Virtual Nuclear Capabilities and Deterrence in a World Without Nuclear Weapons

George Paloczi-Horvath

VERTIC research report No3

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Baird House
15-17 St. Cross Street
London EC1N 8UW
United Kingdom

tel: +44 (0)171 440 6960 fax: (0)171 242 3266
email: vertic@vertic.org
http://www.fhit.org/vertic

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VERIFICATION RESEARCH, TRAINING AND INFORMATION CENTRE
Carrara House,
20 Embankment Place,
London WC2N 6NN,
United Kingdom
Tel: +44 (0)171 925 0867
Fax: +44 (0)171 925 0861
E-mail: info@vertic.org
Web: http://www.fhit.org/vertic

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Preface

In 1996 VERTIC launched a project funded by the W. Alton Jones Foundation and the Ploughshares Fund on Verification of the Transition to a Nuclear Weapon-Free World and Sustaining the Verification Regime for an Indefinite Period, otherwise known as the 'Getting to Zero' project.

The aim of the project is to investigate the verification challenges facing the transition to complete nuclear disarmament and how a verification regime might be sustained once the stage of zero nuclear weapons is achieved. Verification is the key to achieving nuclear disarmament, since without it the risk of 'breakout'—the illicit retention or production of nuclear weapons—would be high and the inclination to actually abolish nuclear weapons low. Verification of nuclear disarmament therefore needs to be highly intrusive and thorough, allowing for as little margin of error as possible. Given the exrreme sensitivity of the nuclear weapon states about their security requirements, especially regarding their nuclear capability, this will be enormously difficult.

Many questions are pertinent: how should a verification regime be structured so that there is a high degree of confidence that no country or organisation could be hiding or manufacturing a stockpile? what technologies and techniques are most appropriate? how can one build on the precedents set by other nuclear agreements, such as the Intermediate-range Nuclear Forces Agreement and the Strategic Arms Reduction Treaties I and II, and non-nuclear agreements such as the Chemical Weapons Convention and the Biological Weapons Convention? how is the verification regime to be staged to match the gradual dismantling and destruction of nuclear arsenals? how should nuclear materials, nuclear laboratories and nuclear knowledge be dealt with? how is the verification regime to be implemented so that it builds trust and confidence? how are the de facto nuclear weapon states to be brought into the process and will the same verification provisions apply to them as to the declared nuclear weapon states? are nuclear and non-nuclear confidence-building measures required to supplement the verification regime? how can the regime cope with breakout should it occur?

Not only does the verification of nuclear disarmament have to be effective and efficient during the process of getting to a nuclear weapon-free world, it is also vital that there is confidence in the verification regime's ability to survive indefinitely. Questions here include: for how long should an intrusive verification regime last? 50 years? 100 years? could nuclear weapons be easily re-manufactured by a former nuclear weapon state or would they have to be essentially re-invented? what happens if the international situation seriously worsens? should the regime be implemented so that enthusiasm, expertise and funding is maintained? should the strictness of the regime be eased over time as a nuclear weapon-free wotld becomes the norm?

The research product of VERTIC's 'Getting to Zero' project comprises four reports dealing with:

1) verification of the transition to low levels of nuclear weapons, covering the period in which the nuclear weapon states would be expected to cut their nuclear warheads to below 1000 each;

2) verification of the transition to a nuclear weapon-free world, covering the period when complete nuclear disarmament is achieved and detailing the type of treaty and accompanying verification arrangements likely to be required;

3) management and verification of 'virtual' nuclear capabilities and 'virtual' nuclear deterrence, whereby residual nuclear capabilities (such as skilled personnel, fissionable materials and general industrial capacity) would give some states, especially former nuclear weapon states, the edge in any attempt to reconstitute nuclear weapons, thereby giving them a form of nuclear deterrence; and

4) how to sustain the verification system for a nuclear weapon-free world into the indefinite future.

On the question of the nuclear status of states, the four papers use the following terminology:

- **nuclear weapon state (NWS)**: a state which, as defined by Article VIII of the 1968 nuclear Non-Proliferation Treaty (NPT), had 'manufactured and exploded a nuclear weapon or other nuclear explosive device prior to January 1, 1967'; the NWS are thus China, France, Russia, the UK and the USA;
- **de facto nuclear weapon state (DFNWS)**: a state known to have nuclear weapons but which is not recognised by the NPT as being a nuclear weapon state; currently the DFNWS are considered to be India, Israel and Pakistan;
- **non-nuclear weapon state (NNWS)**: a state which is party to the NPT and legally recognised as not having nuclear weapons; there is in addition a tiny number of states not party to the NPT but which are also assumed not to have nuclear weapons, most notably Cuba.

This report, by George Paloczi-Horvath, is the third in the series.

VERTIC is grateful to the Ploughsbares Fund of San Francisco and the W. Alton Jones Foundation of Charlottesville, Virginia for their financial support for the Getting to Zero project. VERTIC is also grateful to those individuals who have commented on draft manuscripts, offered advice and assistance and participated in VERTIC workshops as part of the project.

