CONFERENCE ON DISARMAMENT

CD/1771
12 May 2006

Original: ENGLISH

SWITZERLAND

WORKING PAPER

A PRAGMATIC APPROACH TO THE VERIFICATION OF A FMCT[1]

The verification of a FMCT is impossible, some have said. Is it really so?

Taken as a blanket statement, this is wrong. The verification of nuclear materials is much easier than the verification of chemical and biological agents. The radioactivity (in essence, a radio signal betraying the presence of suspected materials) is a determining advantage in any kind of nuclear verification. For a FMCT, the verification of ALL nuclear facilities in the eight States of interest may well lead to financial costs that would make the proposal practically "impossible". In last analysis, a proper *technical* verification is always possible with the help of several hundred inspectors supported by top-notch detection systems - on site or remotely controlled - if cost is of no relevance. This would also be true for the mostly very old nuclear facilities that would come under a FMCT. To achieve a given level of non-diversion assurances in an old facility, the verification agency may have to install more surveillance equipment and pay more frequent visits. But, possible, it is.

Yet, is there a pragmatic approach to the verification of a FMCT? Any consideration of proper verification mechanisms for a FMCT must start with the question: what kind of FMCT needs to be verified? It is pointless to argue whether a treaty is verifiable or not from a technical point of view and whether the costs of verification are acceptable or not, without knowing what is the objective. Indeed, the process of negotiation of a FMCT would probably begin with some understanding on the objective of the treaty and on the scope to be verified. The debate on verification would follow.

For now, in the absence of objective and scope, one needs to presuppose a tentative FMCT model in order to address some of the verification parameters that could come into play.

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1 This Working Paper has been prepared by Mr. Bruno PELLAUD, Nuclear Consultant and former Deputy-Director General of the IAEA and does not necessarily represent in all aspects the official position of the Swiss Government.

Scope of a FMCT: a tentative working model

This working paper is based on the following proposition:

Core objective: a worldwide cut-off of all production of fissile materials for weapons, and the placement under FMCT verification of all civil stocks of fissile material and of non-civil stocks declared as "excess".

In other words, the treaty envisaged here would ban the future production and would contain a clause by which parties could place irreversibly "excess" and civil stocks under the treaty[1].

In parallel to the negotiation of this core objective, the parties would seek an appropriate framework within or without the FMCT to implement confidence-building measures and subsidiary objectives that would strengthen the FMCT (and indirectly the NPT itself), such as

(a) Declarations by Russia, the United States and the United Kingdom of their total fissile-material stockpiles, as already done partially, as a pace-setter and model for others to follow;

(b) Agreements to limit the number of national fissile production facilities for civil applications - enrichment and reprocessing plants - through "*multinational nuclear approaches*" incorporating the joint operation of such facilities in a regional context[2];

(c) Near-total elimination of the use of highly-enriched uranium as a civilian reactor fuel, and rapid reduction of current civilian plutonium stockpiles through the recycling of mixed-oxide fuel (MOX) in nuclear power plants.

In essence, the above model shows a compromise that would reconcile those who want to limit the scope of a FMCT to the future production of fissile materials and those who want to see stocks incorporated into a first FMCT agreement. Subsidiary objective A registers the steps already made by the US, UK and Russia towards a better transparency of their stockpiles. Subsidiary objectives B and C would substantially enhance the FMCT and the NPT without curtailing the essential rights of NPT parties under Art. IV to engage in relevant fuel cycle activities. Altogether, these steps would be significant, would be powerful signals towards a realistic and verifiable first-stage FMCT.

A gradual approach to verification

Past attempts to reach an agreement on a fissile material production cut-off treaty have failed because they tried to achieve too much, too quickly. Many negotiators wanted to make the treaty from the very beginning as stringent as the NPT itself in terms of technical definitions and verification objectives, an

unachievable convergence of NPT and FMCT prior to further progress in nuclear disarmament. Others wanted the treaty to include at once exhaustive information on existing stocks of fissile materials and the consideration of both declared and clandestine activities. And, of course, everybody wanted the resulting verification system to provide the highest degree of effectiveness and efficiency…

The present working paper suggests a more pragmatic step-by-step approach for the most salient verification parameters, an approach that focus on the specificity of the FMCT.

The definition of fissile material

The first question to be resolved is the definition of fissile materials. The FMCT is designed to proscribe production of fissile material for nuclear weapons or other nuclear explosive devices by States that already have nuclear weapons; thus, not all nuclear material need be subject to safeguards in such States.

