the current gridlock. He characterized the relationship between the FM(C)T and the CD as "abusive" and took diplomats to task for repeating statements promoting FM(C)T as a top priority while doing nothing in practice to break the deadlock. Although the constructive ambiguity of the Shannon Mandate was briefly useful, Pakistan openly states that an ambiguous approach to stocks would be insufficient to protect its security interests. On the one hand, more than 150 countries annually support a resolution at the United Nations on banning fissile material production for weapons purposes, yet non-aligned countries refuse to support negotiations anywhere but the Conference on Disarmament. Ambassador Meyer called for an end to the hypocrisy of insisting upon negotiations at the CD and to shift the focus to the UN General Assembly which is not subject to the veto of any one state. He urged concerned states to champion a UN resolution that would establish an open-ended working group that could undertake negotiations. Ambassador Meyer noted that it would require a significant diplomatic effort to ensure a supportive majority for a UN General Assembly Resolution authorizing

negotiations, but argued that in light of Pakistan's continued intransigence on FM(C)T negotiations, states need to seriously consider a venue for negotiations beyond the CD.

One participant questioned whether the issue really was the inability of the CD to get negotiations started or a more fundamental divide – the fact that while some states supported the disarmament element of the treaty, others did not. The debate over existing stocks reflected not just a difference on the scope of the treaty but in fact a much deeper divide that no forum may be able to bridge. Another participant suggested that Geneva could still be involved in some technical and verification work even though negotiations might be far off.

Dr. Pavel Podvig summarized the work of the Group of Governmental Experts (GGE), which met for four sessions in 2014 and 2015. Dr. Podvig suggested most countries agree upon the [broad outline of a treaty](#), but contentious details remain—including questions of fissile material definitions, specific verification measures and their degree of intrusiveness, and verification objectives. He noted there was general agreement that fissile materials produced for civilian or non-proscribed military purposes would need to be followed downstream to ensure non-diversion. He also identified interest in the treaty as a disarmament measure, though this and other GGE discussions were not reflected in the final GGE report. He suggested that even if the eventual treaty does not include existing stockpiles, the mechanisms that are required to ensure non-diversion of newly produced fissile materials could easily be

adapted to ensure non-diversion and elimination of materials produced in the past and the materials that would originate in the process of nuclear disarmament.

Dr. Podvig recommended a few short-term steps to keep up the momentum of GGE. First, non-nuclear weapon states could make public declarations of fissile material stocks as a way of encouraging nuclear weapon states to make similar declarations. Second, states could commit to keeping nuclear weapons-usable material under safeguards (e.g., the plutonium transferred from Japan to the United States), and third, the plutonium disposition agreement between the United States and Russia should be revitalized.

One participant averred that the GGE, while useful as a discussion forum, did not report agreement on many issues, but rather presented a range of views on specific topics. Another participant expressed concern that a two-tiered system, with some fissile materials under safeguards and others not, is ultimately unworkable. Unless existing civilian HEU stockpiles are captured, they become a problem for verification. This would also be true of plutonium in future spent nuclear fuel. Politically, most participants agreed that linking an FM(C)T with disarmament would increase active support from some states, but would make others more reticent to negotiate and ultimately sign a treaty.

Mr. Simond de Galbert highlighted the provisions and objectives of the French draft treaty submitted in April 2015 to the Conference on Disarmament. The five main pillars of the treaty include the prohibition of future production (including shutdown,

dismantling or conversion), verification, organizational structure, confidence-building measures, and standard right of withdrawal. As in the NPT, the specific verification measures are not defined. The French treaty does envision an organization to carry out implementation of the treaty, and includes confidence-building measures regarding existing stocks. Mr. de Galbert noted three key objectives of the verification system: providing proof of permanent shutdown (dismantlement or conversion) of production facilities; verifying that fissile material produced following entry into force will not be used for prohibited purposes; and providing proof that material already extant will not be clandestinely diverted. Mr. de Galbert also explained that the draft treaty did not include all fissile material production facilities (only those above a certain production threshold), though it does call for states to submit voluntary transparency declarations. Several components of the draft treaty drew from other arms control measures, including the Chemical Weapons Convention and the Comprehensive Test Ban Treaty.

Participants raised several questions related to the French treaty's objectives, noting that any FM(C)T's goals would significantly influence its scope, verification requirements, and even its likelihood of success if taken up by different negotiating bodies. Participants agreed that verification challenges could be proportional to the scope of the treaty (as in more scope, more challenges) but also that a broader treaty could, in some cases, actually make verification easier. For example, if the treaty prohibits the production of both civilian and military HEU, then any HEU

produced after the treaty's entry into force would constitute a violation, making verification a bit easier. Other potential treaty boundaries could make verification more challenging – e.g., if the treaty required states to declare (and verify) aggregate stockpiles, including material currently in weapons. There are no currently acceptable approaches that provide confidence without revealing classified information and experts agree that this area requires further technical research.

