DISCUSSIONS OF VERIFICATION OF A FISSILE MATERIAL CUTOFF TREATY

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Abstract

A universal fissile material cutoff treaty (FMCT) will be a key building block in nuclear disarmament, nonproliferation and prevention of nuclear terrorism. Negotiation of an effectively verifiable FMCT has been pursued over a decade. The principle of " trust but verify" has played a great role in arms control and nonproliferation regime. However, the Bush administration announced in July 2004 that while it supported negotiating a cutoff treaty, it would no longer support such a treaty with verification arrangements. The U.S. new position on unverified FMCT could damage efforts to conclude a meaningful treaty. In this paper, I will examine whether the FMCT can be effectively verified without compromising the legitimate security interest of the State Parties. Specifically, I will explore what kind of verification measures would be needed to effectively detect covert nuclear material production facilitates including reprocessing and enrichment plants, and whether those effective verification measures could be feasibly established while protecting national security secrets. Moreover, the cost and security benefits of a verifiable FMCT will be discussed.

Introduction

In 1993 the United Nations General Assembly adopted a resolution calling for the negotiation of a nondiscriminatory, multilateral, and internationally and effectively verifiable treaty banning the production of fissile materials for nuclear weapons or other nuclear explosive devices. In May 1995 at the NPT extension conference, the Parties adopted a principles and objectives document that called for the "immediate commencement and early conclusion" of FMCT negotiations. The 2000 NPT review conference once again called for FMCT negotiations to start immediately and to be completed in five years. However, negations on the FMCT have been stalled since 1998 due to competing negotiating priorities at the CD in Geneva. While expecting to resume the FMCT negotiation, the Bush administration announced in July 2004 that although it supported negotiating a cutoff treaty, it would no longer support such a treaty with verification arrangements. On May 18, 2006, the U.S. tabled a new draft FMCT at the CD and circulated a draft mandate to establish an Ad Hoc Committee to negotiate the treaty.[1] Meanwhile, its "white paper" stated: "effective verification" of an FMCT cannot be achieved." As continued in the "white paper," "The United States has concluded that, even with extensive verification mechanisms and provisions -- so extensive that they could compromise the core national security interests of key signatories, and so costly that many countries would be hesitant to implement them -- we still would not have high confidence in our ability to monitor compliance with an FMCT."[2] The U.S. new position on unverified FMCT runs counter to an effort at CD to conclude an effectively verifiable FMCT, which has been pursued over a decade. It is necessary to examine whether the U.S. new position is rational.

The Need for an International Verification Provision

A primary goal of an FMCT will be to attain the signatures of the five NPT nuclear weapon states and three non-NPT countries (India, Pakistan, and Israel)(hereafter referred to as eight target states). While North Korea has withdrawn from the NPT and declared itself a nuclear weapon state, ending production of its fissile material would depend on the negotiation on North Korean denuclearization. All the NPT non-nuclear weapon states are already prohibited from producing nuclear material for weapons and have adopted the comprehensive IAEA safeguards on all their nuclear material and activities. Moreover, while all five NPT nuclear weapon states have stopped production of nuclear materials for weapons, India, Pakistan, and Israel are believed still to be producing fissile material for weapons. Thus, one focus of any useful FMCT would have to be participation of the three non-NPT countries.

Then, without an international verification mechanism and provision for an FMCT, can the international community have confidence that those states indeed have ended the production of fissile materials for weapons? While the U.S. new position would not support an FMCT with international verification provision, it wants to verify an FMCT by "national means and methods." This new verification approach of national means and methods,[3] which is to replace the old term of "national technical means"(NTM) as the administration advocates, would allow nations to apply information from not only the NTM, but also information including commercial satellite imaging and other open sources. Thus, one question is whether this new verification approach itself without an on-site verification mechanism can provide confidence in compliance with the treaty.

