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Verification at low/zero levels of Nuclear Weapons: What will it take?

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Introduction

The verification and compliance regime for a nuclear weapon-free world will need to be more effective than any disarmament regime hitherto envisaged. One hundred per cent verification of compliance with any international arms agreement is highly improbable. However, in the case of nuclear disarmament the security stakes will be so high that states will not agree to disarm and to disavow future acquisition of nuclear weapons unless verification reduces to a minimum the risk of non-compliance.

Similarly, the compliance mechanism must be as compelling as possible, providing a high degree of assurance that any violation will be dealt with firmly and effectively. Both the verification and compliance systems must be able to cope with the most feared threat to complete nuclear disarmament – breakout – where a state party is suddenly revealed to have a previously hidden nuclear arsenal or to have produced new weapons.

Meeting these requirements is a tall order, but not an inconceivable one. For a start, a verification and compliance regime for total nuclear disarmament will not be constructed from scratch. It will build on the practical experience of the disarmament process as it moves towards zero and draw on yet unforeseen developments in the information and technology revolutions. Moreover, the same conjunction of good relationships between major states that will permit the negotiation of a nuclear disarmament treaty will necessarily overcome many of the obstacles, which today seem insurmountable, to the construction of an appropriate verification and compliance system.

What are verification and compliance?

Verification is the process of gathering, analysing and using information to make a judgement about compliance or non-compliance with an agreement. A compliance mechanism is a process for taking action on the basis of a verification judgement. The aim of verification is to increase confidence that a treaty is being implemented fairly and effectively. It does this by:

- providing compliant parties with the opportunity to convincingly demonstrate their compliance;
- detecting non-compliance; and thereby
- deterring parties that might be tempted not to comply.

The effectiveness of verification is a function of the scope of the treaty concerned, the monitoring mechanisms, techniques and technologies used, the credibility of the compliance arrangements and the political and strategic environment in which the treaty operates.

Verification procedures, techniques and technologies

An array of procedures, techniques and technologies that would be used to verify complete nuclear disarmament has already been identified, researched and evaluated. In some cases they have been already implemented, especially in relation to US/Russian bilateral nuclear arms limitations, the nuclear test ban and nuclear safeguards. Continuing research is needed to ensure that the latest technological advances are incorporated and promising avenues pursued. The long-term aim should be to preclude verification from becoming a negotiating obstacle once the political will to achieve nuclear disarmament emerges.

Dismantlement and destruction of declared weapons

Presumably, by the time the transition to complete nuclear disarmament is imminent, the US and Russia will have reduced their arsenals below 1,000 warheads each through a continuing Strategic Arms Reduction Talks (START) process, non-strategic reductions and limitations and/or unilateral measures. Their remaining weapons are all likely to be considered strategic: tactical weapons, those for battlefield use, will have to have been prohibited and the ban subject to verification (itself a highly challenging undertaking which will set precedents for intrusive verification).[1] Depending on the size of the remaining US and Russian arsenals, the lesser nuclear weapon states (China, France, India, Israel, Pakistan and the UK), all of them by this stage declared, will either have joined in the process or be ready to. The remaining weapons, as zero is approached, will certainly no longer be on alert status or deployed on missiles or aircraft, but kept in secure storage.

The first task of any verification system for a nuclear weapon-free world once this stage is reached will be to verify the dismantlement and destruction of all remaining weapons. This would begin with each possessor state submitting to an international verification organisation (the nature of which remains to be determined) a declaration giving a detailed inventory of its remaining weapons and weapons-grade fissionable material and their location. The weapons and materials would be placed, if this had not already been done, in sealed containers with a unique tamper-proof tag and seal affixed to each warhead and container. Any untagged items subsequently discovered would constitute a treaty violation. The containers would be stored in secure identifiable locations, sometimes referred to as ‘bonded store’, well away from any potential delivery systems.[2] After declarations had been made, these sites would be monitored permanently by international and national on-site inspectors, supplemented by a range of sensors directly linked by satellite both to the national and international verification organisation. Such a system would be the starting point for verifying the dismantlement and destruction of the weapons. (Some experts have suggested pooling all remaining weapons into a single site under international auspices, although this may be considered a step too far by some nuclear weapon states and too tempting a target for a state with a secret cache of remaining weapons).