### **Political Challenges**

Countries still producing fissile material for weapons offer the most significant political challenges to an agreement to restrict such production, especially India and Pakistan. Dr. Toby Dalton suggested that while Pakistan receives the most criticism for blocking FM(C)T negotiations, India could present even greater challenges to a treaty in the future. He contrasted Pakistan's program with India's: Pakistan currently has no civilian fissile material, though there is the potential for separated plutonium in the future while India has large quantities unsafeguarded fissile material in both the civilian and military sectors.

Dr. Dalton highlighted three particular challenges that the evolving deterrence landscape in South Asia poses for an FM(C)T. First, Pakistan is moving from a policy of minimum credible deterrent to full-spectrum deterrence with an overtone of counterforce targeting, which undergirds its assessed requirements for fissile material. Second, Pakistan concurrently appears to be shifting toward plutonium-based warheads, while still producing HEU. This growth in fissile material stocks is

unbounded and there are no checks and balances in the decisionmaking system that could result in restraint. For Pakistan, parity in fissile material stocks does little to redress imbalances in conventional forces, leading to ever increasing reliance on nuclear forces. Third, India's three-stage fuel cycle plan, the mixing of civilian and strategic facilities, and the development of naval nuclear reactors creates difficult verification challenges. And if India successfully pursues its thorium-based civilian energy program without utilizing breeder reactors, it could have large plutonium stockpiles without purpose or disposition plans.

The overall context of growing arsenals with more assertive plans for use, coupled with no desire in either country to reduce nuclear risks, makes progress difficult, if not impossible, for an FM(C)T. There has been little success in external pressure on Pakistan to reduce its production. The U.S.-India nuclear deal (to enable civilian nuclear trade with India) fundamentally changed the strategic picture for Pakistan: the military assumes India's nuclear arsenal will continue to grow and has therefore adopted a more expansive nuclear posture.

Within India, there is little pressure on or oversight of the Indian fissile material production program. Dr. Dalton stressed that fissile material production in South Asia could not be addressed in isolation, particularly without resolving political asymmetry and deterrence instability. However, he saw value in efforts to identify points of influence or leverage—for example in the context of criteria for membership in the Nuclear Suppliers Group.

Dr. Hui Zhang traced the history of Chinese policies on fissile material production, noting the 1978 “military to civilian conversion” policy and the halt in military plutonium production in 1987. Dr. Zhang suggested the collocation of military and civilian facilities on a single site could present verification sensitivities. The Jiuquan Plutonium Production Complex, for example, has a civilian pilot reprocessing plant, facilities for processing plutonium and HEU into metal, and facilities for fabricating and assembling weapons components. The Heping Gaseous Diffusion Plant at Jinkouhe (Plant 814) was also used for weapons HEU production until 1987, when it was converted; the plant still continues non-weapons operations today. At sites such as these, certain on-site monitoring (e.g., sampling) could reveal sensitive chemical composition information. China is likely to support less intrusive inspections at former weapons sites as a result and has expressed concerns about the potential abuse of on-site challenge inspections.

Officially, China has supported negotiations on future stocks only, and has linked negotiations of an FM(C)T to missile defense and space weaponization. Dr. Zhang indicated that Beijing would be unlikely to support required stockpile declarations, which it views as a fundamental precursor to disarmament. In discussion with other participants Zhang suggested that China was sensitive to being viewed as India's competitor and that China viewed Japanese fissile material capabilities as a source of concern. On the plus side, China's traditional aversion to transparency may be softening, since Chinese officials

now seem to recognize that transparency can be used to show strength.

### **Technical Challenges**

In his presentation, Dr. Malte Göttsche outlined the types of sites that would require verification and the strategies that could be employed for each. He stressed the importance of verification measures to detect undeclared facilities. Dr. Göttsche proposed several verification options of various degree of intrusiveness to verify designated stocks of military fissile materials. Naval fuel, hypothetically verifiable with perimeter control measures, will nonetheless present significant challenges for managed access. It would also be more difficult to conduct verification measures at existing sites, whereas future sites could be constructed according to inspection and monitoring requirements.

Participants noted that the French treaty included verification only for facilities above a certain threshold capacity level of significant quantities, with the likely effect that research facilities would be excluded. One participant noted that this could easily leave a large loophole—a facility might not be able to produce weapons-grade fissile material due to domestic regulatory restrictions, but could nonetheless be technically capable. Most participants agreed that, regardless of the treaty's scope, IAEA safeguards under the Additional Protocol would likely serve as the foundation for the treaty's verification system. Lingering questions included the level of certainty required that no diversion had occurred, the amount of material the verification system needs to be able to identify, and whether upstream verification

is equally important as downstream. Dr. Göttsche proposed the establishment of cooperative research projects, including joint exercises, to build confidence and begin to work through potential verification challenges.

### **Current Issues for the United States**

Dr. Frank von Hippel argued that the large Cold War stockpiles of HEU render future production of HEU almost unnecessary for at least fifty years. (India's naval use could be a possible exception). Dr. von Hippel explored strengthening a potential FM(C)T by banning the production of uranium enriched above a certain level. The motivation for keeping enrichment levels as low as possible is to keep countries as far from the risky threshold of weapons-usable uranium as possible.