Trevor Findlay
Series Editor
October 1998

Executive Summary

- 'Virtual nuclear capabilities' (VNC) can be defined as the ability of a state not equipped with nuclear weapons to produce them within a matter of months or years, using fissile material and/or technological skills and materials available to it.
- 'Virtual nuclear deterrence' (VND) would use these capabilities to a specific end. It could be a temporary posture adopted by former nuclear weapon states as a guarantee against nuclear weapon 'break out'. VND could hence reinforce a temporary security architecture, even if in this instance 'temporary' might mean up to around ten years.
- In the context of getting to 'zero', VND would not be an end in itself, but rather serve as an element of the security architecture of a world free of nuclear weapons.
- VND would only be adopted by the acknowledged nuclear weapon states (NWS)—China, France, the Russian Federation, the United Kingdom and the United Stares of America—after they commit to complete nuclear disarmament, sign the appropriate treaties and perceive the temporary adoption of this form of dererrence to be in their political and security interests.
- As with the NWS, VND will only be accepted as an interim form of security by the de facto nuclear weapon states (DFNWS)—India, Israel and Pakistan—when they can be assured that their vital security interests would be guaranteed by other means after they sign a nuclear disarmament treaty.
- There are several alternative approaches to VND. These range from various types of precise or explicit virtual deterrence to more implicit or tacit forms.
- An explicit VND posture might allow materials and capabilities relevant to the construction of a nuclear weapon to be retained under verified arrangements for a limited time. This report explains why explicit VND would not be a reliable tool for reinforcing a nuclear disarmament treaty, as it could undermine the treaty's whole purpose.
- An implicit VND posture would not permit the retention of any weapons-related fissile material or items specific to nuclear weapons. The nuclear disarmament treaty need not take specific account of implicit VND. It would entail only a tacit intellectual understanding that, in the early years after complete and timetabled nuclear disarmament, an NWS or DFNWS might retain the de facto capability to re-arm.
- An explicit VND regime would require intrusive and effective verification and enforcement measures and clearly defined regulations concerning their application. Implicit VND would not have such a 'regime' and would be verified in the same manner as a nuclear disarmament treaty and would hence not require separate arrangements.
- This report suggests that an implicit VND posture might help guarantee observance of a nuclear disarmament treaty during the early years after going to 'zero', by

representing the ability of treaty signatories to re-arm in response to nuclear weapon 'break out'.

- Any form of VND risks becoming a permanent state of affairs after nuclear arsenals are reduced to 'zero'. For this reason, a fully-implemented nuclear disarmament treaty cannot be regarded as the end of efforts to contain, and eventually eliminate, states parties' ability to recreate their arsenals.
- It would be necessary for a nuclear disarmament treaty to include a codicil on restraint in official public statements about nuclear and delivery system capabilities in order not to undermine an implicit VND posture.
- The objective would be to move beyond implicit VND to unambiguous nuclear disarmament over a defined period, so that this form of assumed deterrence is no longer needed. In any case, VNC would remain a permanent fact of life in a nuclear weapon-free world after going to 'zero'. Therefore, a time-limited security architecture should be part of the nuclear disarmament treaty, specifying exactly how long states can retain the nuclear weapons-related capabilities underpinning any VND posture.

Glossary

AAA	Working Committee for Nuclear Issues (Swiss)
AIP	Air-Independent Propulsion (Submarine)
BJP	Bharatiya Janata Party
CTBT	Comprehensive Test Ban Treaty
DFNWS	De Facto Nuclear Weapon State
FMCT	Fissile Material Cut-off
HEU	Highly-Enriched Uranium
IAEA	International Atomic Energy Agency
INF	Intermediate-range Nuclear Forces (Treaty)
IISS	International Institute of Strategic Studies (London)
ISIS	Institute for Science and International Security (Washington)
LEU	Low-Enriched Uranium
NATO	North Atlantic Treaty Organisation
NEMP	Nuclear Electro-Magnetic Impulse
NNWS	Non-Nuclear Weapon State
NPT	Non-Proliferation Treaty
NRDC	Natural Resources Defense Council (Washington)
NTM	National Technical Means
NWS	Nuclear Weapon State
OTA	Office of Technology Assessment (Washington)
P-5	Permanent Members of the UN Security Council
Pu-239	Plutonium-239
R-11/17	Raketny-11 (NATO codename 'Scud')
SIPRI	Stockholm International Peace Research Institute
SSBN	Nuclear-Powered Ballistic Missile Submarine
START	Strategic Arms Reduction Treaty (I & II)
U-235	Uranium-235
UAV	Unmanned Air Vehicle
UN	United Nations
UNSCOM	United Nations Special Commission
UK	United Kingdom of Great Britain and Northern Ireland
USA	United States of America
VNA	Virtual Nuclear Arsenal
VNC	Virtual Nuclear Capabilities
VND	Virtual Nuclear Deterrence

1. Introduction: What are 'Virtual Nuclear Capabilities and Deterrence'?

In its most straightforward form, 'virtual nuclear capabilities' (VNC) are possessed by a state which has, or could have access to sufficient quantities of weapons-usable fissile material and/or the ability to produce it, and which also possesses the requisite technical equipment, materials and skills to produce a nuclear device.

'Virtual nuclear deterrence' (VND) could he the assumed benefit a state might wish to derive from its VNC, especially if that state can use its fissile material, equipment and skills to produce a nuclear device in a period of only weeks or months. This definition of VND can be modified to suit several different types of VND posture.

The term 'weapons-usable' is employed here because of the proven ability of nuclear powers to build nuclear weapons using reactor-grade, rather than weapons-grade fissile material. The United States is known to have conducted at least two nuclear tests using reactor-grade material and Sweden also investigated this technology. Other nuclear powers, notably India, may also have conducted research into this option, which would become much more significant after any future ban on the manufacture of weapons-grade fissile material takes effect.

This report assumes that after a nuclear disarmament treaty the former nuclear powers might still have faith in their understanding of the concept of 'deterrence' in the context of their 'virtual nuclear arsenals'. They would do so because there is no reason to suppose that such a treaty would necessarily, in their eyes, invalidate previous deterrence theories.

Opponents of nuclear weapons have often felt uncomfortable with—if not contemptuous of—nuclear deterrence theory. But for those who believe that nuclear weapons do deter, the core of nuclear deterrence theory was always the impossibility of disproving, at least as long as nuclear weapons were never used, that possession of nuclear weapons would deter a hostile power. The same arguments about deterrence theory would all continue to be aired and would no doubt still be the source of intense debate after any future nuclear disarmament treaty was implemented. The debate would arguably even strengthen deterrence.