Nonetheless, proponents of a strong FMCT recommend a verification system that uses the same definitions of fissile material as those chosen for the IAEA in the application of safeguards under the NPT, namely:

- plutonium with an isotopic concentration of Pu-238 of less than 80%;
- highly enriched uranium (HEU), i.e. containing 20% or more of the isotope U-235, as well as U-233.

Already under the NPT, this approach seems obsolete and excessive, leading to a waste of IAEA financial resources.

At the other extreme, the Russian Federation has proposed to limit the "fissile definition" to only the best weapon grade materials, namely plutonium with more than 90% of Pu-239 and uranium with more than 90% of U-235, with in addition the verification of only facilities capable of producing such materials and with no verification of former military and dual use facilities and fuel fabrication facilities for naval propulsion[3].

On the one hand, the use of the IAEA definitions is claimed to be necessary to maintain a conceptual commonality between FMCT and NPT, allegedly to avoid a weakening of the NPT verification system. Yet, a different definition of fissile materials would only be one of the many differences needed to create a credible and affordable FMCT. This would be no rejection of the ultimate objective of bringing together FMCT and NPT at a more advanced stage of nuclear disarmament. But, the IAEA definitions have no place in the first stage of a FMCT. On the other hand, the Russian proposal goes too far in excluding from the treaty good fissile materials that can easily be used for weapons without much technological difficulties.

An appropriate FMCT compromise would be a fissile material definition characterised by the following parameters:

- plutonium with an isotopic concentration of Pu-239 of more than 70%;
- highly enriched uranium containing more than 40% of the isotope U-235; as well as U-233 and neptunium-237.

As to plutonium, the technological difficulties (heat, radiation and spontaneous fissions) associated with isotopic mixtures containing more than 30% of Pu-238 and Pu-240 make them unsuitable for weapon applications, as the French scientist and engineer Robert Dautray - former High-Commissioner of the French Atomic Energy Authority and a key figure of the French nuclear weapon programme - has written in a book dedicated to nuclear energy[4]. Under a FMCT regrouping serious NWS of all shades, possessing acknowledged stocks of good quality weapon-grade plutonium, no weapon designer will ever envisage to fiddle with the "fizzle yields" associated with "filthy plutonium mixtures".

The case of highly enriched uranium is somewhat different. Several observers have in the past drawn attention to the excessive enrichment span of the current definition that goes from 20 to 100%; they suggested the introduction of a "very highly enriched" category above 40% (VHEU). In the context of the FMCT, such an intermediate level would make sense in order to clearly recognise the greater weapon suitability of higher enrichment levels.

A word about the naval applications that make use of 90% enriched uranium. France has shown that submarines can run with 20% enrichment, albeit at the price of compactness and weight[5]. The proposed cut-off enrichment of 40 % is likely to facilitate and possibly allow the continuous use of current reactor designs. At any rate, verification methods have been developed by the IAEA to determine certain attributes of fissile material inside containers (an agreed isotopic range) without the inspectors seeing the material itself. For naval fuel, it should therefore be possible to devise verification approaches that do not reveal classified information.

Neptunium is added here to the list of fissile materials for the FMCT, since neptunium is the best weapon nuclear material of all in terms of nuclear and mechanical properties.

Rather than isotopic characteristics, many observers prefer to define "fissile material" according to its radiation status, that is containing or not radioactive fission products. In this approach, the FMCT would verify only "unirradiated direct use material", that is plutonium and uranium free of fission products. This approach would create a serious loophole. Irradiated spent fuel would not be subject to FMCT verification, thus leaving outside the verification scope valuable and sensitive fissile materials that weapon designers are keenly attracted to, namely low-burnup spent fuel resulting from short reactor exposures in military or civilian facilities, as well as blanket materials used in nuclear fast breeder reactors. In both cases, the plutonium produced can exceed 90% of Pu-239; such plutonium can be easily reprocessed and chemically separated in small facilities, when so decided. The current political controversy in India about the application of IAEA safeguards to fast breeders in the frame of the US-India nuclear agreement betrays the sensitivity of this issue for the Indian weapons programme.

For these reasons, this working paper gives preference to an "*isotopic discrimination*" rather than to"*radiation discrimination*" to constrain the verification scope of an FMCT to a manageable level, both in terms of effectiveness and efficiency. The FMCT fissile materials would thus be genuine "direct-use materials", that is plutonium with more than 70% Pu-239 and uranium with more than 40% U-235. The Pu definition would include all unirradiated Pu mixture - whether irradiated or not - containing such high-quality plutonium. In comparison with radiation discrimination, the approach of isotopic discrimination would be more expensive in terms of volume of spent fuel to be monitored, but more effective in plugging the loophole of low-burnup and blanket fuels. Most efficient and most effective would be a combination of both approaches, one in which verification would ignore all irradiated materials (according to a proper definition of an "irradiated" threshold), except those containing "direct use materials" as defined here above for the FMCT.