1 For some states, such as Israel, India and Pakistan, whose likely intended targets are relatively close, warheads designed for short-range systems would be considered ‘strategic’ for arms control purposes.

2 The following is adapted from Tom Milne and Henrietta Wilson, ‘Verifying the Transition from Low Levels of Nuclear Weapons to a Nuclear Weapon-Free World’, *VERTIC Research Report*, no. 2, June 1999, p. 17 ff.

Before destruction could begin, the contents of the bonded stores would require authentication to prove that they were not fake. This would have to be done without revealing sensitive design information, particularly to international inspectors from non-nuclear weapon states. Research is underway in the US and UK[3] into infallible authentication techniques based on measurement of radiation emissions and other characteristic signatures.[4] 'Fingerprinting techniques' can be used to determine that weapons purportedly of the same type are in fact identical in composition and manufacture.[5]

After authentication, chain-of-custody procedures, like those developed for the 1987 Intermediate-range Nuclear Forces (INF) and the START I and II treaties (1991 and 1993), could be used to monitor the transport of the items to destruction/disposition sites; to verify the dismantling and destruction of weapon components; and to ensure that weapons-grade fissionable material is placed under international safeguards.

As Tom Milne and Henrietta Wilson note, it is conceptually simple to design a dismantling facility with one entrance and one exit. International inspectors would not have access to the inside of the facility, where national personnel would carry out the dismantlement. However, the warheads would be monitored entering the facility and correlated with the warhead 'pits' (reformed into shapes that have no security classification) and other components and materials as they came out through the exit. The pits would be placed under international safeguards and removed to internationally monitored storage facilities to await final disposition.[6]

Restrictions on delivery systems

By the time the transition to zero occurs there will presumably be much more stringent limitations or even outright bans on different types of delivery systems - strategic bombers, ballistic and cruise missiles and nuclear-armed submarines - in place between Russia and the US. These will need to be extended to the other nuclear weapon possessors. If outright bans are impossible to negotiate, specific numbers of delivery systems may be permitted for conventional weapon delivery purposes, or in the case of ballistic missiles for space launch purposes, although such exceptions would make verification more difficult. However, since a great deal of experience has already been and will be further accumulated with regard to verifying numbers of deployed strategic bombers and ballistic missiles, universal restrictions or bans on these items could be verifiable with a high degree of confidence. Intrusive on-site inspections in port could ensure that submarines were no longer nuclear-armed.

Banning other delivery systems is more problematic. Non-strategic aircraft can be used to deliver nuclear weapons. Any cruise or short-range missiles permitted for conventional purposes in a nuclear weapon-free world could be relatively easily converted for nuclear use. Similarly, non-conventional means of delivering nuclear weapons (such as in a suitcase or the hold of a ship) would be as impossible to control and verify as they are today. This makes even more important the need for an effective verification system regarding nuclear warheads themselves.

3 For information on the nuclear verification research programme of the UK's Atomic Weapons Establishment at Aldermaston see Gary George and Martin Ley, ''Nuclear warhead arms control research at the AWE', *Verification Yearbook 2001*, VERTIC, London, 2001.

4 See Oleg Bukharin and Kenneth Luongo, 'US-Russian Warhead Disarmantlement Transparency: The Status, Problems, and Proposals', Princeton University/Center for Energy and Environmental Studies (PU/CEES) report no. 314, April 1999.

5 Theodore B. Taylor and Lev P. Feoktistov, 'Verified Elimination of Nuclear Warheads and Disposition of Contained Nuclear Materials' in Francesco Calogero, Marvin L. Goldberger and Sergei P. Kapitsa (eds), Verification: Monitoring Disarmament, Westview Press, Boulder, Co., 1991.