For the record, nuclear deterrence at the end of the Cold War was assumed to mean the following strategy, as outlined by the NATO heads of state and government in their London Declaration of 6 July 1990:[1]

> These [nuclear weapons] will continue to fulfil an essential role in the overall strategy of the Alliance to prevent war by ensuring that there are no circumstances in which nuclear retaliation might be discounted.

[1]London NATO Conference Declaration, 6 July 1990, reproduced in *Survival*, IISS, London, Sept.-Oct. 1990), pp. 469-72., para. 18.

By 1998, in the British Strategic Defence Review, one justification of nuclear deterrence theory had been modified:[2]

> Deterrence is about preventing war rather than fighting it... The Government wishes to see a safer world in which there is no place for nuclear weapons. ...while large nuclear arsenals and risks of proliferation remain, our minimum deterrent remains a necessary element of our security.

Clearly the current nuclear weapon states (NWS) and de facto nuclear weapon states (DFNWS) would satisfy the basic VNC requirements of possessing fissile material and the relevant technologies even after they had dismantled their nuclear arsenals under the provisions of a nuclear disarmament treaty. This would be the case even if all their weapons-grade fissile material had been safeguarded. A number of other countries would also be in the same category, even though the great majority are currently parties to the nuclear Non-Proliferation Treaty (NPT) and most are not judged to be 'nations of concern'.

A country which has possessed nuclear weapons and retains the resources needed to produce them might be assumed to exercise a potent 'explicit' form of VND. A state that has had nuclear weapons, has dismantled the related infrastructure and skills base, and has disposed of all weapons-usable fissile material could be said to still exercise a less potent, but nevertheless 'implicit', form of VND.

The same could be said of a country which has had ambitions to build nuclear weapons, but which never got as far as assembling a nuclear device. The numerous countries in this category—like Brazil and Taiwan—are in a half-way house between the fully-fledged nuclear powers and countries with VNC. They have the reactors, technology and skills base, but not the intention to build nuclear weapons.[3]

South Africa is the sole current example of a country straddling the two general categories of VND—explicit and implicit—which has eliminated its nuclear arsenal. But while it placed its weapons-grade uranium (U-235) under International Atomic Energy Agency (IAEA) safeguards and, it claims, has also destroyed all paraphernalia and documents relating to its weapons programme, it retains at least part of the infrastructure and skills base needed to produce a nuclear weapon.

Sweden is a country which had a clandestine nuclear weapons programme for a long period (1945-72), yet never amassed the fissile material or summoned the political determination to actually assemble a device. Today Sweden denies any military nuclear ambitions. But the mere fact of its past work in this field and its capabilities could be seen as providing it with at least the dubious benefits of an implicit form of VND. The key question, as Michael J. Mazzarr has written, 'is not whether it could build nuclear weapons, but rather how quickly it could build them'.[4]

The tacit nuclear knowledge possessed by key personnel in a former nuclear weapon state's military nuclear infrastructure would form a key element of VND. Thus while South Africa dismantled its nuclear weapons relatively recently (1990-91), it will still

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[2] *The Strategic Defence Review*, The Stationery Office, London, 1998, para. 60, p. 17.

[3] Some of these countries' nuclear weapons programmes are considered in more detail in the later section of this report on Historical Models of Virtual Deterrence.

[4] Michael J. Mazzarr, 'Virtual Nuclear Arsenals', *Survival*, IISS, London, autumn 1995, p. 8.

take a long time for various South Africans' racit knowledge about nuclear weapons assembly to dissipate. Without documentation and the ordered dissemination of tacit knowledge, it could be said that such knowledge will only disappear when the scientists involved actually pass away— as long as they do not commit the essentials of their tacit knowledge and skills to others, or leave it on paper.

If weapon design documentation is retained—and as Mazzarr has observed there is no reason to suppose it has not been kept somewhere in Sweden for example—a country could be said to retain its VNC. The tacit knowledge associated with nuclear weapons will continue to exist in the minds of many personnel formerly involved in the various nuclear weapon programmes following any nuclear disarmamenr treaty.

Even without the tacit knowledge of the cognoscenti, a wealth of material about nuclear weapons will still be available in open print and in the electronic media. Some of that information includes surprising levels of detail on nuclear weapon design, providing any country with a basic 'do-it-yourself kit' on the essential technical requirements of a basic VND posture. Various internet sites demonstrate that the essentials about nuclear weaponry, including detailed information on and diagrams of weapons and design principles, are freely available to anyone with the time and inclination to look.[5]

Just as there is also the ever-present threat of a sub-national group developing a simple and, using the hackneyed term, 'crude' nuclear weapon using less challenging technologies, countries could conceivably choose to exercise a 'virtual' deterrence in the same way. One authority, quoting an admittedly controversial analysis, has said that all ir might take to build a nuclear device is one year's effort or the efforts of two major industrial companies.[6]

The Office of Technology Assessment (OTA) of the US Congress concluded in 1977 that:[7]

> A small group of people, none of whom have ever had access to the classified literature, could possibly design and build a crude nuclear explosive device. They would not necessarily require a great deal of technological equipment or have to undertake any experiments. Only modest machine-shop facilities that could be contracted for without arousing suspicion would he required. The financial resources for the acquisition of necessary equipment on open markets need not exceed a fraction of a million dollars. The group would have to include, at the minimum, a person capable of researching and understanding the literature in several fields and a jack-of-all trades technician... There is a clear possibility that a clever and competent group could design and construct a device which would

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[5] See for instance, the various sites accessible via The High Energy Weapons Archive at http://www.envirolink.org/issues/nuketesting/hew

[6] Professor Norman Dombey, Sussex University, in an interview with the author, March 1990, quoting *Anarchy Handbook*.

