Verification and security in a nuclear-weapon-free world: elements and framework of a Nuclear Weapons Convention

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At the 2010 Review Conference of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) in New York a number of states and non-governmental organizations called for a Nuclear Weapons Convention (NWC), which would implement the comprehensive goal of a world without nuclear weapons.[1] The final document of the conference noted UN Secretary-General Ban Ki-moon's five-point proposal for nuclear disarmament of 24 October 2008, "which proposes, inter alia, consideration of negotiations on a nuclear weapons convention or agreement on a framework of separate mutually reinforcing instruments, backed by a strong system of verification".[2] Many states and most anti-nuclear civil society groups now see negotiation of an NWC in the near future as politically feasible and indeed necessary if we are to move beyond the current disarmament stalemate.[3]

The concept of the NWC goes back to the mid-1990s and was promoted by non-governmental organizations (NGOs) at the 1995 NPT Review and Extension Conference.[4] In April 1997, Costa Rica submitted a Model Nuclear Weapons Convention, drawn up by an international consortium of lawyers, scientists and disarmament experts, to the United Nations.[5] An extended and updated version of the Model NWC was presented at the 2007 Preparatory Committee for the 2010 NPT Review Conference as part of the launch of the International Campaign for the Abolition of Nuclear Weapons (ICAN).[6] Ban Ki-moon has described the Model NWC as "a good point of departure" for negotiations,[7] and studies by the Weapons of Mass Destruction Commission, the International Commission on Nuclear Non-Proliferation and Disarmament and the Stimson Center all seriously consider a comprehensive agreement for a nuclear-weapon-free world.[8]

At the United Nations General Assembly, a majority of 125 states, including the nuclear-weapon possessors China, India and Pakistan, voted for the 2006 NWC resolution, which called for "commencing multilateral negotiations leading to an early conclusion of a nuclear weapons convention prohibiting the development, production, testing, deployment, stockpiling, transfer, threat or use of nuclear weapons and providing for their elimination".[9]

Now is an appropriate time to think about how a Nuclear Weapons Convention could be structured, implemented and, in particular, verified. Such a comprehensive agreement will only be effective if it enhances global security and can be adequately verified.[10] The Model NWC can serve as a reference point, bearing in mind that the model should not be confused with a real future NWC.

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Perspectives and requirements of verifying the elimination of nuclear weapons

To eliminate their nuclear arsenals, the nuclear-weapon states must be confident that other states are in turn eliminating and not (re)building theirs. Verification measures are required to detect prohibited activities related to nuclear weapons with sufficient reliability. Adequate verification means that the residual uncertainties of non-compliance would be tolerable. The following questions must be considered for the verification process:

- What are the requirements/tasks of verification?
- Which verification means could be applied to monitor states and their activities?
- Can an intolerable deviation from the agreement be detected in time with reasonable verification efforts (what are the benefits, costs and security risks of verification)?

The Model NWC suggests a legal framework for the verifiable ban and elimination of all nuclear weapons and the monitoring and control of the nuclear complex and fissile materials. In Article I, it explicitly seeks to prohibit the development, production, testing, deployment, stockpiling, transfer, use or threat of use of nuclear weapons, and provides for their elimination. Nuclear-weapon states are required to destroy their nuclear arsenals.

As the world moves toward complete nuclear disarmament, and as warhead numbers decline, uncertainties and risks will become more important, since just a few hidden nuclear weapons can make a significant difference. An effective NWC requires specific verification mechanisms that ensure the elimination of existing stockpiles of warheads and materials, prevent future acquisition or production, and detect clandestine nuclear-weapon-related activities as early as possible and with high confidence. The risks and costs to would-be violators must be high. The Model NWC seeks to lay out a verification regime that creates the necessary confidence that the elimination of nuclear weapons is complete and will not be reversed. Such a regime will assure states that participation provides a better guarantee of security than maintaining the nuclear option. The two major verification tasks are:[11]

- disarmament: to monitor the agreed path of reducing nuclear arms and eliminating the nuclear weapons complex within tolerable limits of uncertainty and sufficient confidence; and
- preventing rearmament: during the transformation to a nuclear-weapon-free world, and after it has been achieved, to observe any objects and detect any activities that might indicate a nuclear weapons capability.

