

*This research paper has been commissioned by the International Commission on Nuclear Non-proliferation and Disarmament, but reflects the views of the author and should not be construed as necessarily reflecting the views of the Commission.*

## FISSILE MATERIAL CUT-OFF TREATY – A DISCUSSION

John Carlson  
Director General  
Australian Safeguards and Non-proliferation Office

6 July 2009

*The views in this paper are those of the author. The Australian Government has not yet determined its position for the FMCT negotiations.*

### EXECUTIVE SUMMARY

The purpose of the proposed FMCT is to ban production of fissile material for nuclear weapons and other nuclear explosive devices. By capping the amount of fissile material available for weapons use, the FMCT will be an essential step towards irreversible nuclear disarmament.

Non-nuclear-weapon states party to the NPT have already given a commitment, verified by IAEA comprehensive safeguards, not to produce fissile material for nuclear weapons. The FMCT will apply a similar commitment – including appropriate verification – to the nuclear-weapon states and the non-NPT parties.

The principal area to be settled is the FMCT's scope – which materials and facilities will be covered? As a minimum, the FMCT would apply to new (i.e. post entry-into-force) production of fissile material. Verification would apply to:

- newly produced fissile material – likely to be defined as high enriched uranium and separated plutonium – to ensure it is not used for nuclear explosives; and
- facilities “producing” fissile material – i.e. enrichment and reprocessing facilities – to ensure that all new production is declared for verification.

The most contentious issue is likely to be that of stocks, i.e. holdings of fissile material predating the FMCT's entry-into-force. The FMCT's negotiating mandate implicitly applies to further production – it is not possible to ban past production. However, there is an expectation by many states that the negotiations should include stocks. If there remain, free of any constraints, significant fissile stocks that can be drawn on to produce additional nuclear weapons, the FMCT would be seen by many as only a limited success. So stocks must be addressed as disarmament proceeds – it is an issue of how much can be agreed for inclusion in this treaty and possible parallel arrangements.

Verification will be a major element of the FMCT. Since there is already a well-established verification system directly relevant to FMCT objectives – IAEA safeguards – it makes sense to use this system rather than duplicate it. The opportunity can be taken to strengthen the safeguards system. Effective measures against undeclared fissile production will be a challenge – complementary confidence-building measures may be required. Another challenge will be verification against diversion through naval reactor programs.

Although it makes sense to base FMCT verification on the IAEA safeguards system, FMCT parties may decide on FMCT-specific executive and decision-making arrangements.

## CONTENTS

1. Introduction .....	3
2. FMCT objectives and scope .....	3
3. Treaty commitments .....	4
3.1 Fissile material .....	5
3.2 Production .....	6
3.3 Stocks .....	7
3.4 Non-proscribed activities .....	7
4. Verification	
4.1 Basic principles .....	8
4.2 Non-nuclear-weapon states party to the NPT .....	9
4.3 Other states – nuclear-weapon states and non-NPT parties .....	9
4.4 Undeclared nuclear material and activities .....	10
4.5 Stockpile stewardship activities .....	11
4.6 Verification of naval propulsion programs .....	11
4.7 Other verification issues .....	12
5. Institutional arrangements .....	13

## 1. INTRODUCTION

The purpose of the proposed Fissile Material Cut-off Treaty (FMCT) is to ban production of fissile material for nuclear weapons and other nuclear explosive devices. The FMCT has the potential to deliver substantial benefits to the twin objectives of nuclear disarmament and nuclear non-proliferation.

By capping the amount of fissile material available for weapons use, the FMCT will be an essential step towards irreversible nuclear disarmament. A cut-off treaty would further tighten controls on fissile material, reducing the risk of fissile material leaking to proliferators or terrorists. The FMCT will complement the Comprehensive Nuclear-Test-Ban Treaty (CTBT). The CTBT imposes qualitative restrictions on the development of nuclear weapons by prohibiting testing – the FMCT will impose a quantitative limit on the amount of fissile material available for weapons use.

After more than a decade of impasse, the UN Conference on Disarmament (CD) has now agreed to commence negotiation of the FMCT. It is hoped negotiations will commence early in 2010. The negotiating mandate for the FMCT, agreed by the CD in 1995, is as follows:

“... a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices.”