Dr. von Hippel laid out the declining need for HEU. He noted that since 1978, 150 HEU-fueled research reactors have been retired and an additional 65 have been converted to LEU. Molybdenum-99 production increasingly utilizes LEU and, while politically challenging, existing stockpiles of HEU can supply the current naval reactor fleet until the reactors are converted to LEU or replaced. Dr. von Hippel cited the low priority given by Russia to converting its research reactors as a problem, but pointed out that many of the Russian HEU reactors are older and slated for replacement regardless. Dr. von Hippel noted an increasing demand for 19.75% LEU in lieu of HEU, and one participant identified URENCO as a possible source for high-assay LEU fuel for research reactors.

Dr. Alan Kuperman provided context for further discussion on restricting enrichment

for naval fuel. He noted that naval fuel uses of HEU (3-4 tons annually) dwarf all other non-weapons uses, so achieving progress in this area is important. Dr. Kuperman suggested that existing stockpiles of HEU might last longer than the current estimates (2064), but that nevertheless time could run out to begin the process of reactor conversion because of long development requirements. Of course, the 2064 deadline assumes that no more weapons HEU will be declared excess and made available to the Navy, that there is no change in the planned composition of the fleet, and that no vessels will be switched to using LEU fuel. Dr. Kuperman presented scenarios under which the current fleet of nuclear-powered submarines and aircraft carriers could be converted to LEU or replaced with LEU-fueled vessels. He calculated that if the US Navy converted or replaced only aircraft carriers, and found a new source of LEU fuel, it could buy 12 extra years of HEU fuel for submarines, delaying the required resumption of HEU production until 2076. In his view, this short extension would not significantly affect deadlines for converting reactors or obtaining new HEU.

Participants discussed how the use of lower enrichment in submarine fuels by France and China affect operational requirements (e.g., maintenance, refueling). Dr. Kuperman noted that the United States and the United Kingdom benefit strategically and financially from the use of lifetime cores in their naval reactors. U.S. opposition to non-lifetime cores arises from concerns about cost, delays, and quality assurance related to the need for refueling hatches. Reportedly, while the Navy is confident in its nuclear personnel at sea, it

is less confident that on-shore maintenance would meet its standards.

One participant noted that calculations of HEU drawdown assumed that conversion of submarines to LEU could only be achieved at the start of a new class of vessels. Would it be possible to convert to LEU fuel in the middle of a production run of a class of vessels, rather than just at the start? Another participant noted that such an incremental approach could increase replacement costs dramatically while another noted that what may be technically feasible may not always be politically feasible. Dr. Kuperman expressed concern that, unless new classes of submarines are fueled with LEU by 2074, the United States might actually need to resume HEU production. Other options considered included URENCO providing 19.75% enriched fuel for the US Navy.

#### **Fuel Cycle and Fissile Material Restrictions**

Dr. Hal Feiveson explored the connections between fissile material stockpile declarations, an FM(C)T, and nuclear disarmament in his presentation. He suggested three reasons for including existing stocks under a treaty: to ensure a cap on nuclear weapons (and to know how many weapons there are at the time of entry into force), to rationalize verification under an FMCT (eliminating a second tier of unsafeguarded materials after entry into force), and to provide a baseline for verification under further nuclear disarmament steps.

Current declarations of fissile material vary widely among different categories of states. For example, the non-nuclear weapon states under the NPT declare all their fissile

material to the IAEA as a requirement of their comprehensive safeguards agreements and have those declarations verified. In contrast, states outside the NPT that have nuclear weapons have made no declarations at all, while nuclear weapon states party to the NPT have made regular declarations on their civilian fissile materials that vary in comprehensiveness. The United States has provided the most insight into its weapons stockpile and past production history of any nuclear weapon state, as suggested in the comparison shown in the International Panel on Fissile Materials' transparency scorecard (see page 36, International Panel on Fissile Materials' [Global Fissile Material Report 2015](#)). Dr. Feiveson highlighted the reporting of civil plutonium stocks under INFCIRC/549, which is limited to nine countries, and the fact that the UK, France, and Germany also report on HEU stocks under INFCIRC/549. Still, wider application of INFCIRC/549 has not been seriously considered, given that participation was intentionally limited at the outset to ensure that negotiations would proceed relatively smoothly. One participant suggested the possibility of India and Pakistan implementing INFCIRC/549.

Dr. Feiveson and others argued that it makes sense for non-nuclear weapon states to make fissile material declarations, given that the information is already assembled and shared annually with the IAEA. Verification of any declarations (of civilian stockpiles, production histories, or military stockpiles) could be implemented gradually. Unverified initial declarations could initially help to establish confidence while political support builds for intrusive verification measures. While some participants saw value in the establishment of a system that

could verify disarmament, including fissile material disposition, others expressed caution in overestimating that value.

Dr. von Hippel spoke additionally on limiting enrichment under an FM(C)T. Most reactors, he noted, use LEU enriched to less than 5% U-235 and nearly all the current demand for civilian HEU and LEU >5% is met by downblending US and Russian excess HEU. Dr. von Hippel also argued that existing smaller enrichment plants are unable to compete economically with larger ones, and that any plants built today will likewise be unable to compete economically with those already in existence. Because of this, he found little evidence to support the argument for national enrichment facilities to supply domestic needs. While some proposed small modular reactors (SMRs) would require fuel enriched to slightly above 5%, current civilian and naval needs for enrichment to greater than 5% could be met with only 0.4% of current global enrichment capacity (in the event that excess weapons HEU is not available for downblending). To supply 19.75% LEU assay for naval reactors, Dr. von Hippel raised the possibility of establishing a multinational supplier of for naval use if effective safeguards against diversion could be devised.