Elements and means of verification

In verifying a ban on nuclear weapons, the regime will have to monitor a wide range of nuclear weapons objects (nuclear warheads and components, nuclear materials, equipment, facilities, delivery systems, command and control) and nuclear weapons activities (research, development, testing, production, acquisition, deployment, stockpiling, maintenance, transfer, use, threat of use, destruction, disposal and conversion). Some of these are easy to monitor (such as nuclear explosions), others require considerable detection efforts and capabilities (such as finding hidden warheads).

The complete elimination of nuclear weapons presents particular challenges to the verification regime and rather than relying on a single verification measure or a one-time activity of monitoring, verification of a nuclear-weapon-free world has to be a dynamic, iterative process that involves various mechanisms and phases, including declaration, monitoring, inspection and enforcement, being repeated successively and in parallel.

Declaration, registration, transparency and confidence-building

Data gathering and exchange provide baseline information on the initial state of affairs to allow for comparison with future changes, either agreed or prohibited. These activities also increase transparency and build confidence among states parties, which are essential to starting the process of elimination of nuclear weapons.[12] States parties would declare all inventories and facilities related to nuclear weapons, including numbers, types and locations of warheads, fissile material stocks, and production and assembly plants. Declarations should cover all civilian or military sites that produce nuclear materials potentially relevant for nuclear weapons. All treaty-limited items would be tagged, identified and registered using advanced identification techniques, without revealing sensitive design information. Site diagrams for each facility would indicate all locations where nuclear weapons are present and the number of warheads in each location, each with a unique identifier that could be checked against the declaration in future.

According to the Model NWC, these data would be gathered in a central registry that would maintain a list of all nuclear warheads, delivery vehicles, facilities and materials subject to verification. The declaration could be updated at agreed intervals or whenever a warhead was moved.

Increasing mutual nuclear transparency will be a difficult task, partly because of concerns about confidentiality, partly because of uncertainties and poor book-keeping from the beginning of the nuclear era. The sooner transparency can be achieved regarding the numbers, types and deployments of nuclear weapons, delivery systems and holdings of special nuclear materials, the earlier confidence can be established.

Confidence-building measures (CBMs) are essential in the initial declaration phase of the NWC and throughout its implementation. Among other things, CBMs strengthen reciprocal monitoring and information sharing between states. Activities could include exchange visits and cooperative monitoring ventures between the nuclear-weapon possessors.[13] CBMs can build on extensive bilateral experience between the Russian Federation and the United States in verifying the Intermediate-range Nuclear Forces (INF) Treaty and the Strategic Arms

Reduction Treaty (START), as well as in working together on the Cooperative Threat Reduction programme, in which the United States provided assistance to dismantle parts of the Soviet nuclear complex and control the fissionable material from dismantled nuclear weapons. Former nuclear scientists and facilities could be employed in the disarmament process to prevent knowledge from spreading. This minimizes the risk that personnel involved in verifying nuclear disarmament acquire new knowledge and thus contribute, inadvertently or deliberately, to proliferation.

Providing historical records of warhead production, deployment and dismantlement would build confidence in the accuracy and completeness of declarations. Under a future NWC countries would declare all highly enriched uranium and plutonium produced in military and civilian facilities. It is difficult to verify historical production, but the task has been accomplished in South Africa.[14] In 1996, the United States declared its production of weapon-grade plutonium between 1945 and 1994.[15] Although it will be virtually impossible for any nuclear-weapon state to give a complete and accurate account,[16] the documentation of past production must begin as early as possible to make sure that discrepancies are not strategically significant and potentially destabilizing.[17]

To counter concerns that declarations could provide sensitive information about the nuclear arsenal to adversaries and thus make a state vulnerable to attack, critical information needs to be protected at an early stage. One option is the encryption of data, which may be decrypted later if necessary.[18]