6 Milne and Wilson, p. 21.

Prevention of diversion of fissionable materials to new nuclear weapons production

Since it is highly unlikely that all use of nuclear materials will be banned in a nuclear weapon-free world, there will continue to be a need for a strong regime of nuclear safeguards to prevent diversion of nuclear materials from peaceful uses to weapons. Such a system would be based on, but be even more stringent than, the strengthened safeguards system currently being implemented by the International Atomic Energy Agency (IAEA).

A safeguards system in a nuclear weapon-free world would need to cover all nuclear material worldwide (civil and military), including all weapons-usable nuclear material, whether in reactors, stockpiles or extracted from dismantled weapons. The amount of material and number of facilities requiring safeguards would therefore increase substantially, compared with today. If weapons-usable materials (plutonium and Highly-Enriched Uranium (HEU)) continued to be permitted for peaceful purposes, primarily in nuclear power and research reactors, the verification task would be much greater than if nuclear reactors were permitted to use only Low-Enriched Uranium (LEU).

In addition, if HEU continued to be used in naval propulsion, special arrangements would need to be made to bring such material under nuclear safeguards. Safeguards should also be extended to uranium mining and milling (currently they only begin when uranium is converted to 'yellowcake', a form suitable for fuel fabrication or enrichment) to ensure that all sources of new fissionable material are accounted for.

Other ways in which safeguards would have to be further strengthened include increasing the intrusiveness of inspections, lowering the quantities and increasing the types of nuclear materials requiring declaration and inspection, and increasing the intelligence and data-handling capacities of the international verification organisation.[7] Some of the most important measures would be the following:

- The current 'significant quantity' of weapons-usable material considered necessary for producing a nuclear weapon (8 kilograms of plutonium or 25 kilograms of HEU) would have to be lowered to provide greater reassurance.
- Other nuclear materials recently identified as weapons-usable would have to be accorded their own standards.
- The standard for 'timely detection' would also have to be revised downward from months to weeks, since former nuclear weapon states could convert diverted material into a fabricated weapon more quickly than non-nuclear weapon states to which the current standard applies.
- All nuclear facilities, whether operating or decommissioned, would have to be monitored continuously and the data transmitted in real-time to the verification headquarters by satellite link.
- Intelligence information of the highest quality would have to be available to the international verification organisation.
- Permanent environmental monitoring, especially around nuclear and nuclear-related facilities, would have to be undertaken, to detect normal as well as accidental releases into the environment
- Import/export regimes will need to be multilateralised, strengthened and universalised.

Finally, the international verification organisation will need the right to conduct virtually no-notice 'anytime, anywhere' inspections of any suspect site, an even more intrusive system than that envisaged for the Organization for the Prohibition of Chemical Weapons (OPCW) under the Chemical Weapons Convention

7 Adapted from Steve Fetter, 'Verifying Nuclear Disarmament', Occasional Paper, no. 29, The Henry L. Stimson Center, Washington DC, Oct. 1996.

(CWC).

Timely detection of research, development and manufacture of new nuclear devices

This will be one of the most difficult verification tasks in a nuclear weapon-free world, since the facilities required for these activities, unlike those for the illicit production or diversion of fissionable materials, are relatively small and may be relatively easily hidden. Illicit new production is unlikely to be done at old facilities, but at new, specially designed facilities underground or at remote locations.

While random and challenge on-site inspections, aerial monitoring through a co-operative open skies inspection regime and satellite imagery (from an internationally-controlled satellite system) may reduce the risks and increase the costs of such activities to an actual or potential violator, it is difficult to conceive of systematic verification techniques to completely guarantee the detection of such violations.

The possibility of detection may however be enhanced through two means that are external to the formal verification system. One is so-called national technical means (NTM), which refers to verification and monitoring capabilities under individual state control and which include satellite monitoring, electronic eavesdropping, information-gathering and espionage. These will all continue and perhaps intensify in a nuclear weapon-free world. Many states will require the additional assurance that national systems can provide before ratifying a nuclear disarmament convention. While data from such systems may be manipulated and used in a self-serving fashion or be misused politically within the state concerned, such possibilities would be attenuated in a nuclear weapon-free world by the existence of a strong multilateral system with its own independent data collection and analysis capabilities.

