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Briefing
Paper

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Beyond technical verification

prepared for
NPT PrepCom
Geneva, 1998

sponsored by the
Nuclear Age Peace Foundation

Briefing Paper

Beyond technical verification

Transparency, verification, and preventive control
for the Nuclear Weapons Convention

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1. Critical issues in verification and enforcement of a Nuclear Weapons Convention

The Nuclear Weapons Convention (NWC) needs to foresee a number of provisions which help to create the necessary confidence that the elimination of nuclear weapons is complete and will not be reversed.¹ The critical issues in verification and enforcement of the NWC are the following basic obligations:

1. No nuclear weapons or relevant nuclear material may be held back and hidden in the current nuclear weapons states. The existing arsenals of nuclear weapons need to be disarmed completely. No single nuclear warhead and not one significant quantity of nuclear-weapons-usable material may be retained. In addition there should be no hidden inertia of the whole nuclear weapons production system.

2. No break-out of the ban to develop or manufacture nuclear weapons should happen in any country.

a) The nuclear weapon needs to be "disinvented" to the degree achievable. First of all the whole infrastructure of the now existing nuclear weapons complex has to be dismantled. No research for or testing of nuclear weapons should be conducted. The nuclear weapons expert knowledge should not be intentionally maintained, in particular the important specialised personal knowledge directly related to the design of weapons. By that way the threshold against reinvention of nuclear weapons can be significantly increased. Dual-use science and technology which is perceived as too important for civilian purposes to be banned has to be put under control.

b) In any country which conducts nuclear power or nuclear research programs a possible break-out to divert nuclear materials for nuclear weapon purposes needs to be prohibited and timely detection of any related activity is desired. Thus nuclear-weapon-usable materials should neither be produced for weapon purposes nor removed from existing stocks. Step-by-step, existing stocks have to be reduced down to zero.

3. No intention to acquire nuclear weapons should remain or have a reason to come up again. Evidence needs to be provided that nuclear weapons are inherently negative and the conviction should prevail that the possession of nuclear weapons is undesirable.

It is questioned whether these obligations can be enforced universally and forever and whether compliance can be satisfactorily verified.

Technical verification of a NWC would need to focus on monitoring a wide range of nuclear-weapons objects (nuclear warheads and components, nuclear materials, equipment, facilities, delivery systems, command & control) and nuclear-weapons activities (research, development, testing, production, acquisition, deployment, stockpiling, maintenance, transfer, use, threat of use, destruction, disposal, conversion) and their combination. These include, in particular, dismantlement of nuclear weapons; disposal of nuclear material; conversion or destruction of certain nuclear facilities; monitoring the location and status of nuclear weapons, nuclear material, nuclear facilities, delivery systems, and command and control systems to insure that they are not used for research, development, testing, production, transport, deployment or use of nuclear weapons. Other

prohibited activities would include storage, transfer and handling of nuclear weapons and fissile material.²

2. The technocratic approach

Advocates of an overly technocratic approach could pose the following demands on a technical verification system in relation to the above given critical issues of the NWC:

1. The baseline verification of the NWC needs to detect any single nuclear weapon and any significant quantity of nuclear-weapons-usable material that has been hidden at any place in the world. The whole earth would have to be scanned by helicopters which are equipped with neutron detectors. In addition, any basement in which plutonium can be handled needs to be closed or put under strict and international inspection.

2. a) Any physical knowledge that is somehow related to nuclear weapons has to be eradicated from text books and computer files. Former weapon designers need to be put under arrest. Dual-use science and technology is either banned or put under control by inspectors who need to have a basic understanding of nuclear weapons technology and therefore are under arrest as well.

b) Diversion of nuclear energy for nuclear weapons purposes has to be principally disabled. Should it occur,

i) the operation of a clandestine facility would emit certain signatures that have to be observed and identified without error from satellite or by a global radioactive monitoring network and

ii) nuclear material accountancy needs to work on a digital basis without measurement errors and would detect any removal from existing stocks in real time.

This caricature of an overly technocratic approach towards NWC verification, reminding of George Orwell's 1984 vision, makes it clear that a perfect and complete technical verification system is neither achievable nor desirable. In many cases statements about verification problems are instrumentalised as arguments against the near term goal of a NWFV. In order to be able to make well founded judgements about the feasibility of a NWFV one needs to take a close look at the limits and capabilities of technical means for verifying and enforcing a NWC.