## 2. FMCT OBJECTIVES AND SCOPE

Since negotiations have not yet commenced, the main provisions of the FMCT cannot be predicted with certainty. The basic objective, reflected in the CD's mandate, is to prohibit production of further fissile material for nuclear weapons, and to establish arrangements to verify the observance of this prohibition.

The principal area to be settled is the FMCT's scope – which materials and facilities will be covered? This will involve a complex mix of considerations:

- What is necessary to ensure the treaty's effectiveness?
- Resource constraints – these involve not only the cost of verification, and who would pay, but whether the necessary verification specialists can be found;
- What will the states most affected – those with nuclear weapons – be prepared to agree to at this stage?

Regarding resources, some have suggested that if verification measures similar to the comprehensive safeguards applying in non-nuclear-weapon states party to the NPT were required in the nuclear-weapon states and non-NPT parties, the verification effort could be roughly three times the current IAEA safeguards workload (and possibly three times the cost – currently around \$US 140 million p.a.). The IAEA has difficulties recruiting and maintaining safeguards inspectors at its current scale – there is a serious question whether a three-fold increase would be practicable.

Regarding what the nuclear-weapon states and non-NPT states are prepared to agree to, the most contentious issue is that of fissile material stocks, i.e. holdings of fissile material pre-dating entry-into-force of the treaty. The CD's negotiating mandate

makes no reference to stocks. The negotiating mandate, being directed at the banning of production, implicitly means further production. It is not possible to ban past production. On this basis, the treaty would not apply to fissile material pre-dating entry-into-force.

However, there is an expectation by many states that the negotiations will have to include the issue of stocks. If there remain, free of any constraints, significant fissile stocks that can be drawn on to produce additional nuclear weapons, the FMCT would be seen by many as only a limited success. And there would be concerns about the durability of quantitative warhead limits agreed in disarmament negotiations.

One thing can be said with absolute certainty – the states with nuclear weapons will not agree to instant disarmament. So calls for the FMCT to extend to all fissile material, including fissile material in nuclear weapons, are unrealistic. On the other hand, the issue of stocks cannot be ignored – the negotiations will have to find a way of addressing stocks. This is discussed further in section 3.3 below.

As a minimum, the FMCT would apply to new (i.e. post entry-into-force) production of fissile material. Verification would apply to:

- newly produced fissile material – likely to be defined as HEU (high enriched uranium) and separated plutonium (i.e. not spent fuel) – to ensure it is not used for nuclear explosives; and
- facilities “producing” fissile material – i.e. enrichment and reprocessing facilities – to ensure that all new production is declared.

In addition, as discussed, there is the issue of inclusion of at least some pre-existing stocks.

### 3. TREATY COMMITMENTS

The main provisions of the FMCT eventually negotiated might be along the following lines:

1. Basic commitment – each party undertakes not to produce fissile material for nuclear weapons or other nuclear explosive devices;
2. Definitions relevant to the scope of the treaty, including the fissile materials that are the subject of the FMCT commitments, and a definition of “production”.

The definitions might also clarify non-proscribed activities (e.g. non-explosive military uses such as naval propulsion);

3. An entry-into-force formula – entry-into-force might be made conditional on ratification by specified states;
4. Provisions on pre-existing stocks of fissile material.

The prohibition on nuclear weapons use would apply to stocks brought under the FMCT, and this would be irreversible, i.e. once under the treaty, stocks could not be removed from coverage;

5. A commitment to negotiate/accept appropriate verification arrangements. The FMCT would set out the principal verification commitments. Detailed

verification provisions would be set out in supplementary agreements, such as IAEA safeguards agreements – see section 4 below;

6. Institutional arrangements – these might include a general conference and an executive council (to be decided whether these would be specific to the FMCT, or would use IAEA organs – see section 5 below);
7. Institutional arrangements could include a mechanism for parties to review the operation of the FMCT at regular intervals;
8. Institutional arrangements could also include a mechanism for parties to bring to the attention of all other parties issues of concern in relation to the operation of the FMCT – either in general or in the case of suspected non-compliance with FMCT commitments;
9. Provisions for settlement of disputes;
10. Provisions dealing with non-compliance – determination of non-compliance and reporting to the Security Council;
11. An amendment mechanism.