[7] Nuclear Proliferation and Safeguards, Office of Technology Assessment US Congress, Washington D.C., 1977, quoted in Frank Barnaby, *The Invisible Bomb*, I.B.Tauris & Co., London, 1989, p. 133. Barnaby writes that experienced former nuclear weapon designers led by J.Carson Mark came to similar conclusions in their chapter in *Preventing Nuclear Terrorism*, Lexington Books, Lexington, Mass., 1977. They concluded that such a crude device might even use uranium or plutonium oxide powder, 'with no post-acquisition processing or fabrication' (Barnaby, p. 134).

produce a significant yield (i.e. a yield much greater than the yield of an equal mass of high explosive).

Because of the documentation and tacit knowledge—never mind the fissile material—which might still be available in a future 'nuclear weapon-free world', it is very important to avoid hyperbole in considering what 'free of nuclear weapons' might actually mean after a nuclear disarmament treaty is implemented.

Even if worries over the residual ambitions of the NWS and DFNWS are discounted following conclusion of such a treaty (and these worries would be considerable) any state with VNC (civil nuclear power-plants and a reasonable industrial infrastructure and scientific skills base) will still be theoretically able to exercise a form of VND if it wishes—even if it has never had any military nuclear ambitions in the past.

In 1988 some 40 states were expected to be capable of manufacturing a nuclear device by 2000.[8] Of the states on that list, perhaps five or six could still theoretically build a nuclear weapon in a matter of months, depending on the concentration of national effort. Those states are Belgium, Germany, Italy, Japan and the Netherlands. North Korea could be added if, as suspected, it has retained sufficient weapons-usable plutonium reprocessed from fuel rods clandestinely removed from the Yongbyon reactor before meaningful IAEA controls were introduced.[9]

All these countries are industrialised states with the requisite facilities to build nuclear weapons, even if all are NPT parties; North Korea has also pledged not to build nuclear weapons under its arrangements with the US. The original 1981 list on which this estimate is based also included India, Israel, Pakistan and South Africa.[10] South Africa has disposed of its nuclear arsenal, while India and Pakistan have tested devices and possess small arsenals. Israel is known to possess a somewhat larger arsenal.

If these states or the NWS ever disarm they will still retain a theoretical capability, which has been well defined by Jonathan Schell in *The Abolition* as 'weaponless deterrence'.[11] However, a so-called 'minimal' or 'low salient' deterrent under which a small number of weapons might be retained by a NNWS or DFNWS, in either assembled or disassembled form, would still not constitute a true 'virtual' arsenal and should not be regarded as such.

Such a capability is fairly routinely—and mistakenly—assumed in some of the literature to have the same meaning as the explicit VND posture described in this report. Such a capability, which would certainly exist in the period before 'zero', is covered in more detail in the second report in this VERTIC study.

Some ideas on how minimal or low salient deterrents might constitute a form of VND or virtual arsenal are very curious, when considered in the context of nuclear

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[8] This number of prospective nuclear weapon-capable states in 2000 was given by the Iklé-Wohlstetter Commission on Long-Range Integrated Strategy, *Discriminate Deterrence* (report), United States Government Printing Office, Washington D.C., 1988, p. 10.

[9] These controls were again under threat in the spring and summer of 1998.

[10] The estimate of five or six states is the author's 1998 update of assumptions originally made by Joseph Nye, 'Maintaining a Nonproliferation Regime' in George Quester (ed.), *Nuclear Proliferation: Breaking the Chain*, Madison University Wisconsin Press, 1981, pp. 15-18.

[11] Jonathan Schell, *The Abolition*, Picador, London, 1984, p. 158.

disarmament. For instance, one 'post-nuclear ethic' which has been suggested is the retention of 100-200 'actual' nuclear weapons, with a much larger 'virtual' arsenal of disassembled or deactivated weapons held in teserve.[12] Retaining 100-200 weapons plus a larger number of disassembled weapons as a so-called minimal nuclear force would mean retaining an arsenal which is probably close in size to those now deployed by the United Kingdom or Israel—hardly models of virtual nuclear deterrence. Retaining, say, anything between 10 and 80 weapons, or the fissile material needed to produce them, might equate to the present size of the Indian and Pakistani actual or 'virtual' nuclear arsenals, and would be larger than the past South African arsenal.

In this context it is also irrelevant whether or not a DFNWS is a 'screw turn' or two away from an assembled device. The DFNWS are nuclear powers in every substantive sense of the term. Their remaining nuclear ambiguities (if there are any) may even undermine their own notions of what constitutes deterrence, especially if their new advances in nuclear weapons-related technology (missiles, reactors and the like) only worsen tensions over their de facto military nuclear capabilities.

In a more extreme version of the above, far removed from VND and yet described as providing the building blocks of a so-called 'minimum deterrence' or 'virtual abolition' environment, a 'stable' US virtual nuclear arsenal in the year 2040 comprising hundreds of warheads could effectively be a major capability[13]. In the eyes of any nuclear power other than the US or Russia, such retained weapons and capabilities would be a more than adequate nuclear capability today. Such ideas are far removed from how a truly virtual capability might better protect the interests of a country which has signed a nuclear disarmament treaty.

The worries of the non-NWS parties to the NPT that VND might allow parties to a nuclear disarmament treaty to keep their military nuclear capabilities for ever, preserving the gap between the nuclear 'haves' and the nuclear 'have nots', will have to be addressed within the architecture of the disarmament treaty.

This would mean that the treaty would have to be unambiguous in reinforcing any existing ban on the production of weapons-usable fissile material and would have to contain a process for the gradual dismantlement of the nucleat weapon infrastructures of the NWS and DFNWS. This period, perhaps ten years, is assumed to be the operating period of the VND postures outlined in this report.