3. Technical capabilities and limits

The question of capabilities and limits of technical verification always depends on the degree of political demands. For example the main purposes of nuclear safeguards on special nuclear materials as fore-

seen in the Non-Proliferation Treaty (NPT) are timely detection of and deterrence against diversions of significant quantities of these materials. I.e. the nuclear safeguards are not designed in a way to prevent diversion of such materials, but to deter from diversion by the risk of detection. Diversion remains always a technical possibility. With respect to a nuclear-weapon-free world such a political goal may change. The demand may be posed that compliance with treaty obligations is not only verified with a high probability of detection but also rendered impossible especially through a strict reduction of the availability and accessibility of nuclear-weapon-usable materials.

The experiences with clandestine nuclear weapons programs in Iraq and other countries call for very strong and efficient verification as long as nuclear installations using, producing or storing significant amounts of nuclear-weapons-usable materials are existing. The 93+2 program of the IAEA resulted in a number of improvements which strengthen the effectiveness and improve the efficiency of the nuclear safeguards system. But there are still deficiencies. Especially, it is not clear whether the goal of universality can be achieved, since the signing of the new protocol is voluntary.

One significant criticism of the current nuclear safeguards system refers to the problem that large amounts of material unaccounted for (MUF) will inevitably occur at any large bulk handling facility like reprocessing plants for spent fuel elements. This problem is exemplified drastically with the publication of the US plutonium inventory for the first 50 years. While there is a current stockpile of about 100 tons of plutonium, the amount of not less than 2,8 tons of plutonium is unaccounted for. This is enough material for hundreds or even a thousand nuclear weapons. This raises a big concern. Will we ever have the chance to get enough confidence that no nuclear-weapons-usable material is hidden by any country which now possesses large amounts of such materials, even if we can apply the most sophisticated methods of nuclear archaeology as Steve Fetter called it? Such methods are used to reconstruct the past production history by investigating traces which are characteristic for the relevant past activities at production facilities and by doing model calculations.

The experience of the International Atomic Energy Agency (IAEA) in verifying South Africa's nuclear inventory and the termination of its weapons program is of high value for developing and evaluating the framework for verification of complete nuclear disarmament within the Nuclear Weapons Convention. By comparing calculations

with physical inventory measurements, apparent discrepancies indicated that an amount of enriched uranium-235 was unaccounted for. Though extensive examinations were able to significantly reduce the magnitude of these apparent discrepancies, the IAEA had to conclude that the assessment of the completeness of South Africa's inventory of nuclear materials is not free from uncertainty. Nevertheless, the international community is satisfied with the result of the investigations which led to the conclusion that there were no indications to suggest that the initial inventory is incomplete or that the nuclear weapon program was not completely terminated. This positive conclusion is only possible because of the openness for transparency and the cooperation of the South African authorities with respect to access to information and locations in the past as well as in the future for the case of further investigations that the IAEA might wish to undertake.

On a more negative note, the current developments for laboratory testing and computer simulation are reducing the possibilities to drive back the knowledge about nuclear weapons. With the improved simulation technology, a development is enabled that is highly undesirable from the standpoint of the goal of a nuclear weapons free world. At the end of an era of comparably primitive trial and error, a scientific revolution is now being initiated, which is supposed to deepen the theoretical understanding of nuclear weapons. In addition the systematic conservation of the knowledge relevant for nuclear weapons is enforced independently of the experience of the retiring nuclear weapon scientists and testers. With that going on unrestricted, it is in the future going to be more difficult to disinvent sophisticated designs of nuclear weapons.

The Model Nuclear Weapons Convention bases many of its verification procedures on those employed in other treaties including the START and INF treaties, CTBT, IAEA safeguards under the NPT and the Chemical Weapons Convention (CWC). Such verification systems need to be evaluated with regard to the question how they could be encompassed into a Nuclear Weapons Convention. In addition, a number of new approaches is required. For example, on-site inspections have to be foreseen to search for hidden warheads and related materials and to verify the shut-down of declared facilities. Challenge inspections are necessary to search for clandestine activities. Remote and wide-area monitoring becomes a vital element of the verification regime as soon as the relevant production facilities are shut down and dismantled, especially if only a few

Means of technical verification for a NWC

1. Technologies which are already implemented in existing treaties within the nuclear disarmament and verification regime

- Nuclear material accountancy, limited by Materials Unaccounted For (NPT)
- Containment and surveillance of nuclear materials (NPT)
- Identification and item counting of objects by tagging, fingerprinting, registration (NPT and others)
- Personal observation of suspected activities and destruction (NPT, INF, START)
- Remote sensors in the visible spectrum based on satellites (INF, START)
- On-site sensors for non-destructive characterisation of containers and transport vessels, e.g. for portal perimeter monitoring; measurement of weight, length (INF, START)
- Seismological, radionuclide, hydro-acoustic and infrasound monitoring (CTBT)
- Challenge inspections of suspected facilities without any restrictions, i.e. anytime and anywhere, limited by political acceptability and costs (UNSCOM)

