FM(C)T benefits and burdens: today's needs, tomorrow's opportunities

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Ten years ago, the United Nations General Assembly approved a resolution calling for the negotiation of a 'non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices'.[1] Eight years ago, the Conference on Disarmament (CD) agreed upon a negotiating mandate,[2] and five years ago, an ad hoc committee was established for a brief period to commence work on the treaty.[3] In most years since then, the United Nations General Assembly reiterated its support for this treaty,[4] and every Review Conference of the Treaty for Non-Proliferation of Nuclear Weapons (NPT) has called for its negotiation before the next Review Conference.[5] Aside from the Shannon Mandate and the short-lived ad hoc committee in 1998, the CD has not been able to agree upon a work plan and there has been no work on the negotiation of this prospective treaty.

One reason for this lack of progress may be the perception that the benefits expected from the treaty have not been seen by many as commensurate with the anticipated burdens (negotiation complexity and implementation costs). But times change and today's threats of proliferation and nuclear terrorism warrant another look at the FM(C)T.[6] Appropriately cast, a treaty banning the production of fissile material for the manufacture of nuclear weapons or other nuclear explosive devices could provide a starting point for important progress towards nuclear disarmament, strengthen the international non-proliferation regime and help to prevent nuclear terrorism.

The basic premise is that fissile materials remain essential for all nuclear weapons. Thus, controls on the production and use of fissile materials serve as the foundation of the international non-proliferation regime and the prime focus of International Atomic Energy Agency (IAEA) safeguards.[7] Similarly, controls on fissile materials in relation to nuclear disarmament would inhibit expansion of existing arsenals and provide a means to lock-in arms reductions. It would also help to create the confidence necessary for successive steps towards the eventual elimination of nuclear weapons.

The task of banning future production of fissile materials for use in nuclear weapons or other nuclear explosives connects this treaty to the existing non-proliferation regime. It provides a means to guide future peaceful nuclear applications in directions that will not encourage nuclear ambitions by any state or sub-national body.

Thus, a treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices merits a new look to see how such a treaty could allow international verification related to nuclear disarmament while extending and bolstering the existing non-proliferation and physical protection regimes.

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Nine potential elements of a future FM(C)T

If a treaty banning the production of fissile material for the manufacture of nuclear weapons or other nuclear explosive devices were to incorporate the nine elements identified below, the treaty and the regime it creates would be vital to international security.

Element 1. Verify former military production facilities to confirm that they have ceased operations, or have been converted to peaceful applications or non-explosive military applications:

- high enriched uranium (HEU) enrichment plants;
- plutonium reprocessing plants; and
- plutonium production reactors remaining in operation following entry into force.

This element of the FM(C)T would stop the production programmes that have supported today's nuclear arsenals, and thereby establish a cap (except for imports) on the inventories of fissile material available for use in a nuclear weapons programme. This element would have essentially no impact on states that are currently subject to a comprehensive IAEA safeguards agreement, because those states are already prohibited from producing fissile material for non-peaceful purposes, and are subject to *de jure* requirements to place all of their nuclear materials under IAEA safeguards.[8]

This element would focus on the past.[9] It would call for all of the facilities that were used to produce fissile material for nuclear weapons at any time in the past to be declared, and upon entry into force of the treaty, to be shut down or converted to peaceful use (or for a non-proscribed military purpose).

Through this element, all enrichment plants and reprocessing plants used for military production would become subject to inspection to ensure that they remain shut down or are reconfigured and operated henceforth exclusively for peaceful (or non-proscribed military) purposes. Any fissile material produced after entry into force would be verified to confirm that it is not used to manufacture nuclear weapons or other nuclear explosive devices, and would remain accounted for under the treaty until specified termination criteria have been met.[10]

If these enrichment plants and reprocessing plants were shut down, the monitoring activities would be simple and inexpensive. Depending on the effort required to resume operations, for example, the monitoring operations could be carried out without the need for frequent inspection visits or installed monitoring equipment. Satellite imagery or remote monitoring might also be employed. However, if those enrichment or reprocessing plants remain in operation under the FM(C)T, the monitoring costs and complexities would be much greater, particularly for reprocessing plants. Recognizing that these facilities are located at sensitive sites and that activities related to nuclear weapons may continue in other facilities at the same sites, the monitoring activities, including the equipment to be used, may need to be developed and applied under special arrangements that provide assurance to the state that the monitoring operations do not serve an unintended purpose.

Element 2. Verify all fissile material produced for peaceful use *after* entry into force:

- civil reprocessing plants;
- uranium conversion and enrichment plants;

- conversion / fuel fabrication plants for fissile material;
- reactors fuelled with fissile material;
- hot cells; and
- waste conditioning plants and geological repositories.

Certain peaceful nuclear operations produce fissile material under normal conditions that would be suitable for use in manufacturing nuclear weapons or other nuclear explosive devices. Thus, under the FM(C)T, it would be necessary to verify that *all* fissile material produced in peaceful nuclear programmes *is declared and accounted for*, and thereafter, to assure that the fissile material is not diverted to weapon use.