In particular, what effective measures should be applied for those major production facilities, which are known to have produced significant amounts of fissile material (see table 1) in the three non-NPT countries? For example, the military reprocessing facilities for Israel and Pakistan or Indian weapons plutonium programs would be expected to be shut down under an FMCT. The most effective measures to demonstrate their shutdown status are site environmental monitoring and on-site visits. The on-site inspections would include: on-site visual observation; sealing essential plant equipment or using sensors; and on-site sampling. While the satellite imaging could play a complementary role to monitor the shutdown status of a large reprocessing plant as in the U.S. or Russia, it would have little role to monitor these smaller reprocessing facilities, especially the reprocessing facility at Israel's Dimona nuclear complex, which is underground. If the reprocessing facilities continue operating for civilian purposes, the satellite imagery would be less useful for such a case because it would be difficult to distinguish between different operating modes (whether for weapons or non-weapons production) of operating facilities. Monitoring these declared operating reprocessing facilities would require many on-site inspections as applied by IAEA safeguards.

Moreover, Pakistan centrifuge enrichment plant (CEP) at Kahuta would be expected to be shutdown after an FMCT. Also there is a need to monitor Indian CEP at Rattehalli. The most effective measures to monitor smaller-scale CEPs (whether shutdown or operating for non-weapon purposes) are on-site inspections. While satellite imaging could play an important role to monitor the shutdown status of the gaseous-diffusion plants (GDPs) in the five NPT nuclear weapon states,[4] these CEPs will have much less obviously observable characteristics than a GDP has for satellite imagery. In practice, on-site inspection has played an imperative and effective role to detect undeclared nuclear facilities and activities as already shown in the cases of Iraq, Iran and North Korea. While satellite imagery would be useful for detecting undeclared nuclear facilities and confirming information acquired from other sources, it cannot make the final determination about the activities of the facilities. It needs an on-site inspection to resolve the dispute.

Consequently, an international verification regime (especially including on-site verifications) would be essential to building confidence in the effectiveness of an FMCT. Moreover, without an international verification regime, some nations would be concerned about the abuse of the "national means and methods." It can be expected that there would be countless compliance disputes without a negotiated arrangement to resolve them.

Establishing an Effectively Verifiable FMCT

The verification objective of an FMCT--to ensure that no fissile material is being produced for weapons--is similar to IAEA safeguards for the NPT non-nuclear-weapon states. The IAEA has already accumulated extensive experience over 40 years in safeguarding nuclear materials and activities. In practice, the IAEA safeguards could be much more stringent than the FMCT verification requirements, in particular for the five nuclear weapon states who already have considerable stocks of fissile materials. Based on IAEA safeguards experience, experts have proposed many verification approaches including focused to comprehensive verifications.[5] It is believed that a focused approach is technically adequate and cost-effective for the FMCT. It is most likely to be acceptable by the nuclear states.[6]

After the FMCT enters into force, the FMCT verification would focus, in the first instance, on those declared former military fissile material production facilities (e.g. uranium-enrichment and reprocessing plants). Many of these production facilities would be shut down. It should be easy to monitor the status of these closed facilities.[7] Some would continue operating for non-weapons purpose. For these declared operating facilities, the verification measures necessary for these facilities would be primarily IAEA-type safeguards.[8]

The detection of undeclared enrichment and reprocessing facilities would be a challenge, since a small-scale CEP and a small reprocessing facility could be easily hidden. However, such a hidden facility would become more difficult by some measures. For example, the Additional Protocol to the IAEA safeguards is designed to make a clandestine nuclear program more difficult. After FMCT enters into force, all the eight target states should ratify the Additional Protocol to allow more intrusive measures including complementary access and environmental sampling. Environmental sampling at a suspect site or facilities would disclose the presence of HEU and related activities, as shown in the case at Iranian Natanz CEP site. Covert reprocessing activities would be identified by the sampling at the site as shown in the North Korean case. Sampling analysis can also be used to date whether fissile materials produced before or after the treaty enters into force. Moreover, the Additional Protocol considers the use of "wide-area environmental sampling" to detect undeclared reprocessing or enrichment facilities and activities. For example, monitoring of Krypton-85 in the air would allow remote detection of a reprocessing facility.