Monitoring system

Monitoring aims at detecting prohibited objects or activities with the highest possible confidence. A variety of measures and methods can be used for monitoring: visible, infrared and radar sensing; seismic, radiological, hydroacoustic and infrasound detection; on-site sensors; and aircraft overflights. Continuous monitoring requires information gathering over long periods of time. Remote sensors on satellites and aircraft provide high-resolution images of large areas to detect larger objects, in particular transport vehicles and buildings. The problem is identifying treaty-limited items among the vast number of existing civilian and military objects. However, regular cartographic mapping provides a basis for the detection of irregularities or inconsistencies between official mapping information and actual remote sensing data. Remote and wide-area monitoring will be a vital element of the verification regime as soon as the relevant production facilities are shut down and dismantled, as efforts are concentrated on detecting clandestine facilities and activities.

Currently, states rely predominantly on their national technical means, including satellite observation, information gathering and espionage, to carry out monitoring and verification. In the process of moving toward a nuclear-weapon-free world, however, a strong multilateral system of data collection and analysis capabilities needs to be established, which will complement, or replace, national capabilities. All measures combined will reduce the risks and increase the costs of illicit activity, even though they may not completely guarantee the detection of violations.

The Model NWC suggests establishing an International Monitoring System that would enable an International Agency to carry out monitoring and gather the information necessary for the verification of the NWC. Information generated by equipment owned or controlled by states parties would be shared through agreements with the Agency. Agreements regarding data sharing and verification activities would also be required with existing agencies, particularly the Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO, which has developed its own monitoring system) and the International Atomic Energy Agency (IAEA).

Technical monitoring means and processes have been continuously improving. To address the technical challenges to verifying nuclear dismantlement, research, development and cooperation with regard to creating innovative techniques to monitor declared and to detect undeclared weapons, facilities and materials needs to be intensified. The UN weapons inspections in Iraq stimulated the introduction of new methods such as environmental monitoring to detect releases around nuclear-related facilities.[19] For example, atmospheric concentrations of krypton-85 can be used to obtain indications of clandestine plutonium separation from some distance.[20]

Most of the research in this area has been done in the United Kingdom and the United States. In particular, the Atomic Weapons Establishment at Aldermaston in the United Kingdom has concluded a five-year programme studying the dismantling of Chevaline warheads to identify potential methodologies for a future nuclear disarmament verification regime.[21] In 2005, the US National Research Council's Committee on International Security and Arms Control published a comprehensive assessment of methods for monitoring nuclear weapons and nuclear explosive materials in a disarming world. The Committee concluded: "Current and foreseeable technological capabilities exist to support verification at declared sites, based on transparency and monitoring, for declared stocks of all categories of nuclear weapons—strategic and nonstrategic, deployed and nondeployed—as well as for the nuclear-explosive components and materials that are their essential ingredients."[22]

On-site inspections and techniques

An inspection system for nuclear abolition is likely to be more intrusive than any previous inspection system. It would include both systematic baseline inspections and challenge inspections (any time–any place) of declared and undeclared facilities. Baseline inspections confirm declarations. They provide an account of weapon numbers, which can later be compared with the number of dismantled weapons. They verify the shut-down of declared facilities. Challenge inspections are required as soon as a suspicion of a treaty violation is raised. Inspectors will search for hidden warheads and related materials. The inspected party has to remove any doubts about the number of remaining nuclear weapons and provide clarity about suspicious objects and activities. Not every potential weapon would have to be inspected, only objects that the inspectors believe might be nuclear warheads or other prohibited objects and that the inspected party claims are not. Many of the systems and technologies developed for existing arms control treaties could be used to verify stockpile declarations.

During visits, the inspectors would have the power to request all the necessary detailed information from the inspected party, including the opening of rooms, access to computer codes, and interviews with personnel and neighbours. Inspection authorities can make use of a wide range of techniques, including visual inspection, record checks and non-destructive measurement (for example, with portable X-ray and gamma-ray detectors). Non-destructive on-site monitoring devices at entrance/exit ports or along the perimeter of critical facilities could be applied to track the flow of items and materials and understand the structure and function of equipment.