2. Technical approaches which are established in other international regimes and can be adopted for the NWC

- Preventive controls at nuclear facilities (Convention on Physical Protection)
- Joint overflights with remote sensors in the visible spectrum (Open Skies)
- Managed access (CWC)

3. Technical means which are already developed or demonstrated, but not yet implemented in any international control regime

- Accounting, surveillance and containment of nuclear warheads, limited by access
- Verification of dismantling of nuclear warheads, limited by the interest to protect sensitive design information
- Remote sensors in the infra-red or radar spectra based on satellites, aircraft or on the ground
- Passive radiation measurement, active irradiation using x-ray, gamma ray, beta particles, protons or neutrons, limited by free mean path depending on shielding of nuclear radiation (e.g. Black Sea experiment for the detection of hidden warheads)

4. Technological options which need further research, development or demonstration of their capabilities and limits, before they can be adopted for the NWC

- Wide area radionuclide monitoring to detect uranium enrichment or plutonium separation (e.g. krypton-85)
- Nuclear archaeology to reconstruct the working history of production reactors

sites remain to be inspected and efforts are more concentrated on detecting clandestine facilities and activities. For example atmospheric concentrations of krypton-85 can be used to get indications for clandestine plutonium separation.

The box entitled „*Means of technical verification for a NWC*“ gives four categories of different readiness of verification technologies and provides a few examples for each of these categories. From this, it becomes apparent that most verification technologies which are required or proposed by the Model Nuclear Weapons Convention are already implemented in existing treaties within the nuclear disarmament and non-proliferation regime. Some others are established in other international regimes and can be adopted for a NWC. In addition, there are further technological means which are already developed or demonstrated, but which are not yet implemented in any international control regime. Only very few verification technologies which may be helpful or necessary to verify a NWC are not yet developed or proven to work sufficiently. However, it has to be noted that most technologies have inherent deficiencies and need to be evaluated on a critical basis. Some of these technical limits are mentioned in the box on „*Means of technical verification for a NWC*“. Also, the finding that most technical means which are of use for the verification of a NWC are already existing does not imply that these means are covering satisfactorily all verification demands.

To admit that there are limits of technical verification must definitely not lead to the pessimistic view, that a NWFV and an irreversible path aiming at that goal is not verifiable. Instead, the political consequence of this merely technically induced evaluation is to find strategies to increase the barrier against a first or renewed access to nuclear weapons.

4. Political consequences of verification limits

From the previous analysis it becomes clear that the verifiability of a NWC depends on political assumptions and requirements as well as the available resources and capabilities for verification, which are not only technical. A bargaining process is necessary between political demands and technical capabilities. If political demands increase, the technical solution may become more expensive. If technical or economic limits for introducing advanced or improved verification means are reached, political demands have either to be cut back or need to be satisfied by non-technical measures. For example more intrusive measures of physical protec-

tion and control can be introduced which go beyond verification of compliance with treaty obligations.

Given their limits, verification of a Nuclear Weapons Convention would not only rely on technical measures. A number of means and procedures can be applied to detect clandestine objects and activities and clarify critical questions, including various monitoring technologies (remote and on-site sensors); cooperative procedures for information exchange, inspections and safety controls; and institutional verification and societal verification (see box entitled „*Main elements for integrated verification and implementation of a Model NWC*“). How well these elements can be integrated into a coherent and effective verification system for a Nuclear Weapons Convention requires further examination.

Preliminary consequences can be outlined as follows:

1. The boundary conditions under which a NWFV is achievable and sufficiently verifiable as well as enforceable can be identified.
2. Many verification technologies and strategies are already in place which can serve the transformation process to a NWFV.
3. Advanced technical means have already been or can be developed with the capability to improve verification procedures and to fill some gaps. Besides of established verification systems new tasks are demanding new verification approaches in the nuclear field.
4. However, technical means have all their specific inherent limits. Therefore, approaches going beyond purely technical means are of importance. Creating transparency and openness and societal verification will play a crucial role.
5. Safeguards on nuclear materials need to be replaced by an integrated approach of minimisation, verification and physical protection without national access to any significant quantity of nuclear-weapons-usable materials. This integrated approach is named preventive control by the model NWC. In a more idealistic picture all weapons-usable materials are banned from the world.

A further evaluation of technical verification and enforcement has to be guided by the following questions:

- What kind of weapon-sensitive activities and material inventories are convincingly verifiable, today and probably in the future? What seems to be not or only insufficiently verifiable? To what extent have nuclear safeguards to be replaced by measures of preventive control?

● What kind of new and promising verification technologies could be supported in the future? Which deserve further research or demonstration?