Ms. Squassoni argued for an approach to ultimately convert national enrichment facilities into multinationally owned/operated enrichment facilities. She suggested that the argument underpinning an FM(C)T – that no country should be producing fissile material for nuclear weapons – could be used to erode support for purely national enrichment or reprocessing facilities that are unnecessary

and uneconomic anyway. Ms. Squassoni stated that there has been undue emphasis on sovereignty with regard to fuel cycle decisions and that requiring multilateralization – through an FM(C)T – could level the playing field. Absent progress on a treaty, she raised the question of whether a push toward multilateralizing enrichment plants would help reduce some of the friction within the NPT, stop production of fissile material for nuclear weapons outside of the five nuclear weapon states, and reduce risks of further proliferation of sensitive nuclear technologies. If incorporated into an FM(C)T, could multinationalizing enrichment and reprocessing provide additional verification assurances? Would it be possible without an agreement to phase out HEU for naval fuel?

One participant suggested that if the economic argument for national enrichment and reprocessing has been disproven, and supply security can be obtained through alternate means (including acquiring a stockpile of LEU now, when prices are at an 11-year low), then the only reason left to develop or maintain national fuel cycle technologies is to maintain a latent weapons capability. Another participant suggested that because nuclear power plants are so expensive (e.g., costing as much as \$5B each), investing an additional \$1B for an enrichment capability may not be too big of an obstacle. Many, however, emphasized the importance of presenting restrictions in national fuel cycle capabilities as a net benefit, rather than as a restriction. One participant argued against internationalizing reprocessing since it could save an industry that might otherwise fade out, and several others

objected to offering any support whatsoever to reprocessing. Another participant suggested that Japan’s experience in this area is instructive: there is no interest in multinationalizing Rokkasho from any direction.

Participants discussed several approaches for “nudging” countries toward making the right choice – that is, to empower multilateralization. Would it be possible to structure the system so that countries believe it’s better to avoid the pathway of national enrichment or reprocessing? In this context, participants identified analogous situations where countries relinquished capabilities of arguably vital national security importance, including Molybdenum-99 production, space launch services, or indigenous aircraft production. For example, dozens of countries rely on a few foreign suppliers of Mo-99, even though they all consider it a vital resource. Sixty to seventy countries rely on just a handful of countries to launch their satellites. In these cases, security of supply does not seem to be an issue. It would be important not only to build a norm of not having national facilities, but also to ensure a diverse supply base. In the nuclear power arena, Ukraine’s recent success in identifying and creating arrangements with alternate suppliers for nuclear power fuel, uranium enrichment, and fuel fabrication services, as well as spent fuel management services as a result of its current conflict with Russia, is instructive.

Participants also explored possible venues for encouraging alternative approaches to an FM(C)T, including the IAEA General Conference, starting negotiations among a smaller group of nuclear weapon states,

and working through the International Partnership for Nuclear Disarmament Verification (IPNDV). One participant thought the differences among even the five nuclear weapon states should not be underestimated; another thought that the IPNDV forum could be quite useful if it addressed fissile material, rather than just nuclear warheads. Yet another participant considered that the IPNDV process was fairly far removed from reality. After all, if countries get to the point where they can talk about dismantling warheads, the IPNDV process will not be a focal point for action. Another participant agreed that the IPNDV process did not particularly include the kinds of experts needed and that while it addresses “big picture” issues, it will not yield technical results. However, one of the key U.S. objectives, which is to get other countries to accept that these problems are not trivial, may be achievable.



*Front row (left to right): Charles Ferguson, Laura Kennedy, Sharon Squassoni, Harold Feiveson, Paul Meyer  
Back row (left to right): Steven Horowitz, Malte Göttsche, Theo Kalionzes, Miles Pomper, Alan Kuperman, Micah Lowenthal, Frank von Hippel, Pavel Podvig*

## Appendix

### Participants List

**Ms. Audrey Beldio**, Domestic Uranium Enrichment Program Manager, Department of Energy/ National Nuclear Security Administration (Dinner Only).

**Dr. Toby Dalton**, Deputy Director, Nuclear Policy Program, Carnegie Endowment for International Peace.

**Mr. Simond de Galbert**, Visiting Fellow, Europe Program, CSIS.

**Mr. Jeffrey L. Eberhardt**, Office of Multilateral and Nuclear Affairs, U.S. Department of State (Lunch Only).

**Dr. Harold Feiveson**, Lecturer of Public and International Affairs, Princeton University.

**Dr. Charles Ferguson**, President, Federation of American Scientists.

**Dr. Malte Göttsche**, Program on Science and Global Security, Princeton University.

**Mr. Steven Horowitz**, Federation of American Scientists.

**Mr. Theo Kalionzes**, Program officer, MacArthur Foundation.

**Ambassador Laura Kennedy**, Former US Ambassador to the Conference on Disarmament and Acting US Representative to the IAEA.