The unavoidable lesson of the foregoing is that all the NWS and DFNWS would still be able to count on what they might perceive to be the 'benefits' of some form of VND posture following implementation of a nuclear disarmament treaty if they wished—as

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[12] Wilson, 'Issues of Force Structure, Nuclear Infrastructure, and Survivability', in Michael J. Mazzarr (ed.), *Nuclear Weapons in a Transformed World: The Challenge of Virtual Nuclear Arsenals*, St. Martin's Press, New York, 1997, p. 92. This arsenal would include 'rapidly operational nuclear weapons' comprising 180 bombs at three underground storage sites, plus 180 intercontinental cruise missiles on mobile launchers in another three underground sites. '...in essence, this part of the arsenal would play the role of SSBNs (nuclear-powered ballistic missile submarines) at sea'. The same analysis also posits a nuclear 'reserve' of 300 weapon 'pits' at three deep underground storage sites, and 'several hundred long-range bombers and/or fighter bombers that can be modified to carry nuclear weapons within 360 days'. The above would be supported by a nuclear production infrastructure with a production facility ar a deeply buried site capable of building 300 bombs within 360 days, the extant nuclear power infrastructure, plus several temporary, and one deeply-buried nuclear waste storage sites.

[13] Wilson, p. 92.

might many other countries. The next question is: to what ends might virtual capabilities and a VND posture be put?

2. The Benefits of Virtual Capabilities and Deterrence

Virtual nuclear deterrence could be the best interim form of security that parties to a global nuclear disarmament treaty might have against 'breakout', that is, when another party breaches the treaty and reassembles nuclear devices. The assumption that VND could become part of the disarmament 'end game' for the NWS and DFNWS could critically influence the nuclear powers' willingness to sign such a nuclear disarmament treaty.

The varying degrees of scepticism about disarmament which the NWS displayed since they became nuclear powers demonstrate that the task of ever persuading them to accept disarmament will be an immense political challenge. If there is ever to be the faintest hope of meeting this objective it will be necessary to show them that it could be in their security interests to sign such a treaty.

The merits of VND could be used to sweeten what the nuclear powers may regard as the bitter and hazardous pill of disarmament. It could help convince them that the signature of a treaty is not quite the leap into the unknown they might fear, because there will be the temporary security afforded by virtual nuclear deterrence.

But VND should not be regarded as an end in itself, only as a stage on the road to a world unambiguously free of nuclear weapons. As proposed, any VND posture would at most be a temporary security measure lasting up to ten years. The former NWS and DFNWS would adopt VND precisely because it could be presented as a temporary form of security against 'breakout' from a nuclear disarmament treaty by another former nuclear power.

Just as it will be very difficult to ever persuade the NWS to accept nuclear disarmament, there will be no chance of it ever being accepted if the DFNWS do not sign up to it.

Therefore a policy reliant on VND might become the internationally recognised temporary security policy of the DFNWS after such a treaty. The past stance of all of the DFNWS was that they never admitted to possessing nuclear weapons. India and Pakistan have now openly tested, although Israel still adopts a deliberately ambiguous stance, despite its known capabilities.

All these countries can produce nuclear devices: India tested one in 1974 and five more in 1998; an astonishing wealth of detail about the Israeli programme was revealed by former Israeli nuclear technician Mordechai Vanunu in 1986, while Israel may have clandestinely tested in the 1960s and 1979; Pakistan tested six devices in 1998, following a long-standing research programme.

But in the context of VND's role in getting to 'zero', it might nevertheless be very useful for the NWS to simply accept the preferred stance of each of the DFNWS— whatever each may be— during the negotiations on a nuclear disarmament treaty. Such an apparently relaxed attitude on the part of the NWS would shift the argument over the DFNWS' actual nuclear capabilities to consideration of what their desired future status should be following a nuclear disarmament treaty. At that time, they too could adopt a

VND posture. The temporary security that this would afford them could become a major inducement to securing their agreement to actual nuclear disarmament.

This would essentially mean that India, Israel and Pakistan would adopt the South African model as part of the nuclear disarmament 'end game', unilaterally dismantling weapons in their possession and placing the fissile material in storage prior to its disposal.

Given the extreme scepticism of the nuclear powers about disarmament and the certainty that sustained political pressure will have to be maintained to achieve that end, VND could well provide what these powers may feel is a welcome alternative to the politically increasingly embarrassing choice of doing nothing. (In this context, NWS reactions to the Indian and Pakistani tests in 1998 provide an interesting indicator of how easily minds can be concentrated on the previously unacceptable idea of a level negotiating playing field with the DFNWS).

VND could therefore help tip the balance towards an acceptance of complete nuclear disarmament. It could provide today's nuclear weapon decision-makers with an alternative to the view that nuclear disarmament is impossible, since it could give them confidence that a reliable form of security could be maintained during the final 'end game' phase of the nuclear disarmament process following implementation of a disarmament treaty.

If the potential benefits of VND are to be appreciated, the arguments against both it and other virtual arsenal concepts must be faced. One persistent critic, Kenneth Waltz, has written that:[14]

> Nuclear weapons have always formed part of the scenery of international politics, which is the appropriate place for weapons suited for deterring rather than for fighting. One may hope, *and virtual weaponeers do in fact hope*, (emphasis added) that nuclear weapons will continue to cast their shadow over international affairs, thus providing a considerable assurance of peace among states enjoying their protection.

The notion that virtual weaponeers hope that nuclear weapons will 'continue to cast their shadow over international affairs' does not take into account the concept of tacit VND, or something like it, as a stage on the road to complete nuclear disarmament, as outlined in this report.

In the same commentary Waltz asserts that:[15]

> For two closely connected reasons a system of virtual arsenals is untenable. First, deterrence without second-strike forces will not work. Second, a system of virtual arsenals would be unstable.