Non-governmental organizations, individuals, and government intelligence agencies could also uncover a secret nuclear program. If history tells us anything, it is that the more people involved and the more open the society, the more difficult it is to hide a secret for long. Indeed, there are several cases where clandestine nuclear programs were disclosed by defectors, including Israel's Dimona complex and Iraq's nuclear program. Moreover, high-resolution commercial satellite imagery is making the sky more open. For example, an Iranian opposition group first revealed publicly the existence of the Natanz CEP site in August 2002. Then based on this information, the Institute for Science and International Security (ISIS) released the first public commercial satellite images of the site in December 2002.[9] Furthermore, the verification provision itself would play a role of deterrence. From the beginning the FMCT verification should be designed for detection and deterrence of noncompliance.

Protecting National Security Interests

One major concern that motivates the U.S. in revising its position is that FMCT verification "could compromise the core national security interests of key signatories." Indeed, under an FMCT, the eight target states would continue to hold legitimately some sensitive nuclear processing facilities and activities including undeclared facilities (e.g. for nuclear weapon assembly/disassembly, weapon material recycling) and undeclared materials (from pre-stocks), which could be co-located with declared or suspected facilities (such as reprocessing and enrichment plants) requiring verification. Thus, some nuclear states could worry about potential loss of sensitive information (e.g. chemical composition information from these activities) at those defense-related nuclear processing sites.

For such cases, a managed access approach as in the Chemical Weapons Convention (CWC), which would build confidence that no secret facilities exist while protecting national security secrets, will be vital to FMCT verification. For most cases of managed access situations, simple procedures are sufficient. For example, the undeclared facilities and activities would be detected by sampling around the site through their signatures in the effluents such as fission products from reprocessing and HEU from enrichment activities. However, in some locations, sampling might not be permitted. For example, chemical composition information associated with weapons-manufacturing activities at a nuclear-weapon facility or a fissile material manufacturing facility could be divulged through sampling and analysis. In some cases, it is necessary to enter into controlled access areas. Thus, appropriate measures to protect sensitive information are needed. For example, sensitive information (weapons components or process machinery that provide design information) at the nuclear weapons assembly facility might be vulnerable to the visual access. For such a case, protecting measures including masking of sensitive equipments or other obvious method should be taken. Consequently, it is believed that an effective FMCT verification regime should be able to be established while protecting national security secrets. In fact, a U.S. State Department official suggested, as he presented an earlier U.S. government position on verifying an FMCT in the 1999 Carnegie International Non-Proliferation Conference, "We think that a strong regime of routine monitoring of all [fissile] production facilities and all newly produced material and a regime for nonroutine or so-called challenge inspections would give us enough building blocks to build an effective verification regime."[10]

Finally, the verification of HEU for naval reactor would be a challenge. However, based on the experiences from the Trilateral Initiative (among the United States, Russia, and the IAEA) and bilateral nuclear arms control agreements (between the U.S. and U.S.S.R./Russia), and the managed access approach, it is believed that appropriate verification should be able to be devised to ensure that HEU for naval use is not diverted to weapon use while not revealing classified information.[11] Moreover, if U.S. and other states with naval-propulsion reactors are to convert and design their next-generation naval reactors to be fueled with LEU, as China's and some of France's nuclear submarines already did,[12] it would not only reduce any concerns about the naval fuel issue under an FMCT, it would also fix the loophole of existing NPT safeguards, which allows states to withdraw nuclear material from international safeguards for non-explosive military purposes, including HEU for use in military reactor fuel. Also it would prevent a "breakout" from arms reduction obligations by precluding huge stocks of HEU for naval use as the U.S. does now--which has set aside 160 tons of excess WgU for future use in naval-reactor fuel.