**Dr. Alan Kuperman**, Nuclear Proliferation Prevention Project (NPPP) Coordinator, and Associate Professor, LBJ School of Public Affairs, University of Texas at Austin.

**Dr. Micah Lowenthal**, Senior Board Director, Nuclear and Radiation Studies Board, National Academy of Sciences.

**Ambassador Paul Meyer** (retired), Senior Fellow in Space Security, The Simons Foundation.

**Dr. Pavel Podvig**, Director and Principal Investigator, Russian Nuclear Forces Project.

**Mr. Miles Pomper**, Senior Fellow in the Washington D.C. office, James Martin Center for Non Proliferation Studies, Middlebury Institute of International Studies at Monterey.

**Mr. Nicholas Quintero**, Department of Energy/ National Nuclear Security Administration (Dinner Only).

**Ms. Sharon Squassoni**, Senior Fellow and Director, Proliferation Prevention Program, CSIS.

**Ms. Mallory Stewart**, Deputy Assistant Secretary of State for Space and Defense Policy in the Bureau of Arms Control, Verification, and Compliance, U.S. Department of State (Lunch Only).

**Dr. Frank von Hippel**, Senior Research Physicist and Professor of Public and International Affairs emeritus, Princeton University.

**Dr. Hui Zhang**, Senior Research Associate, Project on Managing the Atom, Belfer Center for Science and International Affairs.

# **Fissile Material Restrictions in Nuclear Weapon States: Treaties and Transparency**

Center for Strategic and International Studies  
1616 Rhode Island Avenue, Washington, D.C. 20036  
June 27–28, 2016

## **Monday June 27, 2016 Room C115**

**1:30 p.m.**

**Registration**

**2:00 – 2:15 p.m.**

**Introduction** – Ms. Sharon Squassoni, CSIS

*Objectives for the workshop: To identify steps that could usefully contribute to an eventual fissile material treaty, including one that might restrict stocks. These might include voluntary limits on enrichment levels, safeguards or other measures for breeder reactors, declarations of civilian or military stockpiles of HEU and Pu, or other transparency measures.*

**2:15 – 3:45 p.m.**

**Session I: Current FM(C)T Status Update**

*This session will cover status of past negotiations, assessment of challenges*

- CD issues – Ambassador (ret) Paul Meyer, The Simons Foundation
- Summary of 2015 French treaty – Mr. Simond de Galbert, CSIS
- Results from Group of Governmental Experts – Dr. Pavel Podvig, Russian Nuclear Forces Project

**3:45 – 4:00 p.m.**

**Break**

**4:00 – 5:30 p.m.**

**Session II: Political Challenges**

*This session will cover Pakistan, India, Israel, China and Russia*

- South Asia – Dr. Toby Dalton, Carnegie Endowment for International Peace
- China – Dr. Hui Zhang, Belfer Center for Science and International Affairs

*Dinner will be held at the Tabard Inn (1739 N Street, NW) from 6:15-7:45pm  
Audrey Beldio (DoE/NNSA) will give informal remarks on DoE's Enriched Uranium  
Management Plan*

## **Tuesday June 28, 2016, 9th Floor Board Room**

- 8:30 – 9:00 a.m.**                      **Breakfast**
- 9:00 – 10:00 a.m.**                      **Session III: Technical Challenges**  
*This session will cover verification challenges and some of the tools to address them.*  
Dr. Malte Göttsche, Princeton University
- 10:00 – 11:45 a.m.**                      **Session IV: Current issues for United States**  
*This session will consider the impact of potential requirements for unencumbered LEU or for HEU on U.S. positions on an FM(C)T.*
- Future weapons requirements and excess defense material – Dr. Frank von Hippel, Princeton University
  - Future Naval Requirements – Dr. Alan Kuperman, University of Texas
- 12:00 – 1:00 p.m.**                      **Luncheon Speaker: Deputy Assistant Secretary of State Mallory Stewart**
- 1:15 – 2:45 p.m.**                      **Session V: Fuel Cycle and Fissile Material Restrictions**  
*This session will consider specific steps that could facilitate a fissile material treaty, whether they are outside the treaty (in advance or on the margins) or incorporated into the treaty.*
- Declaration of Civilian and/or Military Stocks – Dr. Harold Feiveson, Princeton University
  - Limiting Enrichment Levels Globally – Dr. Frank von Hippel, Princeton University
  - Banning National ENR – Ms. Sharon Squassoni, CSIS
- 2:45 – 3:00 p.m.**                      **Break**
- 3:00 – 4:15 p.m.**                      **Continuation and Wrap-Up**

Discussion Paper for CSIS Workshop on  
***Fissile Material Restrictions in Nuclear Weapon States: Treaties and Transparency***  
Sharon Squassoni, Senior Fellow, CSIS  
June 17, 2016

The United States has supported a treaty to cease the production of fissile material for nuclear weapons for more than half a century. This step, along with a halt in nuclear testing, was considered essential to limiting the nuclear arms race as well as the logical prerequisite for nuclear disarmament. After the Nuclear Nonproliferation Treaty (NPT) was signed in 1968, it became clear that some states would remain outside the NPT, and a fissile material treaty also acquired the objective of limiting nuclear proliferation. For decades, the United States has supported both the disarmament and nuclear nonproliferation goals of such a treaty.