### 3.1 Fissile material

“Fissile material” is not a term formally used in current verification agreements, and this term will need to be defined for the FMCT. The fissile materials to be covered by the treaty should be those relevant to the manufacture of nuclear weapons. Broadly speaking, these are high enriched uranium (HEU) and plutonium. The materials regarded by the IAEA for safeguards purposes as “direct-use materials” – nuclear material that could be used for the manufacture of nuclear explosive devices without transmutation or further enrichment – are as follows:

- HEU, i.e. uranium enriched to 20% or more in the isotope U-235;
- plutonium containing less than 80% of the isotope Pu-238;
- uranium-233.

These would seem an appropriate basis for definitions in the FMCT, with the following qualification. Plutonium in irradiated fuel cannot be used for nuclear explosive devices without first being separated from uranium, fission products and other radioactive materials by reprocessing. It is suggested that for the purposes of the FMCT, “production” of plutonium would be defined as reprocessing. In this case the form of plutonium defined as fissile material for the purposes of the treaty would be separated plutonium.

Likewise, U-233, which is produced through irradiation of thorium, cannot be used for explosive purposes without being separated from thorium and fission products by reprocessing. So the form of U-233 defined as fissile material for the purposes of the FMCT would be separated U-233.

Based on this discussion, the FMCT would apply to the following materials, produced after entry-into-force (or in stocks made subject to the treaty)<sup>1</sup>:

---

1. It is necessary to consider whether the FMCT should also cover other *fissionable* materials that could be used to produce nuclear weapons. The IAEA has identified neptunium and americium as “alternate nuclear materials” having potential proliferation significance.

- high enriched uranium;
- separated (unirradiated) plutonium;
- separated U-233.

### 3.2 Production

Production of fissile material, as defined above, requires three processes:

- to obtain HEU – uranium enrichment;
- to obtain plutonium – irradiation of uranium in a reactor, and reprocessing to separate the plutonium from uranium, fission products and other radioactive materials;
- U-233 involves similar considerations to plutonium, i.e. it is produced through irradiation and separated by reprocessing.

For the treaty to encompass irradiation would be to give it an extremely broad scope – essentially, all reactor operations. But plutonium (or U-233) produced in reactor fuel is available for weapons use only if it is separated through reprocessing. Accordingly, as discussed above, for plutonium, the term “production” in the treaty should not encompass irradiation, but only reprocessing.

Thus, for the purposes of the treaty, “production” would mean enrichment (isotopic separation) and reprocessing (separation of plutonium, U-233, and other elements as defined, from irradiated material).

One issue to consider is the status of advanced spent fuel treatments such as electro-metallurgical processing. The objective of these technologies is to enable plutonium to be recycled as fuel in fast neutron reactors without the plutonium being fully separated from fission products and minor actinides. Hence the question arises whether these technologies should be regarded as “reprocessing”.

Although, as currently understood, electro-processing would not directly produce separated plutonium, this technology is not entirely free of proliferation risk – it could form part of a proliferation acquisition path, through substantially reducing the volume of material for diversion to a plutonium separation process. Accordingly, it is suggested partial separation of fissile material and irradiated material, as well as the resultant plutonium-bearing product, should also be subject to verification under the FMCT to assure against diversion of plutonium.

Based on this discussion, the FMCT would apply to the following facilities:

- enrichment facilities;
- reprocessing facilities (and facilities where partial separation of fissile material and irradiated material is undertaken);
- facilities in which HEU is processed, used or stored;
- facilities in which separated (or partially separated) plutonium is processed, used or stored.

Although production of HEU for non-weapons purposes is permitted under the current FMCT negotiating mandate, an issue for consideration is whether, in view of the very limited use of HEU in civil programs, and the very large stocks of HEU currently held by a number of nuclear-weapon states (which should be sufficient to

meet naval propulsion needs for many decades), there is an argument for proscribing high enrichment in this treaty. Another issue that might be considered is proscribing the separation of weapons grade plutonium.

### 3.3 Stocks

As discussed, the FMCT negotiating mandate does not include fissile material pre-dating entry-into-force. However, in the case of existing holdings of spent fuel, reprocessing of such material after entry-into-force would be new production, subject to the treaty commitments.

Although the negotiating mandate does not explicitly include stocks, at the time the mandate was agreed it was noted other issues would not be excluded from discussion, and there is no doubt the CD will want to consider the issue of pre-existing stocks.