The idea that nuclear deterrence is dependent on second-strike forces has been a mantra of nuclear strategists since the 1950s. But it does not take into account the deterrent qualities of very small nuclear arsenals, whose second-strike capabilities are, at the very

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[14] Kenneth Waltz, 'Thoughts About Virtual Nuclear Arsenals' in Michael J. Mazzarr (ed.), *Nuclear Weapons in a Transformed World: The Challenge of Virtual Nuclear Arsenals*, (New York, St. Martins Press 1997), p. 310.

[15] Waltz, p. 311.

least, questionable. For instance, whether Israel, with its small territory and potentially vulnerable nuclear weapon storage sites—whose general locations are likely to be known to potential adversaries—has a true second-strike capability may not be important to the states which are likely to be targets of an Israeli first strike. This seems to be a much more significant factor in Israeli deterrent thinking than second-strike considerations.[16]

The assertion that virtual arsenals would be 'unstable' rests on the assumption that an arsenal which is not 'ready to go' would have uncertain deterrent value. But the example of India's and Pakistan's current nuclear capabilities following their 1998 tests, in which their arsenals may still be small or very small, shows that the smallest actual arsenal might yet provide a compelling deterrent in the mind of an adversary whose thinking is guided by deterrence theory. If only the capabilities and infrastructure are there, but not the completed weapons, the potential may still represent a virtual deterrent.

A more self-interested criticism of virtual arsenals is the threat they would represent to the international status of the smaller European nuclear powers, Britain and France. These countries have relied on their possession of nuclear weapons to demonstrate that they are still militarily more capable than other major conventional powers, Germany being the obvious example.

Shorn of assembled nuclear weapons, in a world in which nations like Germany and Japan may be pressing for eventual permanent membership of the UN Security Council, the British and French virtual nuclear arsenals would seem to be little different from the virtual nuclear capabilities of other major industrialised countries. Nuclear disarmament would still be a great leveller, leaving VND postures as the sole measure of the different status of the former NWS and DFNWS.

Britain and—though it does not care to admit it—France have both relied on their nuclear arsenals as a key to binding the US to a firm commitment to European security. For that reason they might be very unhappy about a VND posture and might therefore insist that the US make an even greater conventional commitment to Europe's defence—admittedly an unlikely prospect at present.

Trenchant criticisms might also be levelled at VND by Russia, whose arsenal's reliability is being called into question while its size shrinks. Russia has come to rely on nuclear deterrence as an increasingly important element of its military posture, while its conventional armed forces atrophy. Reliable operational nuclear weapons have also become more important to Russia's perceptions of its status, as the country becomes weaker.[17] These factors will also present a major challenge to the task of persuading Russia to ever take part in nuclear disarmament.

For China, like Russia and the smaller nuclear powers, another central issue in the VND debate would be the potential of advanced anti-ballistic missile defences to alter the

[16] See Devin Hagerty, 'The Opaque Proliferants' in *Nuclear Weapons in a Transformed World*, p. 247, for a discussion of Israeli nuclear deterrence during the 1991 Gulf War and also the capabilities of India and Pakistan.

[17] The number of reliable, operational Russian strategic nuclear warheads may have fallen to just 1,500, despite much higher START II limits, according to a study by the Natural Resources Defense Council (see 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, May-June 1998).

calculus of VND—especially if, as is highly probable, they form part of a dual-purpose air defence arsenal in future.[18]

Waltz raises a more serious criticism when he suggests that virtual arsenals may not deter an aggressor from, say, seizing territory and immediately announcing that it had clandestinely assembled a small nuclear arsenal, thereby undermining the deterrent potential of an opposing virtual nuclear capability which would still take some time to transform into the real thing.[19]

Schell however argues that the delay in activating a virtual capability would not matter, as the extent of the delay could never be known before the event.

In effect, this strikes at the nub of a problem which, in Waltz's view, may face virtual arsenals: they may not be sufficiently threatening to deter 'breakout' and, if they cannot do that, how then can they be justified ?

The answer must lie in relying on a sufficiently convincing form of VND to dissuade a would-be miscreant from considering the idea of 'break-out'. It is presumed that no rational party to a nuclear disarmament treaty would consider 'break-out' unless it felt its vital security interests were at stake. Even an irrational regime might be dissuaded from breaking out of the treaty by the possibility of what others, especially former nuclear powers, will be able to deploy against it. The irrational miscreant would have no way of knowing that another treaty party has not retained some form of VND capability.

Writing in 1984 Schell presented the options open to a former nuclear power as insurance against 'break-out'. In so doing, he also countered the arguments against VNC/VND advanced subsequently by sceptics. In describing the provisions of an 'abolition' agreement, Schell effectively argues for the benefits of VND when he says that a provision of the abolition agreement:[20]

> ...would permit nations to hold themselves in a particular, defined state of readiness for nuclear rearmament. This provision would, in fact, be the very core of the military side of the agreement. It would be the definition, in technical terms, of what 'abolition' was to be. And it would be the final guarantor of the safety of nations against attack. However, this guarantor would not defend. It would deter. The most important element in this readiness would simply be the knowledge of how to make the weapons— knowledge that nations are powerless to get rid of even if they want to. This unlosable knowledge is... the root fact of life in the nuclear world, from which the entire predicament proceeds. But, just as the potential for nuclear aggression flows from the knowledge, menacing the stability of the agreement, so does the potential for retaliation, restoring the stability of the agreement. Its persistence is the reason that deterrence doesn't dissolve when the weapons are abolished.

So, if VND, based on a nation's VNC, is a viable option, what types of VND might a former nuclear weapon state, actual or de facto, expect to have available after implementing a nuclear disarmament treaty?