Since the mid-1990s, none of the five nuclear weapon states under the NPT (U.S., U.K., France, China, Russia) has produced fissile material for nuclear weapons; all but China publicly announced adherence to a moratorium on such production. In fact, halting production of fissile material for weapons has been held up as a norm for India to emulate. For at least three of the five nuclear weapon states, this has been made easy by the existence of significant military stockpiles of highly enriched uranium (HEU) and separated plutonium (Pu). Simply put, the nuclear weapon states can afford to join a treaty that halts production of fissile material for nuclear weapons because they no longer need to produce such material to maintain their arsenals. In part, this helped fuel a perception from the 1990s that a fissile material treaty (referred to in this discussion paper as FM(C)T so as not to prejudice whether it covers stocks or just future production), was primarily a nonproliferation measure, designed chiefly to get at states outside of the NPT – India, Pakistan, Israel, and now North Korea. Today, it is fair to suggest that there is little appetite or hope for efforts to roll-back the nuclear weapon programs outside the NPT, and so the perception of FM(C)T as a nonproliferation measure is no longer accurate.

By far, the most significant issue is whether the treaty should cover future production or also past production (stocks). Differences (real or manufactured) over this have blocked the adoption even of a negotiating mandate at the Conference on Disarmament (CD) for decades. Other political obstacles, including linkage to negotiations on outer space and ballistic missiles, have also made initiation of FM(C)T negotiations difficult. The fundamental ineffectiveness of the Conference on Disarmament as a negotiating body has also contributed to the stalemate.

Since 2010, three developments have created opportunities to review the context and contributions of an FM(C)T. First, the last six years of nuclear security summits have not only increased awareness about the risks of nuclear terrorism but also that a significant portion of weapons-usable material (half) resides in military stockpiles that the summits did not address. Absent restrictions, those stockpiles will only grow, mostly in states outside the NPT. Second, the 2010 NPT Review Conference endorsed an Action Plan that called upon all NPT member states to apply the principles of irreversibility, verifiability and transparency to the

implementation of their treaty obligations, but also called upon the nuclear weapon states to further enhance transparency. Subsequent reports by the NPT nuclear weapon states varied in the level of detail they provided, particularly on fissile material stockpiles. Third, the nuclear deal with Iran highlighted the fact that reducing the risks of Iran acquiring nuclear weapons required not just paring back Iran's fissile material production and enhancing access and inspections, but also eliminating civilian stockpiles of enriched uranium, especially those enriched above reactor-grade (~5% U-235). The problem is that these limits are unlikely to be adopted more widely, even though safeguarded fissile material production anywhere poses a risk of nuclear weapons latency.

These three developments suggest that it may be time to address stocks in a fissile material treaty or other mechanism but also that it may be time to address civil production limits. An FM(C)T that limited production and stockpiling of weapons-usable fissile material, both in the military and civilian sectors, would reduce risks across the board. Obviously, this is a tall order for a non-existent set of negotiations. However, from the nonproliferation side of the house, there are a few reasons to think big. First, efforts to universalize JCPOA limits will run into the traditional resistance regarding abrogation of rights of peaceful uses of nuclear energy. The fact that Iran was in violation of the NPT and the restrictions appear to be "punishment" will support those who resist universalization. In this context, taking such limits out of the NPT and into a fissile material negotiation could be helpful. Second, disparities in stocks, a sticking point in the scope of FMCT negotiations, is not solved best by states with smaller stockpiles building up. At some point, stocks will need to be restricted, minimized, or eliminated. The ability to capture (at least safeguard) civilian stocks would be quite useful.

Of course, there are obstacles to including existing stocks in the scope of a fissile material treaty. For starters, the five nuclear weapon states and India support a treaty that does not include existing stocks, and the inclusion of those six states is critical to the success of a treaty. Also, regional rivalries could complicate efforts to include existing stocks. In 2008, CSIS completed a study on a Fissile Material Control Initiative (FMCI), which developed an approach to address existing stocks outside of a treaty. The FMCI, which was briefed to a few governments but not published in its entirety, had ten guidelines that spanned activities such as:

- Declarations by all states on stocks of fissile material and commitment to place all civil HEU and Pu under IAEA safeguards
- Ensuring effective nuclear security
- Declarations of excess military material (and placing that material under IAEA monitoring or safeguards)
- Placing HEU for naval propulsion under a special accountancy system
- Minimization and eventual elimination of civil use of HEU
- Minimization of accumulation of civil Pu stocks
- Conversion into forms no longer usable for weapons

As evident by the above description, the FMCI attempted to address not just military stocks, but all fissile material that could pose risks. While the FMCI was developed to see if a parallel, voluntary approach on stocks could allow negotiations of a narrowly focused treaty in the CD to proceed, the approach in this workshop is not to differentiate between legally binding and voluntary measures. This CSIS June 2016 workshop as a whole seeks to build on the FMCI idea of addressing the totality of fissile material risks through non-traditional or indirect approaches. This is not because the opposition to including stocks has declined, but because a fresh narrative is needed to move forward.