The benefits of bringing these 'civil' facilities under verification would be extensive. All reprocessing and enrichment facilities would be subject to essentially the same inspections, and the requirements for rigorous practices would ensure that these facilities and the fissile materials that are produced, processed and used are subject to universal, state-of-the-art material control and accounting requirements. These material control and accounting systems constitute the first line of defence against threats of theft, and thus the material control and accounting practices necessary for the FM(C)T would also serve a direct benefit in relation to the prevention of nuclear terrorism.

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The experience gained in applying IAEA safeguards in non-nuclear-weapon states (NNWS) would be directly applicable. In addition, as the states possessing nuclear weapons gain experience and skill in the accounting and measurement systems and the containment and surveillance methods applied under the FM(C)T inspections, they would be able to adapt those practices to other activities that would not be subject to inspection.

For most of the states possessing nuclear weapons, this element of the FM(C)T would be the most expensive, by far. The costs for IAEA safeguards are currently on the order of US $100 million per year. Given the extensive range of civil nuclear operations in the states that are not subject to comprehensive IAEA safeguards agreements, similar costs should be anticipated for this element of the FM(C)T. [11]

While inspections of civil facilities will be expensive and burdensome, recall that all similar facilities in NNWS are already subject to IAEA inspections. The objective of IAEA safeguards is to detect the 'diversion of significant quantities of *nuclear material* from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.'[12] In fact, the definition of 'nuclear material' is broader than that for 'fissile material' and thus the inspection burden would still be more demanding on NNWS than foreseen under the FM(C)T in states possessing nuclear weapons.

Element 3. Verify the absence of undeclared production of fissile material within the facilities that are submitted for inspection; verify the absence of clandestine facilities; and verify that specialized equipment/material remains dedicated to peaceful use (including dual-use equipment).

Following the discovery of the clandestine nuclear programme in Iraq in the early 1990s, the ability of IAEA safeguards to detect undeclared production of fissile material in existing facilities and in

clandestine facilities was strengthened. Additional safeguards activities were introduced in declared facilities, including the verification of design information to confirm that the facilities are designed and operated in accordance with information provided by the state, and environmental sampling to detect indications of undeclared operations.

Verification activities undertaken to detect facilities that are not declared (i.e., clandestine facilities) involve satellite imagery, extensive information analysis, and complementary access to locations not associated with declared facilities. The Additional Protocol to IAEA Safeguards Agreements provides a legal basis for the IAEA to carry out such activities in NNWS, and should be a part of the verification for all states parties to the FM(C)T. [13]

The verification costs for confirming the absence of clandestine facilities will be far less than the verification activities at declared facilities. Verification activities undertaken to detect clandestine facilities in states possessing nuclear weapons and naval propulsion reactors may have to be more restricted than in NNWS to prevent inspectors from acquiring protected information pertaining to the design or manufacture of nuclear weapons.

Element 4. Verify existing plutonium and HEU stocks from peaceful nuclear programmes to prevent their use in nuclear weapons or other nuclear explosive devices.

If the FM(C)T is to limit the availability of fissile material for use in the manufacture of nuclear weapons or other nuclear explosive devices, then existing stocks from civil nuclear operations should be subject to verification under the treaty. If not, the cap established upon entry into force of the FM(C)T would not be limited to that produced specifically for military programmes prior to its entry into force, but the total of that amount plus the civil stocks existing at that time. In addition to this complication, the verification measures would be made much more complicated by the existence of such stocks—in effect, it could work out that identical fissile material could co-exist within a facility, some of which would be subject to inspection, some not. Under some diversion concealment strategies, the existence of such material would make it difficult to confirm the absence of diversion.

The incremental costs to verify this material would be small, and would be offset by the simplification of not having to contend with dual inventories that would complicate verification.

Element 5. Verify fissile material and facilities engaged in military applications which do not involve the production of nuclear weapons or other nuclear explosive devices:

- verify feed reserves and release stocks for naval reactors and space power reactor fuel manufacturing according to operational requirements;
- verify new fissile material production and stocks produced;
- verify exports and imports of fissile material intended for such use;
- verify the working inventory and scrap at fuel manufacturing plants;
- implement managed access for transparency of reactor fuel manufacturing; and
- verify reactor power changes to provide transparency regarding reactors installed on naval vessels.

Article 14 of INFCIRC/153 provides a mechanism for states parties to comprehensive IAEA safeguards agreements to remove specified nuclear material from safeguards for use in non-explosive

military applications. There are no provisions for any transparency measures during the time that this provision might be exercised. To date, no NNWS has ever exercised this option, although a small number of states have submarine development programmes underway.[14]

Following the provisions established in INFCIRC/153, the FM(C)T would likely also make allowance for states to use fissile material for military applications that do not involve the production of nuclear weapons or other nuclear explosive devices. When the FM(C)T enters into force, the fissile material stocks set aside for military applications, and subsequent production to meet future needs, could conceal nuclear weapons production. Hence, a scheme involving the steps shown in Element 5 would limit the material available to the amounts actually required, and provide assurance that the amounts identified for this purpose are actually employed for that purpose.