Since all fissionable material emits a small number of neutrons, inspectors can use neutron detection to find fissionable material without disclosing sensitive information. For instance, passive radiation measurements taken in proximity to closed missile canisters allow inspectors to distinguish between various warhead and missile types, as was demonstrated for the three-warhead SS-20 and the single-warhead SS-25 missiles during INF Treaty verification. Inspectors can counter attempts to hide warheads in neutron-absorbing material by transmitting neutrons into the object to induce detectable fissions.[23]

Definitive authentication could be carried out at the dismantlement facility and could be accomplished using template or attribute matching. Template matching uses one or a few confirmed warheads to define the characteristics of other warheads of the same type, predominantly focusing on the nuclear properties of the warhead. Attribute matching uses characteristics agreed by all parties as sufficient to make a nuclear warhead, for example, a minimum mass of plutonium or enriched uranium.[24]

Nuclear safeguards and preventive controls

Due to its inherent dual-use potential, the control of nuclear power is one of the biggest challenges for the verification of nuclear abolition.[25] In theory the highest barrier against break-out would be a world without nuclear energy, as it would not have the infrastructure to produce nuclear weapons materials, which would effectively block any path toward the bomb. However, the Model NWC does not suggest prohibiting peaceful uses of nuclear energy (though it does offer an optional protocol on energy assistance for states that choose not to develop or use nuclear energy), which is not seen as necessary for the abolition of nuclear weapons. The Model NWC's proposed verification measures, which would restrict the use of those nuclear technologies that have the highest relevance for nuclear proliferation and make the remaining special nuclear materials as inaccessible as possible, will improve the existing safeguards system, but they will face strong challenges in a world where reactors make bomb fuel.

The Model NWC strives to prevent the construction of nuclear weapons and places the technical barriers to diverting nuclear-weapon-usable material as high as possible: effective prevention will not be possible as long as weapon-usable nuclear material is available and can be diverted for use in nuclear weapons at any time. Therefore, the Model NWC demands the reduction of inventories and restricts the reproducibility of nuclear-weapon-usable materials to the lowest possible level. To guard against break-out, preventive controls[26] on nuclear-weapon-usable material are proposed.

Preventive controls are broader than the safeguards of the IAEA, which are primarily intended to deter diversion of nuclear materials through detection once diversion has taken place, and which apply only to certain civilian nuclear facilities. The measures proposed in the Model NWC include materials held in the military and civilian sectors and concentrate on physical protection of and restricted physical access to “special nuclear material” (containment and surveillance). Such controls may include the establishment of procedures for transport, treatment, storage and disposal of such materials. Preventive controls will contribute to the internationalization of the nuclear fuel cycle, eliminating national access to the greatest extent possible.[27]

A major source of uncertainty is the large amount of “material unaccounted for”. For instance, in 1996 the United States was unable to account for 2.8 metric tons of weapon-grade plutonium.[28] A 2005 report by the US National Research Council makes clear that in view of the sheer size and age of the Russian stockpile of nuclear materials “Russia probably could conceal undeclared stocks equivalent to several hundred weapons”.[29] For states with much smaller programmes, the absolute uncertainty would be much less, nonetheless “these countries could conceal undeclared stocks equivalent to one or two dozen weapons in the case of China, and at most one or two weapons in the cases of Israel, India, and Pakistan.”[30]

The precise accounting of fissile materials will therefore be a highly demanding exercise. The Model NWC’s verification provisions allow for accountancy to begin even before entry into force. An incremental step is the full adoption and implementation of the 93+2 Safeguards Programme, agreed by IAEA members in May 1997. It includes expanded declarations, extended possibilities of inspection and techniques for environmental monitoring.[31]

An international implementation and verification body

To implement and verify a nuclear disarmament agreement, the structure and experience of existing implementation and verification bodies, including the IAEA, CTBTO and Organisation for the Prohibition of Chemical Weapons (OPCW), can be built upon. Rather than amending and expanding the role and responsibility of existing agencies, it probably would be preferable to establish a new entity that is complementary to the IAEA and CTBTO, whose tasks may then be redefined. In particular, the current dual task of the IAEA to promote *and* control the nuclear industry could be divided, possibly transferring the safeguards function to the new agency as part of its disarmament obligation.