Declared facilities

Like Non-NWS under IAEA safeguards, the FMCT parties would declare all relevant facilities, such as enrichment and reprocessing facilities and downstream facilities producing and using the defined fissile nuclear materials. Declared facilities would be monitored through verification mechanisms of graded intensity, such as containment and surveillance, and inspections as discussed below, to verify that declared fissile material is not diverted to nuclear weapons (or purposes unknown). All enrichment plants would still be verified, including those producing low-enriched uranium (LEU), to ensure that there is no undeclared VHEU production. In principle, verification would not need to be applied to lower enrichment levels, but in view of the advantages of LEU as a feed for VHEU production, some verification measures for lower enriched uranium may need to be considered, particularly in the case of States with smaller fissile stocks. As to plutonium inventories of declared spent fuel, verification would be applied in direct proportion to the contained Pu-239 above 70% and up to 100%. The same graduated intensity would apply to such separated plutonium product leaving a reprocessing plant for any other facility. Verification would not apply anymore to high-burnup plutonium from power plants that has been returned to a plant as mixed-oxide fuel and therein irradiated, because the Pu-239 would thereby fall under the 70% threshold. As to stocks of weapon-grade material, the process of degradation in connection with their use in nuclear power plants would also remove them from the FMCT scope.

Undeclared activities

The discovery in 1991 of an extensive clandestine nuclear weapons programme in Iraq provided evidence to the fact that a verification system focused on declared activities was inadequate. Since then, the IAEA Board of Governors has strengthened the safeguards system and addressed the possibility of clandestine, undeclared activities, by prescribing access rights to a wide range of locations anywhere in the territory of a participating State. Similar arrangements were included in the verification provisions of the Chemical Weapons Convention and the Comprehensive Nuclear-Test-Ban Treaty.

Should the FMCT deal with the undeclared production of fissile material outside declared facilities? The short answer is - ultimately yes. Nevertheless, the present working paper takes the view that the inclusion of undeclared activities beyond declared facilities would prohibit the conclusion of FMCT negotiations by making verification very cumbersome, expensive and unmanageable. After all, under the model assumed above, the Nuclear-Weapon States would keep military stocks outside the FMCT; they should presumably have little incentive to risk treaty violation by hiding facilities that should have been declared or by engaging in clandestine undeclared activities.

Verification intensity

Decisions on verification intensity - how much and how soon - need to take into account the true risks of vertical proliferation. This is especially true for those NWS with large stocks. In these circumstances, rigorous verification may not be required, at least in an initial time frame. However, for States with small arsenals, verification intensity will need to reflect the fact that small-scale violations could have a serious effect on strategic relativities[6].

Rather than immediate, rigorous verification, this paper proposes gradual, incremental or sequential levels of verification intensity, from nothing to an exhaustive verification system:

1. Declaration of non-production (no verification)

At the very minimum, the States submit to the FMCT Secretariat the list of facilities subject to declaration under the treaty, with information about the amounts of relevant fissile materials, as well as the movements in and out since the previous declaration. The report contains a formal declaration of compliance by the State. The Secretariat carries out general plausibility checks - only an indirect follow-up - on the basis of information provided by the State or gathered from other sources.

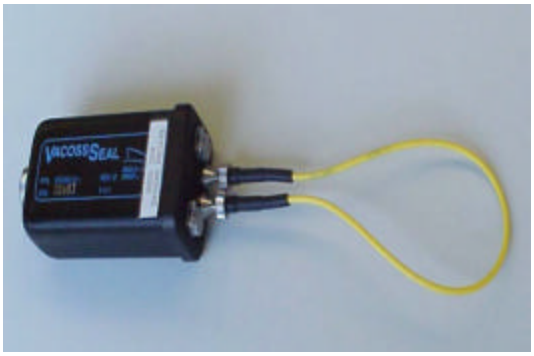
Estimated annual cost: 5 million euros.