One outcome may be that states with pre-existing stocks of fissile material outside civil programs will agree to submit at least excess stocks to coverage of the FMCT. To the extent that at least some stocks remain outside the FMCT, it should be recognised that remaining stocks will have to be the subject of a future treaty or part of further nuclear disarmament steps. As an interim step, the idea of a Fissile Material Control Initiative has been proposed<sup>2</sup>, under which states would voluntarily:

- make regular declarations of their fissile material stocks;
- apply the highest standards of physical protection and accountancy to those stocks;
- regularly declare amounts of fissile material they regard as excess to their weapons needs;
- place such excess material under IAEA safeguards as soon as practicable; and
- convert excess material as soon as possible to forms that cannot be used for nuclear weapons.

Perhaps some of these elements could be recognised by the FMCT, or even incorporated into the FMCT, if necessary on a voluntary basis.

### 3.4 Non-proscribed activities

The FMCT would not proscribe production of fissile material *per se*, only production for nuclear weapons or nuclear explosives (and production undeclared for verification). Reprocessing for civil use would not be proscribed. Nor would production of HEU for civil use or for non-explosive military use (e.g. naval propulsion) – though, as discussed above, consideration could be given to proscribing high enrichment and separation of weapons grade plutonium.

A further non-proscribed use would be clean-up of military plutonium to remove americium build-up. Since this does not involve production of further stocks of fissile material (and in fact arises through decay of fissile material), clean-up is quite

---

2. R.J. Einhorn, *Controlling Fissile Materials and Ending Nuclear Testing*, International Conference on Nuclear Disarmament, Oslo, 26-7 February 2008

different to reprocessing and should be recognised accordingly. This aspect will need to be looked at in the definition of “production”.<sup>3</sup>

### 3.5 Entry-into-force

The FMCT’s entry-into-force might be made conditional on ratification by specified states, as is the case with the CTBT. Since four of the recognised nuclear-weapon states (US, Russia, UK and France) announced that they had ceased production of fissile material for nuclear weapons some years ago, and China is believed to have done so, the FMCT will be particularly important to cap fissile production by the non-NPT states, which currently are under no constraints. The nuclear-weapon states might not be willing to enter a formal commitment unless the non-NPT states do likewise. On the other hand, care will be needed to avoid an entry-into-force formula which is unduly difficult, leaving commencement of the treaty hostage to one or two hold-outs.

## 4. VERIFICATION<sup>4</sup>

### 4.1 Basic principles

The basic commitment would be for FMCT parties to conclude with the treaty’s verification agency, an agreement setting out detailed arrangements for verifying the commitment in the treaty not to produce fissile material for nuclear weapons or nuclear explosive use (and not to use subject stocks for such use).

Whatever the scope of the FMCT, in concept the verification requirements for the treaty would be very similar to the IAEA safeguards system:

- parties will be required to declare subject materials and facilities;
- an inspectorate will verify parties’ declarations, records and reports;
- the inspectorate will also need to conduct verification measures for detection of possible undeclared material and activities;
- procedures will be required for investigation of suspected treaty breaches;
- procedures will be required for compliance determination and enforcement.

In contrast with other treaties negotiated in the CD, e.g. the Chemical Weapons Convention (CWC), there is no need to develop detailed verification provisions, such as a verification protocol, for the FMCT. This is because there is already a well-established verification system which meets most of the verification objectives likely to be specified for the FMCT, namely, the IAEA safeguards system. IAEA safeguards, which have been developed over some five decades, provide an ideal foundation for the FMCT’s verification arrangements.

Every state with significant nuclear activities already has a safeguards agreement with the IAEA – albeit requiring, in the case of the nuclear-armed states (the five nuclear-

---

3. A complication will arise if americium is defined as a fissile material subject to the FMCT – in this case, americium recovered through clean-up of separated plutonium pre-existing the treaty would probably have to be exempted from the treaty.

4. For a general discussion of FMCT verification issues see the author’s *Can a Fissile Material Cut-Off Treaty be Effectively Verified?*, Arms Control Today, January/February 2004, pp. 25-9.

weapon states recognised by the NPT and the states outside the NPT), to be extended to ensure the coverage required to meet FMCT objectives.