● How could a proliferation resistant use of nuclear energy and research be organised? To what extent has the renunciation of specific nuclear activities to be suggested and what kind of activities have to be banned on an international level? How could or even must the use of specific nuclear technologies (and research) be organised in a way that enables safeguards and verification means (reflecting their inherent technical limits) to function convincingly in detecting illegal activities at an early stage?

● In which cases and under what conditions are societal or citizens verification conceivable and advisable for completing the technical approach? By which means can public transparency on nuclear disarmament down to zero and on effective efforts against nuclear proliferation be achieved?

References

[1] As a reference see the model Nuclear Weapons Convention presented on April 7, 1997 in New York. The complete text can be ordered from LCNP or from IANUS/INESAP (see the authors' addresses). An Executive Summary was published as a supplement to the INESAP Bulletin No.13, July 1997.

[2] A number of articles on nuclear disarmament verification, including related references, can be found in the special issue of the INESAP Information Bulletin No.14, November 1997.

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Main elements for integrated verification and implementation of a Model NWC

1. *Registry and International Monitoring System:* The Registry would maintain a list of all nuclear warheads, delivery vehicles, facilities and materials subject to verification, based on nuclear archaeology. The International Monitoring System is to enable the Agency to gather information necessary for the verification of the NWC and would comprise facilities and systems for monitoring by satellite, fixed on-site sensors, remote sensors, radionuclide sampling, means of communication and other systems.

2. *On-site inspections and techniques:* This would include both systematic, baseline inspections and challenge inspections (anytime-anyplace) of declared and undeclared facilities, utilising a range of techniques, including visual inspection, record checks and non-destructive measurement and could be assisted by identification techniques.

3. *Preventive Controls:* Preventive Controls are broader than IAEA safeguards, which are primarily intended to deter diversion of nuclear materials through detection of such diversion once it has taken place. They would concentrate on prevention of diversion through physical protection and restricted physical access to nuclear weapons usable material. Preventive controls may include the establishment of procedures for transport, treatment, storage and disposition of such materials. By banning the technologies for production of direct-use nuclear materials such as the reprocessing of spent fuel and by imposing other appropriate provisions the available quantities of these materials are minimised. The inventories of these materials should be eliminated under international control as far as possible or converted into a physical form that minimises access.

4. *Organisational verification and the implementing Agency:* To implement the NWC and oversee the nuclear disarmament process, the model NWC proposes an international agency, different from the IAEA. Its primary objectives include containment and surveillance of all materials, equipment, or facilities that could contribute to the development, production, or maintenance of nuclear weapons.

5. *Transparency, confidence-building, cooperation:* The model NWC makes transparency and education obligatory, in response to the argument that nuclear weapons technology and knowledge cannot be disinvented. The idea is to promote scientific responsibility and greater public awareness of the link between nuclear science and weapons development. Confidence-building could include bilateral agreements on reciprocal monitoring and information sharing between States. Consultation, cooperation and fact-finding should help to clarify and resolve questions of interpretation with respect to compliance and other matters. Dispute settlement includes negotiation, mediation and referral to regional agencies or to the International Court of Justice.

6. *Societal verification:* In addition to the governmental tasks of verification, new possibilities of societal verification are to be created which provide citizens of all states with the right and the obligation to indicate suspected nuclear weapons activities. This would substantially extend the basis of information and would be a contribution to the protection and creation of democratic rights in all parts of the world. NGOs could play an important role in this process.

Past work of INESAP and the proposed study „Beyond technical verification for the Nuclear Weapons Convention“

The International Network of Engineers and Scientists Against Proliferation (INESAP) was founded in 1993. Two years later, INESAP presented the document „Beyond the NPT - a Nuclear-Weapon-Free World“ during the NPT 1995 Review and Extension Conference. With this INESAP looked into the future and laid the groundwork for discussions about a Nuclear Weapons Convention (NWC). The drafting group for the model NWC was convened by the Lawyers Committee on Nuclear Policy (LCNP) together with INESAP. On the occasion of the first Preparatory Committee meeting for the year 2000 Review Conference for the Nuclear Non-Proliferation Treaty (NPT) in New York (April 7 to 18, 1997) INESAP participated in the launching event for the model NWC.

This year, INESAP proposes to start a new study process, tentatively entitled „Beyond technical verification: Transparency, verification, and preventive control for the Nuclear Weapons Convention“. The main purpose of this proposed study is to increase awareness concerning the scientific-technological constraints and boundary conditions for a way leading to a nuclear-weapon-free world. It will illuminate the verification needs and limits and it will stress especially the importance of transparency. Assumed but not necessary is a comprehensive approach which carries the Nuclear Weapons Convention as the central element. Currently much attention needs to be paid for identifying ways how the current deadlock in nuclear disarmament and non-proliferation at the Conference on Disarmament (CD) can be overcome. The preliminary ideas and political conclusions of this study are presented in this paper.