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[18] See Mazzarr, *Nuclear Weapons in a Transformed World* for prescient discussions of likely Russian, Chinese, British and French objections to virtual arsenals.

[19] Waltz, p. 315.

[20] Schell, p. 118.

3. Various Virtual Nuclear Postures

There is no single model for virtual nuclear deterrence, an inherently flexible concept that relies as much on virtual nuclear capabilities and on differing perceptions of the significance of those differing residual capabilities as on the obvious implications of hard, incontrovertible facts.

Explicit VND

Under one possible VND posture—loosely defined as acknowledged explicit VND—a former nuclear weapon state which adheres to a nuclear disarmament treaty might keep some part of its weapons-related materials and skills base in place in a more formalised way. This may or may not be explicitly permitted in the disarmament treaty. If it is recognised by the treaty, the organisations retaining these materials and skills would need to be monitored to ensure that they do not recruit more personnel or obtain more materials for the period of the VND regime, if such recruitment is not anyway banned under the treaty.

The issue of whether the nuclear disarmament treaty would or would not recognise explicit VND presents uncomfortable choices to the virtual weaponeer. If it is explicitly recognised, the set of rules that would have to be constructed for it to work would be there to be broken by a devious treaty party. If it is not explicit, it will, by definition, be an implicit VND posture, closer to Schell's analysis.

The issue of training new or replacement personnel would also have to be addressed, as the deliberate erosion of tacit nuclear weapons knowledge would probably be a key part of the permanent arrangements which would be established by a nuclear disarmament treaty. The matter of the tacit knowledge possessed by nuclear weapons designers and technicians lies at the heart of the capabilities that will still be available to a former nuclear power which has disarmed. On the premise that detailed knowledge of the physics and mechanics of nuclear weaponry represents a potent VNC, the overt training of new nuclear weapons design personnel should be a major issue during the disarmament treaty negotiations and ideally should be forbidden altogether.

It may also be assumed that agreement will have been reached relating to the control of fissile materials when the nuclear disarmament treaty is signed. Therefore the NWS and DFNWS would agree not to produce more weapons-usable fissile materials after that treaty was concluded, whether safeguarded or not. This would unfortunately not prevent a former nuclear power from having available considerable quantities of weapons-usable fissile material, albeit under stricter safeguards than at present, especially if reactor-grade material is taken into account.

Similarly, limitations would have to be agreed on other retained nuclear materials, for example tritium, polonium and beryllium. Controls over the possession of relevant non-nuclear components of nuclear devices would also be necessary. One key element of both a nuclear disarmament treaty and an overt VND posture would be an effort to control the production and possession of the specialist chemical explosives required for nuclear devices.

There are other non-nuclear materials and technologies critical to the production of a nuclear device. They might include particular kinds of pre-formed metals or plastics, fuzes and other sophisticated electronic and computer systems. Under a treaty-acknowledged explicit VND posture, it might be necessary to define which of these could be retained at identified places for inclusion in reassembled nuclear devices should a party to the treaty decide to activate part of its overt 'virtual' nuclear potential.

An acknowledged, explicit VND posture might therefore allow the following to be retained by a former NWS or DFNWS:

- Civilian nuclear laboratories
- Civilian nuclear reactors
- Trained personnel
- Some safeguarded components specific to nuclear weapons, including specialist chemical explosives, fuzes, neutron initiators, tampers, etc.
- Safeguarded fissile material
- Documentation about former nuclear weapons programmes
- General industrial capabilities available to nuclear-armed nations.

The key to the acknowledged, explicit VND posture would be the ability of a former NWS or DFNWS under the nuclear disarmament treaty to reassemble a nuclear capability if it suspects 'breakout' by another party to the treaty. Because the key to any workable VND regime will be transparency, the implicit danger of a party to the treaty reacting to any suspected 'breakout' by activating part of its 'virtual' nuclear potential should prevent another party from taking the risk involved in such a 'breakout'.

It is assumed that any viable nuclear disarmament treaty would require the simultaneous elimination not only of nuclear weapons, but also of their most potent delivery systems—norably long-range ballistic missiles. If an explicit VND regime was recognised by the treary it would have to define very clearly what nuclear-capable delivery systems, if any, would still be allowed to the NWS and DFNWS.

It will be apparent that acknowledged, explicit VND would create more problems than it would solve, as the risk that it could fatally undermine the disarmament treaty would be too great.

In Peter Wilson's world of virtual nuclear arsenals, it was suggested that a country (the US) might retain under national control, but with tight IAEA monitoring, non-operational weapons in 'cold storage' which could be made ready within a matter of days or weeks, plus nuclear weapon physics packages which could be made ready in the same timeframe, 'depending on the availability of the other components of the bomb or warhead'.

In addition, stockpiles of weapon-grade fissile marerial that could be fabricated into weapons in a matter of months, plus requisite nuclear weapon assembly and fissile

material production facilities could be retained, as could civilian nuclear power and research reactors and nuclear waste-disposal facilities.[21]

While ideas such as these, and others propounded by Michael Mazzarr, are certainly at the higher end of the virtual deterrence curve, they are still relevant to the notion of the more explicit VND posture as described above. Such a posture would yet be meaningfully distinct from the very sizeable nuclear force proposed by some virtual weaponeers.

Implicit VND

Another, and as this report suggests, infinitely preferable approach to VND would not permit either the NWS or the DFNWS to retain any items specific to nuclear weapons at all, nor any equipment specific to their manufacture.

Under this approach, the negotiators of a nuclear disarmament treaty would assume the former nuclear weapon states' continuing possession of an implicit capability— defined as 'implicit VND'—to construct nuclear weapons, but not do anything specific about it. Ideally, the treaty should include time-limited arrangements which could ensure the gradual 'withering away' of that capability by a set date, ideally within ten years.