The second complement to the official verification system is 'societal verification', which employs civil society, including non-governmental organisations, professional organisations (such as academics, scientists and engineers) and individuals, to monitor the activities of governments and if necessary 'blow the whistle'.[8] A nuclear weapons convention should make specific mention of and provision for societal verification. While one could not rely completely on such methods, they certainly add to the complexity of the task facing any would-be violator. Organised societal verification is most feasible in open societies, but even closed societies or open societies with secretive programmes have difficulty in preventing defectors and others from leaking national security information. The cases of Mordechai Vanunu in regard to the Israeli nuclear arsenal, Kamal Hussein in relation to Iraq's biological weapons programme and various Russian defectors and 'whistle-blowers' are instructive. Cheap and ready access to satellite imagery[9] and the instantaneous capabilities of modern communications greatly increase the possibilities for non-governmental organisations to participate in verification activities.

Components of a verification and compliance regime

The official verification capabilities will likely be organised and managed by a dedicated verification and compliance regime established by and for a nuclear disarmament convention. A Model Convention on the Prohibition of the Development, Testing, Production, Stockpiling, Transfer, Use and Threat of Use of Nuclear Weapons and on their Elimination has already been drafted, one version of which was submitted by Costa Rica to the UN General Assembly in 1997.[10] The regime will be elaborate, intrusive and expensive (compared with current multilateral disarmament agreements, but not compared with the cost of maintaining nuclear arsenals). While the specifics of such a regime are necessarily speculative, standard verification and

8 See Dieter Deiseroth, 'Societal verification: wave of the future?', *Verification Yearbook 2000*, VERTIC, London, 2000.

9 See Bhupendra Jasani, 'Remote monitoring from space: the resolution revolution', *Verification Yearbook 2000*, VERTIC, London 2000.

compliance models for international disarmament agreements are likely to be emulated. The following outline is based on an assumption that there would be a single, universal nuclear disarmament convention which would supersede the Nuclear Non-Proliferation Treaty ((NPT), the Comprehensive Nuclear Test Ban Treaty (CTBT) and other nuclear-related treaties.[11]

A Conference of States Parties

This would comprise representatives of all states parties. Given the importance of nuclear disarmament to all states and the breakout danger, membership will need to be universal. The conference would be the ultimate decision-making body for the treaty, responsible for its overall effectiveness, including compliance by all states parties. The conference would be able to recommend amendments to the treaty, which in this case would have to be binding on all parties. It would be impossible to envisage a nuclear disarmament treaty with selective adherence by states parties to amendments.

Executive Council

This would be a standing body, comprising a representative selection of states parties, which would be responsible for day-to-day decision-making about the operation of the treaty, particularly its verification and compliance mechanisms. Constantly alert to potential non-compliance with the treaty, it would receive a steady stream of virtually real-time reports from the treaty secretariat based on information from the treaty verification and monitoring system. This would permit the Council to make judgements about compliance and non-compliance. It would also have the power to demand clarification from any state party and an immediate on-site inspection anywhere on the territory of any state party. The Council would ultimately have the power to recommend action in the case of non-compliance, including by referring the matter to the UN Security Council. Finally, the Executive Council could order improvements or adjustments to be made to the verification system as necessary.

All the current nuclear weapon states (both declared and non-declared) would need to be permanent members of the Executive Council, as presumably would all states with a significant 'virtual' nuclear weapon capability (that is, the ability to manufacture a nuclear device within a short period by virtue of their industrial and non-military nuclear capabilities and assets[12]). All these states would need to be closely involved and have a strong sense of 'ownership' of the regime, since, unlike other disarmament agreements, the existence of only one treaty 'holdout' would completely defeat the treaty's purpose. Hence the Council would be a large body, perhaps needing a small executive sub-organ to make routine decision-making more efficient.

An Organization for the Prohibition of Nuclear Weapons (OPNW)?