The Model NWC proposes to establish an International Agency similar but not identical to the OPCW. The following structure is suggested.

- A Conference of all States Parties, the principal body of the Agency, which would meet annually and for special sessions as necessary.
- An Executive Council, a standing body to be elected by the Conference for a certain period. The Council would oversee implementation and operation of the Convention and would be responsible for day-to-day decision-making on the operation of the treaty. It would also have the power to demand clarification from any state party and recommend action in the case of non-compliance. Membership would rotate, with attention to equitable regional distribution and representation by nuclear-weapon states and nuclear-capable states.
- A Technical Secretariat, headed by a Director-General, which would carry out the tasks of implementation and verification through various mechanisms, including a Registry and an International Monitoring System.

Dispute settlement and enforcement

If sufficient information has been gathered to indicate a treaty violation, the first step would be to demand that the suspected party ends the prohibited activities or enters the destruction and conversion of prohibited objects. If the object or activity of concern is to be excluded from nuclear-weapon use, additional preventive control measures would be applied. Ideally, enforcement measures would be preventive: the NWC regime should discourage non-compliance in such a way that it is clear to any would-be violator that clandestine nuclear weapons activities do not permit any gains, but rather pose a significant risk. The Model NWC emphasizes disincentives over coercion, giving the Agency powers to impose preliminary, targeted sanctions. It would also be useful to develop incentives to make compliance more attractive than non-compliance. As it stands, there are no specific incentives for states party to the Model NWC other than assurances that they will not be attacked by nuclear weapons and that the world will be a safer place with nuclear abolition. In case of a suspected act of non-compliance, a negotiation process is started. It is important to leave the violator an option to save face during the negotiation. The use of force, which might increase the motives for keeping or using nuclear weapons, should be a measure of last, not first, resort.

If timely consultation, cooperation and fact-finding measures fail to resolve a dispute, the Executive Council or the Conference of all States Parties would have the authority to refer the dispute to the International Court of Justice for an advisory opinion and to the United Nations General Assembly or Security Council. Some commentators feel that the Security Council is so biased with respect to nuclear disarmament that situations of non-compliance should not be referred there at all but should instead be referred to the UN General Assembly. Others argue that since the successful negotiation of an NWC requires the commitment of the nuclear-weapon states, they will be committed to its successful enforcement in the Security Council. There has also been a suggestion of reforming the Security Council to ensure that a nuclear-weapon state could not block compliance action regarding its own nuclear weapons programme. The Security Council needs to represent nuclear and non-nuclear great powers in a more equitable manner, in order to delegitimize nuclear weapons and devise an effective and fair compliance system.

Societal verification and education

Cheap and ready access to information and communications technologies has increased the possibilities for non-governmental organizations (NGOs) to participate in verification activities, for example by using commercially available satellite photography.

Societal verification would substantially extend the basis of information and make treaty violation even more complicated. Civil society, including NGOs, professional bodies and individuals, could become more involved in monitoring the activities of governments and if necessary "blow the whistle".[32] No state that secretly strives for nuclear weapons could be sure that persons involved in clandestine activities would not transmit their knowledge to the international community, even in closed societies, as previous cases have demonstrated.

Joseph Rotblat has emphasized the importance of societal verification:

> The main form of societal verification is by inducing the citizens of the countries signing the treaty to report to an appropriate international authority any information about attempted violation going on in their countries. For this system of verification to be effective it is vital that all such reporting becomes the right and the civic duty of the citizen.[33]

The Model NWC provides citizens of all states with the right and the obligation to indicate suspected nuclear weapons activities. Whether the provisions in the Model NWC are sufficient to encourage whistle-blowing and to protect such whistle-blowers remains an open question.