Cost of FMCT Verification

In 1995 the IAEA estimated the cost for four FMCT verification scenarios with scopes ranging from a comprehensive verification system similar to comprehensive safeguards (except the pre-stocks) for non-weapons states to a very limited verification approach.[13]Accordingly, the annual verification cost

would range from $140 million (for the comprehensive approach) to $40 million (for the very limited approach). For comparison, the IAEA regular safeguards budget in 1995 was $87 million. While the 1995 IAEA study did not provide details for others to update its estimation, a study published in 1996 by Brookhaven National Laboratory (BNL) detailed a measure of verification effort --"person days of inspection effort (PDI)."[14] The BNL study discussed three FMCT verification scenarios: comprehensive, focused, and very limited. It concluded the PDI required annually for each case would be 35,000, 29,000 and 10,000 PDI respectively. This is to be compared with the estimates in the IAEA study of about 25,000, 16,000 and 5,000 PDI for roughly the same scenarios.

Given the fact that the status of those production facilities (e.g. reprocessing and enrichment facilities) have had many changes over the decade, as an update and a reference scenario, here I will estimate the verification cost of a focused approach (similar to the Alternative B in the 1995 IAEA study and Option 2 in 1996 BNL study), in which the verification measures include**:** 1) verify declared inventories of separated plutonium, HEU and U233 in store; 2) verify complete material balance at declared reprocessing plants, MOX, HEU and U233 conversion and fuel fabrication plants; 3) verify complete material balance at declared uranium enrichment plants; 4) verify status of decommissioned, shut down facilities and facilities under construction. It should be noted that this focused option would require more inspection effort than the most limited verification alternative (A) as discussed in the 1995 IAEA study, which, for example, would only verify the inputs and outputs of declared reprocessing facilities and the absence of HEU production for weapons purposes in declared uranium-enrichment plants.

Based on the status of the concerned production facilities as listed in Table 1 and the PDI value for each facility type as estimated in BNL study for option 2,[15] it is estimated that implementing this focused approach in the eight target states would require annually about 9,000 and 1,000 PDI for reprocessing and enrichment plants respectively. Moreover, based on an analysis on the 1995 IAEA study and the 1996 NBL study, it is assumed that the other inspection effort would require annually 5,000 PDI for monitoring the declared facilities activities (which include MOX and HEU fuel fabrication, plutonium and HEU conversion, plutonium and HEU storage, LWR MOX, fast research reactor, and fast critical assembly).[16] Furthermore, challenge inspections could require about 10% of the routine inspection effort.[17] Consequently, the total inspection effort for implementing this focused approach would require annually about 17,000 PDI. The corresponding estimates in the 1995 IAEA and 1996 BNL studies (without effort for challenge inspections) were about 16,000 and 29,000, respectively. Considering the IAEA safeguards operation budget in 2004 was about $70 million and the inspection effort was 9063 PDI, the verification cost of the focused approach would be about $130 million (in 2004 prices). For comparison, the 1995 IAEA study estimated the verification cost for the similar case (but without challenge inspection) was about $90 million (in 1993 prices). In addition, a more effective FMCT verification could be needed to monitor those former military plutonium production reactors in the nuclear-armed states. Such effort would only require annually about 600 PDI,[18] which would only increase the cost by about 4%.

In practice, the verification cost could be further reduced for some cases.[19] For example, if the FMCT inspection effort excludes those facilities, which are already subject to international safeguards (e.g. Euratom and IAEA safeguards), it would save about 5,000PDI, thus reducing the cost by 30% (i.e., the verification cost would be about $90 million.) Moreover, after the FMCT enters into force, if one assumes both that some more production facilities would be shutdown and that the FMCT verification would exclude those already-safeguarded facilities, then the verification cost would be further reduced. For example, 1) the two Russian military reprocessing plants which are operating at Seversk and Zheleznogorsk to reprocess the spent fuels discharged from three production reactors (operating to provide heat to nearby cities), would be closed. In fact, these two reprocessing plants and the three associated reactors are planned to be shut down after a replacement of coal-fired plants;[20] 2) the two