Some such body would be required to establish, administer and operate the international verification and monitoring system for the treaty. It would be staffed by international civil servants and scientific and technical experts and be headed by the equivalent of a Director-General. It would presumably include a large technical secretariat, which would manage the verification system, and an international inspectorate responsible for on-site inspections. A scientific advisory board would also be indispensable. As well as a

10 See UN document A/C.1/52/7 and draft convention in Merav Datan and Alyn Ware, *Security and Survival: the Case for a Nuclear Weapons Convention*, International Physicians for the Prevention of Nuclear War, Washington DC, May 1999.

11 This would naturally have to be done without damaging these existing treaties (as the CWC was negotiated without damaging the 1925 Geneva Protocol).

12 For a comprehensive discussion of virtual nuclear capabilities see George Paloczi-Horvath, 'Virtual Nuclear Capabilities and Deterrence in a World Without Nuclear Weapons', *VERTIC Research Report*, no. 3, Oct. 1998.

headquarters, the organisation would presumably need regional offices and offices in all of the former nuclear weapon states and virtual nuclear weapon states in order to liase closely with national authorities responsible for compliance with the treaty and for peaceful nuclear activities permitted by the treaty. The organisation would either supersede and subsume the IAEA and its nuclear safeguards system or the IAEA itself would become the organisation responsible for verifying complete nuclear disarmament. This organisation would also absorb the Comprehensive Nuclear Test Ban Treaty Organization (CTBTO), since the detection of clandestine nuclear tests would also be an integral part of the OPNW's verification task.

Arrangements between former nuclear weapon states

In addition to the international arrangements, there are also likely to be extant arrangements between pairs and groups of former nuclear weapon states, which were established to give them additional mutual reassurance as the nuclear disarmament process proceeded towards zero. These could have been designed to endure indefinitely or only until the multilateral system proved its effectiveness. Such arrangements would include those for the bilateral US/Russia nuclear reduction treaties from START I onwards and any similar arrangements between, for example, China and the US, China and India, India and Pakistan and Israel and its neighbours.

Strengthened Security Council

As the likely final arbiter in any compliance dispute (as in the case of other multilateral disarmament agreements), and therefore a vital component of any compliance system for a nuclear weapon-free world, the UN Security Council would need to be reformed. It is inconceivable that the current permanent five members, which are all nuclear weapon possessors, could be permitted to veto action against themselves or any other state which violated a nuclear weapon ban. In addition, all the current nuclear weapon states, declared and non-declared, and all the other major powers, most of which are also capable of acquiring nuclear weapons, would have to be represented permanently on the Council. Hence a mix of nuclear and non-nuclear great powers would comprise the permanent members of the Council, helping de-legitimise nuclear weapons, although necessarily continuing to reflect the actual distribution of power in an inegalitarian international system.[13]

The 'breakout' problem

While all the verification techniques and institutional arrangements described above would aim to prevent and/or deter breakout, it could, nonetheless, occur. Although in the abstract such an event might seem cataclysmic, in reality its impact would depend on the particular circumstances: whether the violator then threatened to use such weapon (or weapons) to coerce a neighbour or the international community generally; the state of readiness and deliverability of the purported weapons; the relative conventional military strengths of the violator and the rest of the international community combined; the willingness of the international community to respond; and the existence of defences against whatever delivery system the violator might try to use.

Potential responses to such an event include not only sanctions against a violator - political, economic and military - but guaranteed mutual assistance in the case of threatened or actual nuclear attack. Missile defences against nuclear attack by ballistic missile and aircraft could decrease the threat for states most concerned about breakout. Perhaps most important would be the residual ability of states to quickly reconstitute a nuclear device or arsenal in order to deter the violator. For the former nuclear weapon states, depending on

13 In addition to the current Permanent Five one could imagine adding, for instance, Brazil, Canada, Germany, Japan, India, Indonesia, Nigeria and South Africa.

how long a nuclear weapon-free world had existed, this might amount to only a month or two. The threat could then be countered, albeit at the risk of re-igniting a nuclear arms race. An alternative suggested by some observers is a small deterrent arsenal under international control, although this would raise command and control difficulties and be incompatible with total nuclear disarmament.