The measures suggested would respect the rights of states to pursue such applications and their protection of sensitive information, while providing transparency and assurance that this provision did not provide a loophole against the fundamental intentions of the FM(C)T. Technical methods developed for IAEA verification of classified forms of weapon-origin fissile materials might find use in this application.[15]

Element 6. Verify excess military stocks:

- mandatory verification of excess military stocks having no classified properties;
- voluntary verification of excess stocks with classified characteristics (using attribute verification with information barriers); and
- mandatory proportional declarations of excess stocks in conjunction with nuclear arms reductions.

One of the most contentious aspects of past considerations of the FM(C)T has been the issue of military stocks produced before the treaty entered into force. While avoiding positions that might block such a treaty, a scheme that focuses on the verification of stocks determined by the state to be excess to *its* military requirements could provide a means to enhance the arms control benefits of the treaty.

Under a trilateral initiative between the Russian Federation, the United States and the IAEA, the technical, legal and financial issues associated with IAEA verification of weapon-origin fissile material released from military programmes in the Russian Federation and the United States were examined.[16] The FM(C)T could include provisions that would allow states to submit excess military fissile material to verification under the FM(C)T. If the provisions allowed states to submit excess fissile material with classified characteristics,[17] then far greater amounts of excess fissile material could be included much earlier in the inspection regime than if this provision only allows unclassified forms.[18]

Concluding the initial charge entrusted to the Trilateral Initiative, the IAEA, the Russian Federation and the United States agreed that the verification methods developed could be applied by the IAEA for the verification of any form of fissile material, without risk of divulging information on the design or manufacture of nuclear weapons. While additional work would be required to field the specialized verification instruments in a high security environment, the parties expressed their confidence that such a mission is practical.

Thus, incorporating the relevant provisions of the Trilateral Initiative could extend the arms control dimension of the FM(C)T while avoiding the ‘stocks’ complications cited earlier. The verification costs would be moderate, depending upon the verification performance requirements and the operations undertaken in relation to the disposition of the excess materials.

Element 7. Implement a universal system of import/export controls governing commerce in fissile materials, facilities for their production, processing and use, and specialized material and equipment, including 'dual-use' equipment.

Every state that has acquired nuclear weapons has benefited from assistance provided by other states. Sometimes the other state has provided assistance knowingly, sometimes not. The system of nuclear export controls in place today is more robust and effective than ever before. However, it is incomplete in coverage and could be made more effective without hampering prudent and legitimate peaceful applications of nuclear energy.

Commerce in specific technologies, materials and equipment could be taken under the FM(C)T as a means to create a non-discriminatory system for all parties. Such an export control regime could serve to dissuade states from engaging in nuclear activities that are not clearly appropriate for peaceful use. It could also aid in denying states access to sensitive technologies, materials or equipment that might be misused to further nuclear ambitions. Additionally, it might provide the basis for assuring the supply of fresh fuel, which would reduce the need for states to establish indigenous enrichment capabilities. It might also provide for the management of spent fuel or other radioactive wastes, which would reduce the need for states to establish indigenous reprocessing capabilities.

To affect such a control regime, the existing Nuclear Supplier Guidelines might be adopted under the FM(C)T, while taking into account the reporting requirements of INFCIRC/153 and 540.

Element 8. Implement proliferation-resistance principles and practices to aid in preventing further proliferation by guiding the development, demonstration and deployment of nuclear energy systems.

The impetus for the introduction of 'proliferation resistance' comes from renewed interest in developing a new generation of nuclear energy systems anticipating that global climate deterioration may spur an increased demand for nuclear energy in the decades ahead.[19] In particular, there are two programmes underway to develop future nuclear energy systems.

- The IAEA 44th General Conference Resolution GC(44)/RES/22 invites 'all interested Member States of the Agency to combine their efforts under the aegis of the Agency, in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology'. The IAEA's Innovative Nuclear Reactors and Fuel Cycles Programme (INPRO) was established in response to that resolution.
- Similarly, under the Generation IV Program sponsored by the United States and the associated Generation IV (GEN IV) International Forum, the issue of 'proliferation resistance and physical protection' has been a factor in the selection of candidate systems for future research and development, and is one of the specific areas to be addressed in the forthcoming viability and performance phases of the Generation IV Program.[20]

The FM(C)T Conference of States Parties might be charged with the responsibility for implementing proliferation resistance measures as a means to determine whether proposed nuclear activities are prudent and legitimate, and thus are acceptable to the world community. For example, the Conference of States Parties could:

- determine the merit of major new projects, taking into account the national energy demand, existing nuclear capability and the incremental changes that would result from the proposed project, the technical, legal and financial infrastructure, and proliferation risk;

- assure that the operation of a state's nuclear industry is consistent with proliferation-resistance, in particular, that fissile materials are not stockpiled owing to differences in demand and supply;
- monitor the conversion of research reactors fuelled with high enriched uranium to low enriched, and possibly the conversion of naval propulsion reactors to enrichments of 20% or less; and
- oversee the creation of multinational energy parks.

Element 9. Require FM(C)T Parties to adhere to the Convention for the Physical Protection of Nuclear Material (CPPNM) and implement the provisions of INFCIRC/225, and implement physical protection principles and practices in the development, demonstration and deployment of nuclear energy systems to prevent or inhibit acts of nuclear terrorism.