Table 1: Major Production Facilities of Fissile Material Affected by an FMCT

Country	Facilities	Status	Note
U.S.	Reprocessing plants (F & H reprocessing areas) at Savannah River Site	Military/S?	Expected to be closed under an FMCT.
	Reprocessing plants at Idaho National Engineering Lab and Hanford Reservation	Military/S	All those military reprocessing plants would be closed. Pilot reprocessing facilities planned for civilian.
	2 GDPs at K-25 & Portsmouth	Military/S	
	GDP at Paducah	Civilian/OP	Expected to be replaced by two planned CEPs (IAEA)
Russia	TR-1 reprocessing at Ozersk	Civilian/OP	Could be operation after an FMCT
	2 reprocessing plants at Seversk and Zheleznogorsk	Military/OP	Reprocessing SF from 3 prod. reactors for heating. To be shutdown.
	4 CEPs at Angarsk; Seversk, Krasnoyarsk and Sverdlovsk-44	Civilian/OP	Expected to be operation after an FMCT
U.K.	The reprocessing plant at Dounreay and B204 at Sellafield	Military/S	
	B205 reprocessing plant & THORP at Sellafield	Civilian/OP	Euratom safeguards. B205 to be shutdown in next several years.
	GDP at Capenhurst	Military/S	
	CEP at Capenhurst	Civilian/OP	IAEA
France	UP1 reprocessing plant at Marcoule	Military/S	
	UP-2 & UP-3 reproc. plants at La Hague	Civilian/OP	Euratom safeguards
	GDP at Pierrelatte	Military/S	
	GDP at Georges Besse	Civilian/OP	Euratom. To be replaced by the being-built CEP at the site (IAEA)
China	2 reprocessing plants at Jiuquan & Guangyuan nuclear complex	Military/S	
	A pilot reprocessing plant at Gansu	Civilian/OP	Began reception of SF from power reactors in 2003. Planned to build a commercial plant around 2020.
	2 GDPs at Lanzhou and Heping	Military/S	After ending HEU production, both produced LEU for civilian. Lanzhou GDP decommissioned in 1999.
	2 CEPs at Hanzhong and Lanzhou	Civilian/OP	Both in operation. Hanzhong CEP under IAEA safeguards.
India	Trombay reprocessing plant	Military/OP	Expected to be closed after FMCT
	Reprocessing plants at Tarapur & Kalpakkam	Dual? /OP	Tarapur reproc. safeguarded when reprocessing IAEA safeguarded SF.
	Rattehalli CEP	Military/OP	After FMCT, it could continue to operate for naval fuel.
Pakistan	Nilore reprocessing plant	Military/OP	Expected to be closed after FMCT
	Kahuta CEP	Military/OP	Expected to be closed after FMCT
Israel	Dimona reprocessing plant	Military/OP	Expected to be closed after FMCT

Notes: GDP=gaseous diffusion plant; CEP=centrifuge enrichment plant; OP=operating facilities; S=shutdown or standby facilities. **Sources:** The major source of this table is based on *The Technical Basis for a Fissile Material Cutoff Treaty*, A Draft Report from International Panel on Fissile Materials, May 2006.

reprocessing plants in the U.K would be closed;[21] 3) The French and the U.S. GDPs would be replaced by the gas-centrifuge plants, which are being built or planned and would be put under IAEA safeguards. With those assumptions, it is estimated that the inspection effort would require annually about 10,000 PDI. The corresponding estimated cost would be about $80 million (in 2004 price). Finally, for the most limited verification alternative as the Alternative A and Option 3 in the 1995 IAEA and 1996 BNL studies respectively, the inspection effort for such a case would require annually 7000 PDI.[22] The corresponding cost would be about $50 million (in 2004 prices). For comparison, the 1995 IAEA study estimated the verification cost for the similar case was about $ 40 million (in 1993 prices). It should be noted that even for a comprehensive verification alternative, there would be no great increase in the verification effort. For example, the verification cost ($90 million) for the focused approach in the 1995 IAEA study was only about one-third less than the cost for the comprehensive safeguards ($140 million).