Since the achievement of nuclear disarmament would require consensus among the great powers that their relationships had improved so much as to obviate the need for nuclear weapons, the main threat to a nuclear weapon-free world would be a 'rogue state' which had not previously produced nuclear weapons. In considering such a case one has to ask what might be the motivation for acquiring an illicit nuclear arsenal. If it were to be used for political purposes, presumably blackmail, the existence of the arsenal would have to be revealed, or at least hinted at, thereby alerting the international community to a major violation of the treaty. A 'demonstration shot' would have the same effect (and, humiliatingly, might fail). The possibility of an illicit nuclear weapon being used to alter the course of a major conventional war would be presaged by the outbreak of such a war: efforts would have to be made to prevent any nuclear-capable state being backed into such a corner.

The most worrying scenario would be a 'bolt-from-the-blue' pre-emptive strike by the proverbial madman – a nuclear Hitler. Such a rogue state would already be subject to intensified scrutiny by the verification system, including on-site inspections when suspicions were aroused. Any weapon(s) 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. Such a scenario is of course possible today and in some respects is more likely today given the weakness of existing verification regimes. In the current nuclearised world such an attack is deterred by the certainty of nuclear counter-attack. In a nuclear-free world it would have to be deterred by devastating and increasingly accurate and powerful conventional attack, the credibility of which would be enhanced by mutual guarantees by the great powers to come to any state's assistance were it to be threatened or attacked with nuclear weapons.

These hypothetical scenarios notwithstanding, what is clear is that neither the technology of verification nor the broader verification and compliance system can solve the breakout problem alone. Verification can never provide complete assurance that a small clandestine nuclear arsenal or hidden cache of plutonium will be discovered. What verification can do is to significantly, albeit unquantifiably, reduce the likelihood of breakout occurring through a mix of deterrence and enhanced warning time through early detection.

Necessary precursors for effectively verifying a nuclear weapon-free world

Such a dramatic expansion in the scope and intrusiveness of verification as envisaged above will require an iterative process of increasing transparency and confidence-building over many years. In addition to deep cuts by the two largest nuclear weapon states, the US and Russia, all the other nuclear weapon states will need to be drawn into preparing the necessary precursors for a verifiable total nuclear disarmament treaty.

Nuclear transparency

The sooner transparency can be achieved in relation to numbers, types and deployments of nuclear weapons, delivery systems and holdings of special nuclear materials, the earlier and deeper can confidence be implanted. Transparency about past production of fissionable materials will be particularly challenging since, even with the best intentions, it will be virtually impossible for any nuclear weapon state to give a completely accurate account. The experience of the IAEA in verifying South Africa's account of its past production, even with a high degree of co-operation from the South African authorities, is salutary.

Documentation of past production ('nuclear archaeology') must begin now, while any glaring discrepancies discovered are not strategically significant and potentially destabilising.

Confidence-building measures

These should include exchanges by the nuclear weapon possessors on the acceptability of various intrusive verification techniques and growing familiarity with each other's nuclear establishments and facilities through exchanges of visits and co-operative monitoring ventures. This process is likely to begin with the US, UK, France and Russia, but needs to be quickly extended to China, India, Pakistan and Israel.

Deepening experience with nuclear and other verification regimes

A key precursor of a verification system for nuclear disarmament will be the US and Russian experience of verifying deep cuts in START III and beyond, building on their already extensive bilateral experience in verifying the INF and START I and II treaties. The lessons need to be shared with all nuclear weapon states. Multilateral experience in verifying the CWC, the Biological and Toxin Weapons Convention (BTWC) and CTBT, in which all states may participate, will also be germane, particular in regard to on-site inspections and the operation of global multilateral monitoring networks. Valuable lessons have already been learned, including that on-site inspections can be managed in a way that does not reveal security or commercial proprietary information and that some of the concerns that states have prior to negotiating intrusive regimes fall away once implementation occurs and experience grows.