Additional measures to prevent or mitigate the consequences of terrorist acts could be created through the FM(C)T if appropriate provisions were to be included in the treaty. Preventing nuclear terrorism has nothing to do with stopping past military production, but it is relevant to assuring that peaceful nuclear activities carried out at the time of entry into force and in the years and decades that follow, are designed and conducted in ways that reinforce their peaceful intent.

Nuclear terrorism could involve the theft of fissile material for use in nuclear weapons or other nuclear explosive devices, the theft of hazardous radioactive materials for use in radiological dispersal devices, the sabotage of nuclear reactors or fuel cycle facilities, or the sabotage of vehicles, vessels or aircraft transporting fissile or other hazardous radioactive material.[21] The FM(C)T verification required under the elements above would necessitate the adoption of a material control and accounting system at each facility; material control and accounting systems serve as the first line of defence against certain of the scenarios for nuclear terrorism.

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Following the framework suggested for proliferation resistance, the physical protection provisions of the FM(C)T could include a combination of *intrinsic features* and *extrinsic measures* designed to:

- minimize and control access to weapon-usable and other nuclear material, hazardous radioactive material, facilities and transport systems (e.g., through the use of personnel authorization systems, physical barriers, detection equipment, and other appropriate measures);
- minimize the vulnerability of nuclear reactor plant systems to cyber attack;
- provide immediate response, including use of force, if an act of nuclear terrorism is suspected or if unauthorized access to weapon-usable and other nuclear material, hazardous radioactive material, facilities and transport systems is anticipated or attempted;
- take immediate action to recover any stolen material and minimize the consequences of any act of nuclear terrorism; and
- protect vital equipment required to maintain radioactive materials in a safe state, in particular, for reactors the safety systems that provide reactivity control, decay heat removal, and radionuclide confinement.

The manner and extent to which the FM(C)T might incorporate provisions intended to combat nuclear terrorism would depend to some extent on the outcome of an initiative to strengthen the CPPNM. If successful, the effort underway to amend the CPPNM would extend its scope to cover nuclear material in domestic use, storage and transport, and the protection of nuclear material and

facilities from sabotage. The amendment would enhance the value of the CPPNM, but it would still be limited; the amendment under consideration makes no provision for verification or peer review, it includes no requirement for mandatory application of INFCIRC/225,[22] and it does not address nuclear material and nuclear facilities in military use.[23]

Further benefits spawned by and within the regime created by the FM(C)T

The FM(C)T could be the first treaty to gain universal acceptance, as its provisions would be in the interests of all governments. The regime it would create would have a natural nexus with the NPT and other regimes, especially that of the CPPNM. The international norms created through the FM(C)T regime would strengthen the integrity of the workings of the treaties and conventions it embraces and bolster the commitments of the states parties to the respective aims and objectives. To imagine how such a regime might function, it could be useful to look briefly at three aspects of how today's regimes contribute to combating nuclear terrorism beyond the specific provisions of any existing treaty or convention.

Physical protection, the NPT and IAEA safeguards

The NPT was not written with nuclear terrorism in mind, but the regime created around the NPT has provided a context for addressing nuclear terrorism.

While the NPT itself makes no reference to 'terrorism', 'theft' and 'physical protection', the very first NPT Review Conference in 1975 called on the IAEA to further elaborate concrete physical protection recommendations, and on all states with peaceful nuclear activities to follow the IAEA recommendations and 'to enter into such international agreements and arrangements as might be necessary to ensure such protection.'[24] Interest within the NPT review process continues: for example, in the Final Document of the 2000 NPT Review Conference, 'the Conference notes the paramount importance of effective physical protection of all nuclear material, and calls upon all States to maintain the highest possible standards of security and physical protection of nuclear materials.'

Confidence-building measures

In this era of heightened threats, actions are increasingly being taken by states to improve the confidence of governments in their own national physical protection capabilities.

An increasing number of states are voluntarily participating in IAEA physical protection training activities and in peer reviews carried out under IAEA auspices.[25] The International Physical Protection Advisory Service (IPPAS) was created in 1995 to assist Member States in improving the effectiveness of their physical protection of nuclear materials and facilities. Upon request by a Member State, the Agency sends a team of specialists, who review the state's physical protection system and make recommendations for improvements not only on the technical aspects of physical protection, but also on related legal and organizational issues, and can address related needs of the requesting state, such as combating illicit trafficking. With the increased number of requests and substantial voluntary contributions, the current plan is to double the existing capability to support about six such missions per year.

Cooperative Threat Reduction

Regimes facilitate actions at various levels. In relation to nuclear issues, in particular, actions carried out under the title of 'Cooperative Threat Reduction' (CTR) are aimed at eliminating or securing weapons and materials of mass destruction that might otherwise fall into the hands of terrorists. The Material Protection Control and Accounting programme run by the United States Department of Energy is one example. It is intended to consolidate and secure nuclear materials in the Russian Federation. The basic idea behind this programme is simple: the Russian Federation and the United States, sharing the perception of a security threat arising from inadequately protected fissile materials in the Russian Federation, coordinate their efforts to secure fissile materials at specified sites.