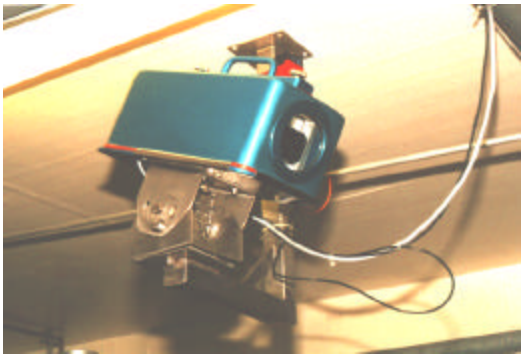
The US Government has indicated that it would only support negotiations on a treaty without verification provisions, pointing out the difficulties associated with topics like clandestine production, naval fuel and stocks. Another reason advanced for going with a treaty that contained no-verification provisions was that it would ostensibly be quicker to negotiate.[7] While apparently insufficient, the value of State's declarations of compliance should not be dismissed out of hand with such an arrangement covering a small number of States subject to great visibility and involved in a dense network of international commitments.

2. Instrumented verification

The declared nuclear production facilities are under the surveillance of a remotely controlled instrumentation network encompassing:

- Numerous electronic seals
- Tamper-proof digital cameras
- Flow meters at strategic points of a facility
- Chemical analysers
- Automatic sample taking





The locally acquired information is supplemented by satellite imagery of significant production facilities. The verification agency carries out inspections only in conjunction with the installation and maintenance of the surveillance system.

Estimated annual cost: 20 millions euros.

This approach would provide credible assurances of treaty compliance, without the need for an administratively heavy inspection organisation.

3. Inspection limited to significant production facilities

In addition to an instrumented verification, the agency carries out periodic on-site inspections of significant production facilities, that is only in declared facilities capable of producing significant quantities of high quality materials, such as enrichment plants, plutonium producing reactors and chemical reprocessing facilities.

Estimated annual cost: 50 millions euros.

4. Random verification (challenge inspection)

In addition to instrumented verification and to periodic on-site inspections of significant production facilities, the agency inspects further potential production facilities in the form of occasional random, unannounced or challenge inspections, such as power plants, research facilities, as well as other processing installations (e.g. uranium conversion). The "Organisation for the Prohibition of Chemical Weapons" and the IAEA have experience in the planning and implementation of these types of verification. The verification agency can also do special *managed-access* inspections at its most sensitive sites, a type of inspection that does not reveal sensitive information.

Estimated annual cost: 70 millions euros.

5. Full verification of all nuclear facilities

In this maximum option, all declared facilities of a State are verified through containment and surveillance and periodic on-site inspections to ascertain - in analogy with a standard IAEA Comprehensive Safeguards Agreement - that "*all nuclear materials produced have been adequately accounted for*". This would entail the verification of all potential production facilities of a State (in particular all research facilities and nuclear power plants) and of all civilian stocks.

Estimated annual cost: 150 millions euros.

The gradual adoption of various verification parameters, in particular in terms of intensity, can also be implemented time wise, that is, starting with a less onerous scheme such as instrumented verification. In this way, the verification agency could gain the necessary experience along the way to ensure an optimum use of financial resources.

Getting started on verification

To make progress in the negotiation of an FMCT, it would seem appropriate to resume detailed work in the CD framework and do so simultaneously on various issues, without the need to have agreed on all fundamental aspects.

As far as verification is concerned, the CD should establish an "**Ad hoc Committee on FMCT Verification**" with 16 members - the 8 States with nuclear explosive capability and the 8 NNWS with the largest civilian stake in the nuclear fuel cycle, as measured by the volume of uranium use and plutonium production (*that is* Belgium, Canada, Germany, Japan, Sweden, Spain, South Korea, and Ukraine). This formal committee could oversee several informal workgroups in which would be assessed issues under consideration (fissile material definition, facilities to be considered, intensity of verification) and this from various points of view (consistency with objectives, costs, added degree of assurance per unit cost, etc.

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[1] Global Fissile Material Report 2006 - First report of the International Panel on Fissile Materials - Princeton University's Program on Science and Global Security.

[2] "Multilateral approaches to the nuclear fuel cycle"; Expert Group Report submitted to the Director General of the International Atomic Energy Agency, February 2005; infcirc 640, at http://www.iaea.org/Publications /Documents/Infcircs/2005/infcirc640.pdf.

[3] Statement by Ambassador Leonid Skotnikov a the Plenary meeting of the Conference on Disarmament," June 28, 2005.

[4] Dautray R., "L'énergie nucléaire civile dans le cadre temporal des changements climatiques (Nuclear energy in the context of climatic upheavals)", Report to the French Academy of Sciences, 127, Editions Tec&Doc (2001)

[5] Tariq Rauf, "The Canadian Nuclear Submarine Acquisition Programme of 1987-1990"; Informal meeting of the Netherlands-Exercise, September 2003, Geneva.

[6] John Carlson, " Can a Fissile Material Cutoff Treaty Be Effectively Verified?"; Arms Controls Today, January-February 2005

[7] Global Fissile Material Report 2006; ibid