Research and development

Currently the vast bulk of research into verification procedures, techniques and technologies is conducted in the United States. Other nuclear weapon states need to establish their own programmes, not only because they need to be convinced of the capability of various standard verification techniques, but also because they could develop innovative techniques and technologies themselves. The non-nuclear weapon states should also be encouraged to conduct such research, as they did in the case of the CWC and CTBT.

Conclusion

An impressive and reliable verification system can, even on the basis of current knowledge, be constructed to verify with high, albeit unquantifiable, certainty that all parties to a universal nuclear disarmament treaty are complying with their obligations. Verification can increase the risks of detection and consequent political costs to any potential violator, extend the warning time to permit responses to be mounted, as well as fostering mutual trust and confidence among the parties.

The path to such a world, clearly different from our own, but not impracticably idealistic, is an iterative one, through increasing transparency, confidence-building, an evolving attitude towards the utility of nuclear weapons, growing experience with verifiable interim steps towards nuclear disarmament and the gradual involvement of all the nuclear weapon states, both declared and undeclared.

Yet there can be no foolproof guarantee against unexpected 'breakout' through the retention of hidden stocks or the manufacture of new ones. This scenario must, however, be seen not just in the context of the verification and compliance systems established specifically for a nuclear disarmament treaty, but in the evolution of the international system between now and then. States will have to have made significant changes in their attitudes towards the limits of sovereignty, the rule of international law and the governance of the international system, particularly in regard to enforcement, for nuclear disarmament to be negotiated.

The attainment of a nuclear weapon-free world is so dependent on such changes that we will only be able to judge its verifiability as we become seriously engaged in moving towards that world. In doing so we need to ponder whether a world with seven declared, one undeclared and numerous potential nuclear weapon states is safer than a denuclearised world with a strong international verification system and the remote chance of nuclear 'breakout'.

Further Reading

- VERTIC's four 'Getting to Zero' reports (1998-1999):
  Patricia Lewis, 'Laying the Foundations for Getting to Zero: Verifying the Transition to Low Levels of Nuclear Weapons', *VERTIC Research Report*, no. 1, Sept. 1998.
  Tom Milne and Henrietta Wilson, 'Verifying the Transition from Low Levels of Nuclear Weapons to a Nuclear Weapon-Free World', *VERTIC Research Report*, no. 2, June 1999.
  George Paloczi-Horvath, 'Virtual Nuclear Capabilities and Deterrence in a World Without Nuclear Weapons', VERTIC *Research Report*, no. 3, Oct. 1998.
  Suzanna van Moyland, 'Sustaining a Verification Regime in a Nuclear Weapon-Free World', *VERTIC Research Report*, no. 4, June 1999.
- Background Papers, Canberra Commission on the Elimination of Nuclear Weapons, Commonwealth of Australia, Canberra, August 1996, especially papers 8, 11-14 and 17.
- Joseph Rotblat (ed.), *Nuclear Weapons: The Road to Zero*, Westview Press, Boulder, Co., 1998.
- Robert Green, *The Naked Nuclear Emperor*, The Disarmament and Security Centre, Christchurch, New Zealand, 2000.
- Barry Schneider and William L. Dowdy (eds), *Pulling Back from the Brink: Reducing and Countering Nuclear Threats*, Frank Cass, London, 1998
- Harold Feiveson (ed.), *The Nuclear Turning Point: a Blueprint for Deep Cuts and De-Alerting of Nuclear Weapons*, Brookings Institution Press, Washington DC, 1999.
- Merav Datan and Alyn Ware, *Security and Survival: the Case for a Nuclear Weapons Convention*, International Physicians for the Prevention of Nuclear War, Washington DC, May 1999.
- Annette Schaper, 'Verifying nuclear arms control and disarmament' in *Verification Yearbook 2000*, VERTIC, London, 2000.
- Edward Ift, 'Verifying nuclear disarmament', in *Verification Yearbook 2001*, VERTIC, London, 2001.

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