Many analysts conclude that the CTR 'model' has been a marked success and could be successfully applied in other regions of the world,[26] that CTR could be based upon multilateral arrangements, perhaps with the involvement of international organizations and non-governmental organizations. On a limited scale, this has already been done, as in the removal of HEU from the research reactor in Belgrade, Yugoslavia, with participation of the governments of Yugoslavia,[27] the Russian Federation and the United States, as well as the IAEA and the Nuclear Threat Initiative, which provided the funding.

There is no evident reason that this kind of cooperation wouldn't work on a larger scale, and a number of possibilities are being explored. The most noteworthy is the global coalition against weapons and materials of mass destruction, which was created at the G8 Summit in June 2002.

It is difficult to imagine that CTR activities could be so extensive without the context provided by the non-proliferation regime. Such accomplishments are also highlighted at each NPT Review Conference. The FM(C)T would extend the existing non-proliferation framework allowing further CTR activities—to help states to meet their treaty obligations, or to address specific problems on which direct, concerted activities would be necessary.

Time phasing of implementation

The FM(C)T will require a significant effort and a long time to be implemented fully. The inspections will be most extensive in those states with the most extensive nuclear industries, military and civil. Ramping up to meet the requirements for full implementation will require a staff comparable to the current size of the IAEA Safeguards Department (about 250 inspectors plus support staff). Hence, it will be necessary to manage FM(C)T implementation in a manner that will not undermine the effectiveness of the non-proliferation safeguards. The priorities and planning for implementation should emphasize the fundamental objective of the FM(C)T as an instrument of nuclear disarmament—i.e., to assure that the facilities created to make fissile materials for nuclear weapons have halted production, and to assure that all excess military fissile material and all comparable civil fissile material is brought under inspection as soon as possible. As time permits, the inspection activities can branch out from there to eventually cover all such materials.

NNWS are subject to IAEA non-proliferation safeguards that are geared to detecting the acquisition of a state's first nuclear weapon. The amounts of interest, the times and the detection probabilities chosen as performance requirements for IAEA safeguards are all driven by this single consideration: timely detection of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or other nuclear explosive devices or for purposes unknown, and deterrence of such diversion through the risk of early detection. Verification in states possessing nuclear weapons and in NNWS should eventually converge, however, at the outset of the FM(C)T,

steps towards convergence should follow full implementation of the basic treaty elements and progress in nuclear arms reductions.

An important responsibility of the Conference of States Parties will thus be to guide, review and approve of the incremental steps leading to full implementation.

Potential impact of a nine-element FM(C)T on three communities

There are presently 191 nations in the world, of which 188 are parties to the NPT. Of these, 183 have become NNWS parties to the NPT.[28] Eight nations are not subject to comprehensive IAEA safeguards agreements, and have fissile material that is available for use in nuclear weapons. Five (France, the People's Republic of China, the Russian Federation, the United Kingdom and the United States) are nuclear-weapon states parties (NWS) to the NPT. The remaining three (India, Israel and Pakistan) have fissile material not subject to IAEA safeguards, and two of those, India and Pakistan, have tested nuclear weapons.

Table 1 illustrates the anticipated impact of the nine FM(C)T elements identified above. (It is assumed in the table that the FM(C)T would be universal.)

Financing the FM(C)T

For the goals and aspirations of the FM(C)T to become reality, adequate and reliable funding must be secured to pay for the verification activities to be carried out and for the implementation actions required in states that would not otherwise be able to meet their requirements under the treaty.

One means to finance the FM(C)T would be to follow the arrangements implemented for IAEA safeguards, including safeguards implemented in meeting the obligations defined in the NPT. The present scheme for financing IAEA safeguards stems from 1957 when the IAEA Statute was written. A budget is proposed by the IAEA Secretariat and reviewed by a Committee of the IAEA Board of Governors. The Committee recommends a budget to the Board, which then submits the budget with its recommendations to the General Conference. The Governors are often required by their respective capitals to avoid budget increases for a variety of policy and economic reasons. The current process is often driven by issues that are not connected with the safeguards mission.

One alternative that might be considered would be to finance the FM(C)T on the basis of a 1% surcharge on all nuclear-generated electricity. Today, there are 434 operating nuclear power plants worldwide and additional plants are under construction and in planning. Such an arrangement would be similar to that used to finance the Yucca Mountain Geological Repository in the United States and other existing arrangements in other states.

Applying a 1% surcharge to all nuclear electricity would produce an income in the range of one billion dollars per year. As a fixed percentage of rates charged around the world, it would increase as nuclear power applications increase, and as inflation raises the rates that customers pay. The 1% figure is expected to more than meet foreseeable needs, and is low enough so as not to impose an economic burden on the states employing nuclear energy.

With such a financing base, the FM(C)T Conference of States Parties could determine how the funding should be committed, without the conflict of limiting the verification budget to the extent that

the effectiveness of the verification system is undermined. Budget excesses could provide a means to expand technical cooperation funding for worthy projects in the developing world.