At this stage it has not been agreed that the IAEA will be the verification agency for the FMCT, and some states have commented this is not a foregone conclusion. However, there is no sense in not taking advantage of the IAEA safeguards system. Without doubt the most efficient basis for FMCT verification is to build on existing safeguards agreements, supplementing these as necessary. This is without prejudice to the question of the appropriate decision-making organs for the FMCT, discussed in section 5 below.

While existing safeguards agreements can be used as the starting point for meeting FMCT commitments, they would need to be amended as necessary by supplementary agreements or protocols, or could be amended directly by the FMCT itself, to meet the FMCT's objectives. Indeed, the FMCT provides an opportunity to address some deficiencies in the IAEA safeguards system. Important principles to be set out in the FMCT, requiring modification of existing safeguards agreements, might include:

Irreversibility A concern with NPT safeguards agreements is that their duration is tied to the state remaining a party to the NPT. If the state withdraws from the NPT, the safeguards agreement lapses. The FMCT could contain an irreversibility provision, that once nuclear material and facilities become subject to non-explosive use and verification commitments they would retain this status in perpetuity, regardless of withdrawal from the FMCT or NPT.

Challenge inspections Another improvement over current safeguards agreements would be introduction of a challenge inspection mechanism. Because of disappointment over the IAEA's lack of use of the special inspection mechanism in safeguards agreements – by which investigative inspections are supposed to be initiated by the IAEA – states may not have confidence in such a mechanism for FMCT purposes. It is likely that a challenge inspection mechanism, which can be initiated by a party, will be required for the FMCT, either instead of, or as well as, special inspections.<sup>5</sup>

Developing the details of verification for the FMCT will require careful technical analysis of existing safeguards agreements and how they would need to be amended or supplemented to meet the technical objectives of the FMCT – this work will be most effectively progressed in an expert working group rather than in the principal treaty negotiation.

#### **4.2 Non-nuclear-weapon states party to the NPT**

Non-nuclear-weapon states party to the NPT have an existing commitment, under the NPT itself, not to produce fissile material for weapons purposes and to accept IAEA safeguards to verify this commitment. This commitment corresponds to the basic objective of the FMCT. So, in principle no separate verification system should be needed to verify the commitments of such states under the FMCT, provided they have in force a comprehensive safeguards agreement (based on IAEA document

---

5. For an example of a safeguards challenge inspection mechanism, see Article 16.1.(b) of the Tlatelolco Treaty.

INFCIRC/153) and an additional protocol (based on IAEA document INFCIRC/540) – though these agreements may need to be amended or supplemented along the lines discussed above.

### **4.3 Other states – nuclear-weapon states and non-NPT parties**

The principal effect of the FMCT – and its verification requirements – relates mainly to the nuclear-weapon states and the three (or four) states outside the NPT. While one approach would be to leave the verification negotiation largely to these states, as the states most affected by the treaty, the international community as a whole has an interest in ensuring that the verification arrangements have the necessary degree of integrity and effectiveness. Further, the negotiating mandate for the FMCT calls for the treaty to be non-discriminatory – so the verification arrangements for the nuclear-weapon states and non-NPT parties should be as similar as possible to the arrangements for the other FMCT parties.

This points in the direction of also using IAEA safeguards agreements as the basis for the FMCT verification arrangements for these states, adjusted as necessary to meet FMCT objectives. The nuclear-weapon states have safeguards agreements based on the same model as the non-nuclear-weapon states (INFCIRC/153), except that in the case of the nuclear-weapon states the agreements are “voluntary” and apply only to nuclear material in designated (“eligible”) facilities. The nuclear-weapon states would have to accept the commitment for safeguards to apply to all existing and future fissile material subject to the FMCT and all relevant facilities, and to designate material and facilities accordingly.

The non-NPT parties have IAEA safeguards agreements based on INFCIRC/66 (“item-specific” safeguards agreements). These too could meet FMCT objectives if these states accepted the commitment for safeguards to apply to all existing and future subject material and relevant facilities, and to designate material and facilities accordingly.

### **4.4 Undeclared nuclear material and facilities**

The nuclear-weapon states and non-NPT parties would have to accept verification aimed at providing assurance of the absence of undeclared nuclear material and activities – i.e. nuclear material and activities that are required to be declared under the FMCT. This would be a substantial departure from the current situation.