The June 2016 workshop will discuss the current status of FM(C)T and its political and technical challenges as a baseline, and then branch out into nontraditional approaches to reducing the risks that enrichment and reprocessing pose. Along the way, it will consider how the current status of U.S. enrichment, reprocessing and material stocks might affect U.S. equities in new approaches. In particular, the workshop will explore the potential for fuel cycle restrictions to help strengthen any future monitoring of an agreement.

#### **The Conventional Wisdom on FMCT\***

**Participation:** At least five nuclear weapon states plus India, Pakistan, Israel and North Korea. All other states are parties to the NPT (except South Sudan).

**Scope:** At a minimum, military fissile material production is halted, meaning that all future fissile material production must be verified to be for peaceful uses. Presumably, IAEA safeguards would be applied to the facilities and follow produced material, but this is not a given. The addition of stocks to the scope refers to past production, or existing stocks.

**Verification:** Monitoring for dismantled/shutdown facilities and equipment; international safeguards for enrichment and reprocessing plants. Advocates for “maximum” verification call for nuclear weapon states to accept full-scope safeguards; something short of that might call for safeguards on enrichment, reprocessing and reactors and leave out military uses of nuclear material.

While the Group of Governmental Experts did not make recommendations on a treaty, its report defines a fairly conservative range of views on issues such as scope, definitions, and verification.<sup>2</sup> Other approaches (e.g., IPFM 2010) have advocated more far-reaching obligations, including prohibitions against using nuclear weapons fissile materials in the civil sector or those declared for use in military reactors. The official French draft treaty presents a set of modest obligations but also includes transparency declarations on civil stocks, material excess for military purposes and enrichment and reprocessing facilities operating below the threshold specified in the treaty.<sup>3</sup> Pakistan’s official response condemned the French approach

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\* The minimalist approach is described here.

<sup>2</sup> For text of GGE report, see <https://documents-dds-ny.un.org/doc/UNDOC/GEN/G15/133/70/PDF/G1513370.pdf?OpenElement>

<sup>3</sup> For text of French draft treaty, see <http://fissilematerials.org/library/france15e.pdf>

as not having any potential to address its “core national security concerns, or even as a bridge between the CD members’ fundamental divide on the issue of a fissile material ban.”<sup>4</sup>

## **Disruptive Approaches**

Although conventional approaches to the FM(C)T focus on military fissile production exclusively, all states that produce (or have produced) fissile material for nuclear weapons have civilian facilities outside of safeguards, and especially enrichment and reprocessing facilities. In some cases, the mingling of civilian and military facilities/material/personnel is significant. Therefore, a fissile material treaty that addresses only military fissile material production and not civilian fissile material production or stockpiles runs certain risks. The obvious solution is for the FM(C)T to include mandatory safeguards on all enrichment and reprocessing. The Group of Governmental Experts pointed out that the verification regime will have to balance effectiveness with costs. Although its report cautioned that costs should not be an excuse for not pursuing some kinds of verification, the long-standing bias has been to minimize cost and intrusiveness for minimal impact. For example, there is a widely held assumption that adding, for example, reactors to the mandatory safeguards list would be prohibitively costly, since so few of them are actually safeguarded in nuclear weapon states. And yet, hiding small-scale reprocessing is likely to be fairly easy for a nuclear weapon state.

An alternative path to seeking comprehensive safeguards in nuclear weapon states is to address enrichment and reprocessing risks from an oblique angle. Fuel cycle restrictions have never been attractive in a nonproliferation context because non-nuclear weapon states have always viewed them as infringing upon peaceful nuclear uses rights. However, in a context of helping reduce the risks of diversion among nuclear weapon states, they may seem more attractive. This paper outlines four options:

- ban national enrichment and reprocessing
- limit uranium enrichment globally to 6%
- limit spent fuel reprocessing
- declare fissile material stocks

The last session of the workshop will explore these in more detail, but the description below should serve as an introduction.

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<sup>4</sup> For text of Pakistani statement, see

[http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwidt-n0ra\\_NAhUMFh4KHR4pBkwQFggeMAA&url=http%3A%2F%2Fwww.pakistanmission-un.org%2F2005\\_Statements%2FCD%2Fcd%2F20150609.docx&usg=AFQjCNFeZidDDJBC\\_sDX1\\_RnteGae9TdMQ](http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwidt-n0ra_NAhUMFh4KHR4pBkwQFggeMAA&url=http%3A%2F%2Fwww.pakistanmission-un.org%2F2005_Statements%2FCD%2Fcd%2F20150609.docx&usg=AFQjCNFeZidDDJBC_sDX1_RnteGae9TdMQ)

### Banning National Enrichment and Reprocessing (ENR)

The idea here is to ban strictly national enrichment and reprocessing facilities, forcing a multilateralization of fissile material production facilities. Details about what levels and kinds of multilateralization (e.g., equity, ownership, management, operation) would be sufficient would have to be worked out. The message is simple: if you don't need to enrich or reprocess for weapons, there is no requirement for a purely national facility. Assurances of supply can be met by diversifying supplies of uranium, conversion, enrichment and reprocessing services.