Table 1. Anticipated impact of the nine FM(C)T elements

Element	Impact		
	NPT NWS	NPT NNWS	India, Israel and Pakistan
1. Past military production	Not applicable; no impact	Significant impact; extent depends upon operational status of production facilities after entry into force	
2. Declared peaceful nuclear facilities and fissile material produced for peaceful use after entry into force	None; all nuclear activities subject to IAEA safeguards	Most impact in France, United Kingdom and Russian Federation; relevance of Euratom safeguards needs to be established. The impact in the United States will depend upon the future use of plutonium fuels, e.g., as foreseen under the Generation IV Program.	Significant impact in India
3. Undeclared production of fissile material within the facilities that are submitted for inspection or in clandestine facilities	For all NNWS with Additional Protocols in force, essentially no additional impact; for other states, impact of INFCIRC/540 Protocol to comprehensive IAEA Safeguards Agreement	Significant impact with implementation of full scope INFCIRC/540 Additional Protocol. Inspection access to sensitive sites restricted according to provisions for managed access; environmental sample taking under special procedures intended to prevent divulging information on nuclear weapons design or manufacture, or other sensitive military operations	
4. Existing fissile material stocks from peaceful nuclear programmes	No additional impact foreseen; all fissile materials subject to IAEA safeguards	Significant impact in France, the Russian Federation and the United Kingdom	Significant impact in India
5. Non-explosive military applications	No impact at present; possible impact in Brazil	Significant impact in all five NWS	Possible impact in India
6. Excess military stocks	Not applicable; no impact	Significant impact in the Russian Federation and the United States initially; others later on	Significant impact later on
7. Export/import controls	No impact for states adhering to Nuclear Supplier Guidelines. In other cases, equal, moderate impact on all states exporting or importing fissile materials or relevant technologies, materials or equipment		
8. Proliferation-resistance features	Impact depends upon whether NNWS is exporting or importing	Impact on development and exports	
9. Physical protection	Equal, moderate impact on all states depending on nature and extent of nuclear operations		

Conclusion

The need for a FM(C)T is as great now as ever before; recognizing today's needs and tomorrow's opportunities could result in a treaty that would be of critical importance in maintaining the integrity of the NPT regime and enhancing security in the century ahead. The FM(C)T suggested in this paper comprises nine elements to provide a broad and substantial basis that will benefit security from the outset and lay the groundwork for future progress. The decisions on what to include in the FM(C)T are for the CD to determine; the suggestions put forward in this article are consistent with the original United Nations resolution, and are not inconsistent with the Shannon Mandate.

Consider the following:

- Current suspicions in several key countries have raised the importance of adherence to non-proliferation obligations and of international inspections to unprecedented levels. In several situations, international inspections may provide the only peaceful means to resolve heightened tensions.
- Cuba submitted its instrument of ratification for the NPT on 4 November 2002 in Moscow. Cuba's accession leaves India, Israel and Pakistan as the only states that are not parties to the NPT. All 183 NNWS parties to the NPT have undertaken not to acquire nuclear weapons, and not to assist other states or to receive such assistance. While the NPT has been remarkably successful in limiting the spread of nuclear weapons, not all parties have honoured their obligations and the future integrity of the NPT remains in question.
- States harbouring nuclear ambitions may still find assistance, sometimes with the knowledge of other states, sometimes without, involving knowledge transfers, sensitive equipment and material.
- The nuclear-weapon states parties to the NPT recognize their obligations under Article VI, but the process foreseen in Article VI has yet to commence. There are no multilateral agreements toward the elimination of nuclear weapons or restraints on the ability to manufacture nuclear weapons. Their reluctance undermines the commitments of the NNWS and denies the NPT its full influence and ability. India, Israel and Pakistan remain largely outside the community of nations on the issues of nuclear security.

Fissile materials remain essential for all nuclear weapons and controls on their production, use and export provide the principal mechanism for the international non-proliferation regime. Similar controls adopted by all states possessing nuclear weapons will provide one important means to encourage progress towards the eventual elimination of existing arsenals, and provide a basis for broader actions in the area of peace and security.

Nuclear terrorism is perhaps more likely to involve the theft of fissile materials for the manufacture of nuclear explosive devices, or the theft of hazardous radioactive materials for use in a radiation dispersal device (i.e., a 'dirty bomb'), or the sabotage of a nuclear installation or transport system with the intention of releasing radioactive material to cause harm. The casualties, property damage and economic costs associated with acts of terrorism would differ dramatically across this threat spectrum, but even a realistic hoax could have a severe impact. There are many means to address nuclear terrorism and while it is not the principal aim of the FM(C)T, it could also—directly and indirectly—reduce each of these dangers.

Incorporating the nine elements presented in this article, the FM(C)T would assume a role of critical importance in international security, setting the foundation for future arms reductions, enhancing global efforts to prevent the proliferation of nuclear weapons, and establishing a common foundation for preventing nuclear terrorism.