Currently, by definition, the nuclear-weapon states and non-NPT parties have nuclear material and facilities outside any safeguards coverage. Under the FMCT, they will continue to have some unsafeguarded material (in particular, nuclear weapons) and locations where this material is stored and processed (e.g. processing for stockpile stewardship). However, it will be essential to allow for verification activities to counter, and to investigate, possible undeclared production of fissile material, which would be a violation of the FMCT. This could be effected through the additional protocol (INFCIRC/540), but it will be essential to ensure that the provisions of each additional protocol are strengthened to give the necessary coverage.

All the nuclear-weapon states, and also India (but not currently Israel and Pakistan), have an additional protocol, but for most of these the provisions fall short of what

would be required for the FMCT. The nuclear-weapon states and non-NPT parties would have to modify/conclude additional protocols that provide the IAEA with the necessary information and access rights.

It will be essential to ensure appropriate protection of national security information. Managed access, to protect sensitive locations, would be very important – and is already provided for under INFCIRC/540. An alternative to INFCIRC/540 would be the development of an equivalent instrument, tailored more specifically to the circumstances of the nuclear-armed states and their legitimate interest in protecting national security information – it is important to appreciate this interest is shared by every state: it is in the common interest of all states to ensure that verification activities do not result in leakage of proliferation-sensitive information.

As with current IAEA safeguards, detection of undeclared fissile material production will be a major challenge. It can be expected that the nuclear-weapon states have extensive information on each other's nuclear programs – sharing of information with the inspectorate will be essential. Unlike the current IAEA system, where information held by the Agency is confidential to it, there may well be a need for sharing of some kinds of verification information with the parties, as is the case with the CWC and the CTBT. Almost certainly, formal verification activities will have to be complemented by transparency and confidence-building measures, possibly including mutual inspections and arrangements such as “Open Skies”.

#### **4.5 Stockpile stewardship activities**

A complication for FMCT is that some nuclear-armed states may require to recycle plutonium from nuclear weapons – either to remove the build-up of americium-241<sup>6</sup> (a practice known as “clean-up”), or to manufacture new weapons (it is not expected that FMCT would prohibit production of new weapons from fissile material in existing weapons). In the past, the nuclear-weapon states have simply withdrawn warheads as they reach the end of their service life and produced further plutonium to replace them, but under FMCT this will no longer be an option.

Verification measures for FMCT will need to be able to distinguish between recycle of existing plutonium and new separation of plutonium from irradiated fuel or targets – new separation for weapons would be prohibited. For national security reasons, access to recycle facilities will not be allowed. But measures such as sampling of gaseous emissions would readily indicate if new separation were being undertaken.

#### **4.6 Verification of naval propulsion programs**

This is a complicated issue for the FMCT, but it is also a potential issue for comprehensive safeguards agreements. These allow non-nuclear-weapon states to remove from safeguards nuclear material intended for non-proscribed military use, under arrangements to be agreed with the IAEA.<sup>7</sup> To date this provision has not been used in practice.<sup>8</sup>

---

6. Pu-241, with a half-life of 14.4 years, decays to Am-241.

7. See INFCIRC/153, paragraph 14.

8. Canada considered nuclear-powered submarines in the 1980s but did not proceed. Brazil has indicated an interest in acquiring nuclear-powered submarines.

Some nuclear-weapon states operate naval reactors with HEU fuel, so there is the possibility that HEU production could continue under the FMCT for this purpose – although it would be an advantage in terms of verification workload if the states concerned concluded that their existing HEU stocks were sufficient and they had no need for ongoing HEU production. If existing naval stocks were outside the FMCT and there was no new production, there would be no verification requirement in this area.<sup>9</sup>

The problem for verification arises because states with naval reactors regard the design of naval fuel, and factors such as core loadings and range between refuelling, as highly classified. While concern about security is understandable, it is essential to develop appropriate verification arrangements so that naval programs don't present an opportunity for diversion. Diversion is not an issue just for HEU fuel – because LEU could be used as feedstock for high enrichment in an undeclared facility, verification arrangements would also be needed for LEU-based naval programs.