Leaving aside military ENR facilities that would be shutdown or dismantled, an FMCT would require the conversion of former military production facilities to civilian production. Banning national ENR could be considered a further extension of conversion – i.e., converting from national to multinational operation/management/ownership. In fact, this option might be more attractive and easier to sell if it is described as conversion of operational modalities.

Questions to consider include

- Whether or not the ban on national ENR could be extended beyond the nuclear weapon holders and if so, how? Entry into force (EIF) could be contingent on all countries with ENR facilities on their soil joining a fissile material treaty, although this could delay EIF in much the same way that the CTBT EIF has been delayed.
- The liability in case of noncompliance. Previous proposals for multinationalization of ENR sites have suggested extraterritorial status. Without extraterritorial status, the national government would be liable for the compliance of a multinational entity.
- Whether multinationalization would significantly improve detection time such that a more comprehensive safeguards approach would not add much.
- Could a ban on national ENR be pursued in parallel with FM(C)T?

### Limit Uranium Enrichment Globally – the 6% Solution<sup>5</sup>

The nuclear security summit process since 2010 has identified minimizing the use of HEU and, where economically and technically feasible, eliminating uses of HEU in the civilian sector. At the 2016 Nuclear Security Summit, states that signed the joint gift basket on HEU minimization agreed to refrain from using HEU in new civilian facilities or applications, convert or shut down all HEU civilian reactors, and report annually to the IAEA on the status of HEU removals, downblending, disposition and stocks. However, the gift basket did not address the issue of HEU production, and of the nuclear weapon states, only the US and UK signed the joint gift basket.

Globally, almost all commercial nuclear power reactors use uranium fuel enriched to five percent or less U-235 (except the Chinese and Russian prototype breeder reactors). HEU fuel in reactors that still currently require it are generally supplied by excess U.S. and Russian military HEU. Even the 19.75% LEU fuel is produced by blending lower enriched uranium with excess military HEU. Currently, there is one plant in Russia that reported plans in 2012 to use one cascade to enrich to HEU levels for civilian purposes. Otherwise, commercial enrichment plants

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<sup>5</sup> This idea is Frank von Hippel's, which he will present at the workshop in greater detail.

enrich uranium to no more than 6%. It should, in theory, be relatively easy therefore to come to an agreement to limit the level of civilian enrichment globally to ~ 6% U-235. In the event that fuel enriched above 6% is required and HEU stocks for blend-down have run low, some flexibility could be built into the agreement. For example, a 6% agreement could run in 5- or 10-year successive periods of duration or allow an exception for one portion of one enrichment plant to satisfy the global demand for 19.75% uranium.

Questions to consider include:

- If not in a fissile material treaty, what form could such an agreement take?
- Would a trial, temporary approach be feasible/desirable?

#### Limit Spent Fuel Reprocessing

Here, the idea is to place operational limits on spent fuel reprocessing. Although plutonium connoisseurs do differentiate between weapons-grade, weapons-usable and reactor-grade plutonium, an analogous limit on reprocessing related to plutonium content is not as useful as the enrichment restrictions. Instead, an approach that would seek to limit the accumulation of spent fuel could be adopted. This “just-in-time” inventory approach might require declarations or inventory verifications. Reprocessing campaigns would be coordinated with fuel fabrication and shipments to reactors. In general, this would amount to a strengthening of the international Guidelines on Plutonium Management, which appears to be not much more than a reporting mechanism. In practice, the French have adopted policies of limiting the accumulation of separated plutonium.

Questions to consider include:

- If pursued outside of a fissile material treaty, would it be useful to establish an international plutonium production advisory board? Peer review process? New plutonium fuel cycle experts group?
- An important limit would be the appropriate working stocks at reprocessing plants, which could vary.

#### Fissile Material Stock Drawdowns

Countries might consider proportional drawdowns to irreversibly reduce risks. HEU could be blended down into LEU; for military Pu it could first entail safeguards (declared excess to military needs) and then one of several options: immobilization and/or mixing with waste, burning in reactors, etc. For civilian separated Pu, it could entail irradiation and/or immobilization. Initial inventory declarations would need to be reviewed/verified. Reductions could be scaled to stockpile sizes. For example:

- Over 500 tonnes – 20% reductions each year. At the end of 5 years, Russian and US HEU stockpiles would be reduced by two-thirds.
- Over 25 tonnes -- 10% reduction each year
- Over 10 tonnes -- 5% reduction each year
- Over 1 tonne -- 1% reduction each year

The numbers here are arbitrary but illustrate commitments by all states with stocks to draw down stockpiles in a steady fashion. A commitment to revisit arrangements could coincide with an agreed-upon benchmark – for example, when countries' stocks reach 10% of initial inventories.

Questions to consider include:

- Since military stockpiles pose challenges regarding sensitive information, could verification focus on material placed under safeguards or converted into less sensitive forms?
- Would INFCIRC/66 agreements be necessary/desirable to tackle problem of civilian Pu in nuclear weapon states? How could the civilian portion of this be extended to NPT non-nuclear weapon states?
- Would a proportional approach be rejected as discriminatory?