Notes

1 United Nations General Assembly resolution 48/75L, 16 December 1993.

2 A negotiating mandate was finally agreed on 23 March 1995 just prior to the opening of the 1995 NPT Review and Extension Conference. The 24 March 1995 report of the Special Coordinator (CD/1299), Ambassador Gerald Shannon of Canada, contained an agreed mandate that basically repeated the operative language from resolution 48/75L together with an understanding that all issues pertaining to the scope could be addressed in the context of treaty negotiation. All United Nations General Assembly resolutions on a FM(C)T since 1995 have referred to a FM(C)T negotiation in the context of the Shannon report and the mandate contained therein.

3 The Conference on Disarmament decision CD/1547 of 11 August 1998 to establish, under item 1 of its agenda entitled 'Cessation of the nuclear arms race and nuclear disarmament', an ad hoc committee to negotiate, on the basis of the report of the Special Coordinator (CD/1299) and the mandate contained therein, a non-discriminatory, multilateral and internationally and effectively verifiable treaty banning the production of fissile material for nuclear weapons or other nuclear explosive devices.

4 United Nations General Assembly resolutions 53/77 I (1998); 55/33 Y (2000); 56/24 J (2001); 57/80 (2002); no resolution was adopted during its fifty-fourth session in 1999. All of these resolutions refer to the report of the Special Coordinator (CD/1299) and the mandate contained therein.

5 *Report of Main Committee I*, 'Article VI and preambular paragraphs 8 to 12', item 10 of NPT/CONF.2000/MC.I/1.

6 From the beginning, disputes on the scope for such a treaty have divided the international community into two camps. States that believe that nuclear powers have not made a start on disarmament have maintained that such a treaty should provide a means to bring in existing military stocks, while states possessing nuclear weapons have not accepted that such a treaty (banning the production of fissile material) is the appropriate place for such steps to be taken. Those holding a broader view identify the treaty as an 'FMT', while those seeking to restrict its application refer to it as an 'FMCT', with the 'C' standing for 'cut-off' on the production of fissile material. In this article, a compromise that has been in circulation is adopted, i.e., 'FM(C)T', where the '(C)' may mean 'control', envisioning the broad scope suggested in this article, or 'cut-off', or that it may be eliminated altogether, as negotiations determine.

7 'Fissile material' in this paper is understood to include all materials suitable for use as the principal fission energy source in a nuclear weapon or any other nuclear explosive device. In that sense, 'fissile material' for the purposes of the FM(C)T should include plutonium of any isotopic composition (except for plutonium containing 80% or more of the isotope ^{238}Pu), uranium enriched to 20% or more in the isotope ^{233}U and/or ^{235}U, plus neptunium and americium. In addition, the treaty should provide a simple means to include as material subject to the treaty, any other actinide capable of sustaining a fast critical reaction that may become available in sufficient quantities in the future to warrant being added to this list.

8 If the negotiators include the actinides neptunium and americium in the definition of material that would be subject to the treaty, then that could involve minor changes. Other areas might also have a minor impact—if challenge inspections are included, for example, or if the information to be reported or disclosed would differ.

9 A question for consideration is whether the treaty should require the states to declare the amounts of fissile material produced prior to the treaty's entry into force, and if so, whether such declarations should be subject to auditing or verification. Such a measure would bear more upon disarmament than on future production, and thus one possibility might be to include such declarations in a later agreement, or this treaty could initially encourage such declarations and later make them mandatory.

10 A decision would have to be taken during the negotiations on the verification of the production reactors. If the reactors were shut down, then monitoring by satellite imagery (infra-red) should be sufficient. If the reactors remain in operation, then on-site monitoring would be needed to provide assurance that all plutonium produced is subject to inspection.
Under IAEA safeguards, termination of safeguards occurs when the IAEA determines that the nuclear material has been consumed, or diluted to the point that it is no longer useful for any nuclear activity relevant from the point of view of safeguards, or has become practicably irrecoverable.

11 The IAEA estimate of US $100 million for verification activities under an FM(C)T is based on a 1995 evaluation in which three verification options were examined. More accurate estimates of verification costs can be developed when the requirements of the treaty are fixed and consultations begin with the states possessing nuclear weapons or nuclear material not subject to a comprehensive IAEA safeguards agreement.

12 This is the 'Objective of Safeguards', taken from paragraph 28 of INFCIRC/153, *The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons*, of June 1972, available at <http://www.iaea.org/worldatom/Documents/Infcircs/Others/inf153.shtml>.

13 Comprehensive IAEA safeguards agreements are based upon INFCIRC/153. The Additional Protocol is based upon IAEA, *Model Protocol Additional to the Agreement(s) Between State(s) and the International Atomic Energy Agency for the Application of Safeguards*, INFCIRC/540 of September 1997, available at <http://www.iaea.org/worldatom/Documents/Infcircs/1998/infcirc540corrected.pdf>.

14 Canada had a programme underway in 1987 to purchase ten to twelve nuclear submarines from the United Kingdom or France and went to the extent of exploring the exemption of the fuels under paragraph 14 of its safeguards agreement. M.F. Desjardins and T. Rauf, *Opening Pandora's Box? Nuclear-Powered Submarines and the Spread of Nuclear Weapons*, Aurora Papers 8 (June 1988), Canadian Centre for Arms Control and Disarmament.