Is the FMCT verification cost (around $100 million per year) too expensive? Compared to its security benefits, such a cost would be modest. An effective FMCT would make an important contribution to nuclear disarmament, the nonproliferation regime, and the prevention of nuclear terrorism. However, a credible verification regime would be vital to an effective FMCT. In addition, the cost of FMCT verification is comparable to another important treaty of nuclear arms control— the Comprehensive Test Ban Treaty (CTBT). The budget of the CTBTO Preparatory Commission for 2004 is $94.5 million.[23] In addition, the verification cost would be much smaller than the operational cost savings realized by the target states through shutting down their production facilities for fissile material. For example, the U.S. spent about $2 billion per year on plutonium production for weapons from 1984 through 1993.[24]

In short, an effective and meaningful FMCT must have a credible verification regime. Without a verification provision, the FMCT would be far less effective. It should be technically feasible and cost-effective to establish an effectively verifiable FMCT while protecting national security secrets. The U.S. should reverse its new position on verification of an FMCT.

References and Notes

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5 See, e.g., "Fissile Materials: Scope, Stocks and Verification," UNIDIR *Disarmament Forum* 2 (1999), <http://www.unog.ch/UNIDIR/E-DF2.htm>.

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14 D. Dougherty, et al., *Routine Inspection Effort Required for Verification of a Nuclear Material Production Cutoff Convention*, Brookhaven National Laboratory Report BNL-63744, SSN-96-14, 1996, http://www.osti.gov/bridge/servlets/purl/434426-5ZaqAm/webviewable/434426.pdf.

15 E.g. PDI for reprocessing plant (OP) =935 (OP=operating); PDI for reprocessing plant (S)=30 (S=shutdown); Pilot reprocessing facility (OP,S)=365,30; GDP (OP, S)=104, 16; CEP (OP, S)=79,16. See BNL Report, op.cit.

16 It includes two operating MOX fuel fabrication facilities in UK and France (both under Euratom safeguards), and one operating in India. Assuming PDI for MOX fabrication=390 as given in the 1996 BNL study.

17 E.g. based on the concept of integrated approach that IAEA is developing, it may assume that two challenge inspections per party per year for the P-5 states, and three inspections for the non-NPT nuclear states, and each inspection needs 10 days and with 10 inspectors participating. Thus, it would need about 1500 additional PDI.

18 E.g. the known, major former plutonium production reactors in the eight target states are about 46. About 15 reactors are operating, which include four reactors are producing weapons plutonium in India, Pakistan and Israel. The others are operating for no-plutonium production. However, it would be expected that only three of these reactors could be operating for tritium production after an FMCT. It is assumed that PDI for production reactor (OP, S)=70,8.

[19] See also an excellent discussion about the reduction of verification cost in: *The Technical Basis for a Fissile Material Cutoff Treaty, op.cit.*

20 "Elimination of weapons grade plutonium," U.S. Department of Energy, http://www.nnsa.doe.gov/na-20/ewgpp.shtml.

21 The B205 plant is to be shutdown in 2012. THORP plant might be expected to be shutdown in the future. See, e.g. *Strategy*, U.K. Decommissioning Authority, March 2006, pp. 45-46. http://www.nda.gov.uk/documents/nda_final_strategy,_published_7_april_2006.pdf.

22 E.g. based on the Table 1 and the PDI value for each facility type as estimated in 1996 BNL study for option 3, it is estimated that implementing this limited approach would require annually about 5000 PDI for both reprocessing and enrichment plants. Moreover, based on an analysis on the 1995 IAEA study and the 1996 BNL study, it is assumed that the other inspection effort (beyond the reprocessing and enrichment) would require annually 2000 PDI.

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