In addition, the Model NWC makes transparency and education obligatory. The idea is to promote scientific responsibility and greater awareness of the link between nuclear science and weapons development. Scientists and engineers can and should be trained to identify and warn others of potentially prohibited activities, and should be alerted to the potential links between nuclear science and nuclear proliferation. This training must be handled carefully and information must be protected, as increasing the openness of the nuclear complex could otherwise contribute to proliferation.

This approach is not the "Big Brother" model of suspicion and surveillance. Rather, societal verification aims for openness and trust in scientific and industrial endeavours: principles that are fundamental to good science and its productive application.

The security context of NWC verification

Whether states judge an NWC to be verifiable depends on the prevailing security environment. In a hostile environment of conflicts between major powers, uncertainties are seen as much more threatening than in a cooperative environment, where countries trust each other and exchange information on a regular basis. And the security environment is continuously changing, shaped by the actions of the key players. The path toward a nuclear-weapon-free world, including the negotiation of an NWC, goes hand in hand with building a more propitious security environment, diminishing the role of nuclear weapons in national security, and establishing an international security community.

It therefore appears that the verifiability of a treaty is not an absolute issue, but a matter of degree. Whether the NWC is verifiable depends not only on the available resources and technical capabilities, but also on political assumptions and requirements. A guiding principle in the search for a viable NWC regime should be a regime that is sufficiently restrictive to ensure the highest level of confidence in compliance, but also sufficiently permissive to allow states to join without jeopardizing their legitimate security interests and commercial activities. The challenge is to find the right balance: the residual risk needs to be reduced to tolerable levels by establishing responses that adequately offset advantages for non-compliance.

For example, the early Reagan Administration would tolerate nothing short of perfect certainty of compliance. Since this was an impossible standard to achieve, even with expensive and intrusive verification efforts, disarmament stalled. However, when Gorbachev took over as leader of the Soviet Union, confidence and trust increased between the superpowers, and finally Reagan accepted lower verification standards in order to conclude the INF and START agreements. More verification was seen as too costly, and the residual risks were accepted because the potential security implications were perceived as manageable.

The lowest verification standards were requested by President George W. Bush, who suggested signing the Moscow Treaty (Trreaty on Strategic Offensive Reductions) without any verification procedures, but this will not work for nuclear abolition: "The verification and compliance regime for a nuclear-weapon-free world will need to be more effective than any disarmament arrangement hitherto envisaged. One hundred per cent verification of compliance with any international arms agreement is highly improbable. In the case of nuclear disarmament, however, the security stakes will be so high that states will not agree to disarm and disavow future acquisition of nuclear weapons unless verification reduces to a minimum the risk of non-compliance."[34]

To master this challenge, the nuclear disarmament process will involve both verification and security measures, as pointed out by the 1997 report of the US National Academy of Sciences: "Complete nuclear disarmament will require continued evolution of the international system toward collective action, transparency, and the rule of law; a comprehensive system of verification, which itself will require an unprecedented degree of cooperation and transparency; and safeguards to protect against the possibility of cheating or rapid break-out." On the other hand, "(e)ven if every nuclear warhead were destroyed, the current nuclear weapons states, and a growing number of other technologically advanced states, would be able to build nuclear weapons within a few months or few years of a national decision to do so."[35]

There may never be a foolproof multilateral verification system for total nuclear disarmament, but this does not mean that comprehensive disarmament is not verifiable. This is clarified by Steve Fetter:

> Although no verification regime could provide absolute assurance that former nuclear-weapon states had not hidden a small number of nuclear weapons or enough nuclear material to build a small stockpile, verification could be good enough to reduce remaining uncertainties to a level that might be tolerable in a more transparent and trusting international environment. And although the possibility of rapid break-out will be ever present in modern industrial society, verification could provide the steady reassurance that would be necessary to dissipate residual fears of cheating.[36]

The verification regime of an NWC would aim for the best possible security but should not give the illusion of perfect security. The security impact of break-out scenarios would depend on a number of factors, but it should be borne in mind that any illicit nuclear weapons produced "would be untested, could not be deployed until the last minute, could probably not be delivered by conventional means, and overt training for use would have been impossible."[37] An actor threatening to use such a weapon would only have a temporary advantage, as other actors would be provoked to rebuild a nuclear device or arsenal.