Because of the sensitivities, verification for naval programs will require novel approaches. However, the problems are not insurmountable – the Trilateral Initiative between the US, Russia and the IAEA<sup>10</sup> demonstrates the practicability of innovative approaches to verifying fissile material of sensitive composition, shape and mass. Formal verification may be complemented by transparency arrangements, e.g. it is easy to check that a vessel is at sea (and therefore has been fuelled).

It would be an extremely valuable contribution, as part of the preparatory work for the FMCT, for experts from one or more nuclear-weapon states and other interested states to conduct a study of appropriate verification arrangements for the naval fuel cycle.

#### **4.7 Other verification issues**

A major challenge for verification of the FMCT will be implementing verification approaches in old facilities not designed with verification in mind, i.e. enrichment and reprocessing plants in the nuclear-weapon states. These are likely to require intensive verification effort – the more of these facilities that can be shut down and decommissioned, the more manageable the verification task will be.

There will be no reason to continue operation of fissile production facilities used only for weapons programs – since the nuclear-weapon states have had informal moratoria on fissile production for weapons for many years, presumably no such facilities are operating now. There should be little if any need to produce HEU (the states with large naval propulsion programs have extensive HEU stocks to draw on). With advanced spent fuel recycling technologies which will avoid the need to separate plutonium – such as electro-processing – on the horizon, there should be little or no requirement for new conventional (Purex-based) reprocessing plants, and existing plants could be phased out over time.

---

9. Although if the FMCT does not cover naval stocks, it can be expected that future agreements will do so, so there will be a need to address verification of these programs in due course.

10. See e.g. T.E.Shea, *The Trilateral Initiative: A Model for the Future?*, Arms Control Today, May 2008.

Another challenge will be the verification workload. This highlights the importance of shutting down as many sensitive facilities as possible, and transitioning to new fuel cycle technologies. A state-level approach, discussed below, will also be important for cost-efficient verification.

One area requiring considerable development is that of verification standards and intensity for the FMCT. In the case of horizontal proliferation, the diversion of relatively small quantities of fissile material will be enough for a state to change its status from a non-nuclear-weapon state to a nuclear-armed state. The sensitivity of IAEA safeguards – reflected in technical parameters such as goal quantities (e.g. the *significant quantity* of 8 kg plutonium), detection probability, timeliness goals, and inspection frequency – has been set accordingly.

For the states that already have nuclear weapons, however, the calculus is rather different. These states will be concerned about treaty violations that are of sufficient scale to alter strategic relativities: for a state with *hundreds* of weapons, it might take a violation of hundreds of kilograms to be strategically significant. On the other hand, for a state with a small arsenal – and the objective of disarmament is that all the nuclear-weapon states will progress to this situation in time – small-scale diversion will be significant. One approach that would meet both these cases is to regard a breakout equivalent to say 1% of the monitored inventory as a strategic change.<sup>11</sup>

These considerations are likely to be reflected in the development of a state-level approach to verification, building on experience being gained with the state-level approach in IAEA safeguards. With a state-level approach, the technical verification objectives and parameters will be the same for all states, but decisions on verification intensity could take account of state-specific factors.

An important part of the verification architecture may well be bilateral or regional transparency and confidence-building arrangements, including nuclear-weapon-free zones, complementing the FMCT's verification arrangements. It is for consideration whether the FMCT would make any explicit reference to the possibility of such complementary arrangements.

## 5. INSTITUTIONAL ARRANGEMENTS

This paper suggests that verification for the FMCT should be based on IAEA safeguards – it follows that the IAEA safeguards inspectorate would be tasked with carrying out FMCT verification. It does not necessarily follow, however, that the IAEA organs would have responsibility for the FMCT. For example, the FMCT parties might not consider that the IAEA Board of Governors is the most appropriate body to exercise executive authority for the FMCT – the parties may prefer executive and decision-making organs (e.g. an executive council and a general conference) that are designed specifically for the FMCT. This is a matter to be addressed in the FMCT negotiations.

Conceptually, there is no reason why the IAEA safeguards inspectorate could not operate on behalf of an FMCT organisation. But if there is to be a separate FMCT organisation, this would raise a number of major issues – e.g. what would be the

---

11. The 1% figure was informally adopted in the Trilateral Initiative (see footnote 7).

relationship between the IAEA Board of Governors and the FMCT executive council on questions of non-compliance? Clearly the institutional arrangements for the FMCT will require careful reflection.