15 Under the Trilateral Initiative, a scheme was developed that would allow the IAEA to verify any form of fissile material without revealing classified secrets related to the design or manufacture of nuclear weapons. This scheme is based upon comparing specified parameters to unclassified values. For example, the isotopic composition of weapon-origin plutonium has a ratio of the isotope ^{240}Pu to ^{239}Pu of less than 0.1. If a container of plutonium is found to hold plutonium with such a ratio, then that 'attribute' is accepted. The isotopic composition of the plutonium is measured by gamma ray spectrometry, using specialized equipment that bars inspectors from any of the measurement information other than the final ratio. The technique used to prevent such access is referred to as 'information barrier technology'. Overall, the method is know as 'attribute verification with information barriers'.

16 T. Shea, 2001, Report on the Trilateral Initiative: IAEA Verification of Weapon-Origin Fissile Material in the Russian Federation and the United States, *IAEA Bulletin*, vol. 43, no. 4, pp. 49–53, available at <http://www.iaea.or.at/worldatom/Periodicals/Bulletin/Bull434/article9.pdf>.

17 'Classified characteristics' means physical properties determined by the state in the interest of its national security to require protection against unauthorized disclosure under the laws and regulations of the state.

18 Nicholas Zarimpas (ed.), forthcoming, *Transparency in Nuclear Warheads and Materials: The Political and Technical Dimensions*, Oxford, Oxford University Press and SIPRI. See, in particular, the chapter entitled 'Potential roles for the IAEA in a warhead dismantlement and fissile materials transparency regime'.

19 Proliferation resistance impedes the diversion or undeclared production of nuclear material, or misuse of technology, by states in order to acquire nuclear weapons or other nuclear explosive devices. The degree of proliferation resistance results from a combination of *intrinsic features* and *extrinsic measures*, including, *inter alia*, technical design features, operational modalities, institutional arrangements and safeguards measures. *Intrinsic features* are intended to reduce the attractiveness for nuclear weapons programmes of nuclear material during production, use, transport, storage and disposal; prevent or inhibit the diversion of nuclear material; prevent or inhibit the undeclared production of direct-use material; and facilitate IAEA safeguards. *Extrinsic measures* include states' commitments, obligations and policies with regard to nuclear non-proliferation and disarmament; agreements between exporting and importing states that nuclear energy systems will be used only for agreed purposes and subject to agreed limitations; and commercial, legal or institutional arrangements that control access to nuclear material and nuclear energy systems (including provisions for multinational ownership of nuclear energy systems, perhaps in extra-territorial locations).

20 See *A Technology Roadmap for Generation IV Nuclear Energy Systems*, available at <http://nuclear.gov/nerac/FinalRoadmapforNERACReview.pdf>.

21 Nuclear terrorism could involve other activities that would not be immediately relevant to the FM(C)T, including the theft of nuclear weapons, strong isotopic sources used in medicine, agriculture and industry, or hazardous radioactive materials containing trace amounts of fissile material, such as high level radioactive waste. These possibilities are not addressed in this paper.

22 Guidance for physical protection of nuclear material in domestic use, storage and transport, without distinction between peaceful and military purposes, is provided in IAEA, *Recommendations for the Physical Protection of Nuclear Materials*, INFCIRC/225 Rev.4 of 1999, available at <http://www.iaea.org/worldatom/Programmes/Protection/inf225rev4/rev4_content.html>. This guidance is further expanded in IAEA-TECDOC-967 (Rev.1), *Guidance and considerations for the implementation of INFCIRC/225/Rev.4, The Physical Protection of Nuclear Material and Nuclear Facilities*, May 2000.

23 *Nuclear Security—Progress on Measures to Protect against Nuclear Terrorism*, Report by the Director General, IAEA, 12 August 2002, IAEA document GOV/INF/2002/11-GC(46)/14.

24 Chronologically, the issue first became international in 1972, when the IAEA published *Recommendations for the Physical Protection of Nuclear Material*, the revised version of which became INFCIRC 225 in 1975.

25 Note that bilateral cooperation agreements involving peaceful uses of nuclear energy often include requirements for the importing states to implement INFCIRC/225 and rights for the exporting state to inspect the facilities it provides in the importing state to determine whether or not the physical protection measures being implemented are adequate.

26 DFI International and Sparta, Inc., 2001, *The future of the Cooperative Threat Reduction Programme: Final Report*, a study for the Defense Threat Reduction Agency Systems and Concepts Office; Rose Gottemoeller with Rebecca

Longsworth, 2002, *Enhancing Nuclear Security in the Counter-Terrorism Struggle: India and Pakistan as a New Region for Cooperation,* Carnegie Endowment for International Peace, Working Paper number 29 (August); Matthew Bunn, John P. Holdren and Anthony Wier, 2002, *Securing Nuclear Weapons and Materials: Seven Steps for Immediate Action,* Harvard University; Michael Krepon, 2001, *Moving from MAD to Cooperative Threat Reduction,* The Henry Stimson Center Report No. 41 (December).

27 The former Federal Republic of Yugoslavia changed its name to Serbia and Montenegro on 4 February 2003.

28 At the time of writing, the Democratic People's Republic of Korea had announced its withdrawal from the NPT. The numbers cited do not reflect the DPRK action, pending further developments.