The Model NWC envisions a security regime based on incentives for compliance and good faith, institutionalizing the norm of non-possession of nuclear weapons, reducing or eliminating the technical possibility for maintaining or developing nuclear weapons, and establishing mechanisms for addressing non-compliance. The framework is explained by Trevor Findlay:

> Complete nuclear disarmament implies not just a significant evolution in verification, but an evolution of the international system. States will have to change their attitudes towards the limits of sovereignty, the rule of international law and governance of the international system, particularly in regard to

> enforcement, if nuclear disarmament is ever to be negotiated. Indeed, the attainment of a nuclear weapon free world is so dependent on such changes that we will only be able to judge fully and accurately its verifiability as we become seriously engaged in moving towards that goal.[38]

In summary, any NWC verification regime will rely on a combination of technical measures with political, organizational and societal elements that define the security environment. How well these elements can be integrated into a coherent and effective verification system for a nuclear-weapon-free world requires further examination.

Notes

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5. Model Nuclear Weapons Convention, in UN document A/C.1/52/7, 17 November 1997, Annex. The full text is also included in Merav Datan et al., 1999, *Security and Survival: The Case for a Nuclear Weapons Convention,* Cambridge, IPPNW, IALANA, INESAP.
6. *Model Nuclear Weapons Convention,* Working paper submitted by Costa Rica, UN document NPT/Conf.2010/PC.1/WP.17, 1 May 2007.
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9. UN General Assembly resolution 61/83 of 6 December 2006, UN document A/RES/61/83, 18 December 2006, paragraph 2.
10. This article builds on Chapter 4 written by the author in Merav Datan et al., 2007, *Securing Our Survival: The Case for a Nuclear Weapons Convention,* Cambridge, IPPNW, IALANA, INESAP. See also Merav Datan and Jürgen Scheffran, 1997, *Principles and Means for Verification of a Nuclear Weapons Convention,* INESAP information bulletin no. 14, November.
11. Martin B. Kalinowski, Wolfgang Liebert and Jürgen Scheffran, 1998, *Beyond Technical Verification: Transparency, Verification, and Preventive Control for the Nuclear Weapons Convention,* INESAP briefing paper no. 1.
12. Harald Müller and Annette Schaper, 2009, *Transparenz für die kernwaffenfreie Welt,* HSFK-Report No, 10/2009, Frankfurt, PRIF.

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14. See Jonathan B. Tucker, 1997, *Verifying a Multilateral Ban on Nuclear Weapons: Lessons from the Chemical Weapons Convention,* INESAP information bulletin no. 14, November.
15. US Department of Energy, 1996, *Plutonium: The First 50 Years,* document DOE/DP-0137.
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17. Methods of nuclear archaeology are important: they can be used to investigate traces of materials that are characteristic of relevant past activities at production facilities and to carry out model calculations. Authentication and fingerprinting techniques are based on the measurement of radiation emissions and other characteristic signatures.
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19. J. Whichello, D. Parise and N. Khlebnikov, 2006, *IAEA Project on Novel Techniques,* INESAP information bulletin no. 27, December, pp. 27–30.
20. See Martin B. Kalinowski, Heiner Daerr and Markus Kohler, 2006, *Measurements of Krypton-85 to Detect Clandestine Plutonium Production*; Martin B. Kalinowski, Johan Feichter and Ole Ross, 2006, *Atmospheric Krypton-85 Transport Modeling for Verification Purposes,* both published in INESAP information bulletin no. 27, December.
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23. Portable neutron generators are available that are small and light enough to be carried by one person (see Fetter and Oelrich, op. cit.).
24. Fetter and Oelrich, op. cit.
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29. Committee on International Security and Arms Control, 2005, op. cit., Executive Summary.
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