During an implicit VND period, it might be accepted that the former NWS and DFNWS will retain the skills and specific documentation required to produce nuclear weapons, but that at its conclusion all documentation specific to a previous capability would have to be destroyed. South Africa is the one example of a former NWS which claims to have destroyed documentation relevant to its nuclear weapons programme, providing a useful precedent for future disatmament measures.

One implicit VND posture, perhaps closer to a low salient explicit posture, might therefore allow the following to be retained by a former NWS or DFNWS:

- Civilian nuclear laboratories
- Nuclear reactors
- Trained personnel
- Safeguarded fissile material
- Documentation about former nuclear weapons programmes
- General industrial capabilities required by a state to produce nuclear weapons.

Why is implicit VND preferable to explicit VND?

An implicit VND posture would be inherently less threatening, and hence less dangerous, than a robust, explicit VND stance, whether it was explicitly recognised by the treaty or not. An explicit VND posture risks provoking miscalculation by other parties to a nuclear disarmament treaty.

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[21] Wilson, pp. 89-90 and Robert A. Manning, *Back to the Future: Towards a Post-Nuclear Ethic: The New Logic of Non-Proliferation*, The Progressive Foundation: Washington DC., Jan. 1994, p. 29, quoted in Mazzarr, *Virtual Nuclear Arsenals*, p. 10, for a similar analysis.

Since an implicit VND posture would be less threatening, it would be politically more acceptable to the non-NWS, especially the majority of NPT parties which have no nuclear weapon capabilities and cannot even theoretically benefit from any form of assumed VND.

That being the case, if the NWS and DFNWS take a step back by committing themselves to an implicit set of capabilities at the treaty stage, they will preempt future difficulties over the treaty's interpretation and observance. In this context, therefore, reliance on an implicit rather than explicit VND posture could underpin the treaty, rather than potentially undermine it.

It would at the same time provide a truly implicit, but credible deterrence in that any former NWS or DFNWS could retain some of the personnel, skills, materials and infrastructure to become a military nuclear power if it wished to.

It is for this reason that an implicit form of virtual nuclear deterrence is preferable for the nation which wants to implement its obligations under a nuclear disarmament treaty, while continuing to possess a meaningful residual form of virtual security.

4. Historical Models of Virtual Deterrence

There are several historical VNC models which are relevant to VND. As described below, these show that there are different approaches to assuming a virtual deterrence posture. The known capabilities of the nuclear proliferants— what they achieved and when— shows that they all had radically differing notions of what might constitute 'reliable' deterrence.

Israel went for a full-blown arsenal, whereas, until 1998, India felt sufficiently reassured by its single test in 1974 and its subsequent clandestine efforts to stay abreast of the relevant nuclear physics and delivery system technology.

While India, Israel, Pakistan and South Africa all developed nuclear weapons, none bar South Africa currently exercises a truly opaque 'virtual' deterrence, as their actual capabilities are too well documented, or proven, to be in any question. South Africa, as the one example of a former nuclear weapon state which has voluntarily dismantled and destroyed its arsenal, provides a rather different and provocative model for VND.

India's stance until the 1998 tests, under which it maintained that it did not possess an operational nuclear arsenal, came close to the more explicit VND postures described in this report. Even though India's public stance prior to the 1998 tests was untruthful, the stance in itself still represents an interesting variant of an explicit VND posture.

Countries like North Korea, South Korea and Taiwan—all of which have had nuclear weapons programmes which have apparently been contained under pressure from the United States—could still be said to theoretically 'benefit' from the doubts which their murky, ex-aspirant nuclear statuses provoke in many quarters.

Argentina, Brazil, Canada, Sweden and Switzerland have also all turned away from nuclear weapons, for which they have had ambitions of varying intensity. Argentina and Brazil have ended their programmes following a remarkable bilateral treaty. The Swedish programme was surrounded by secrecy and obfuscation but was ended categorically. The Swiss programme eventually provided a very interesting model of how a country might still regard itself as a 'threshold nuclear power' after the formal termination of active nuclear weapons research.

Canada is an interesting case, in that it is certainly a virtual nuclear power, having played a major role in the Manhattan Project, and could relatively easily have developed nuclear weapons of its own. But the country chose not to do so, chiefly because of the US nuclear umbrella, the expense and effort involved, and, latterly, a moral revulsion against nuclear weapons.

The list of military nuclear 'aspirants' is somewhat longer if countries which only had imprecise aspirations to obtain nuclear weapons, but no coherently defined or well-funded development programme, are also considered. For example, the fear which Iraqi or Libyan nuclear ambitions has provoked (in the former case its capabilities have been internationally dismantled and subject to continuing monitoring) demonstrates that the lack of an immediately practical route to a weapon is not necessarily the only criterion which potential adversaries need to consider. At the other end of the scale, despite

Israel's preference for nuclear ambiguity, information about its nuclear arsenal is so detailed as to establish deterrence without a clear statement of capabilities.

There is no way of being certain that any of the former nuclear 'hopefuls' listed above do not still retain documentation and information relevant to their past ambitions, even if the technical paraphernalia of a nuclear weapons programme no longer exists. This 'asset', combined with the tacit knowledge of persons formerly involved, could be said to represent the most opaque of virtual nuclear capabilities.[22]

No one would today sensibly assume, that because there are nuclear reactors in Belgium, Canada or Hungary these countries' 'virtual deterrents' are so many screw-turns away from reality. But uranium from the former Belgian Congo, the industrial capabilities of Canada (and its uranium too), plus the scientific expertise to be found in just one school of physics in Budapest, were all critical to the success of the Manhattan Project in the 1940s.

So the list of countries which could theoretically construct a nuclear explosive device, but which strenuously assert that they have no such ambitions, if only because they have signed the NPT and CTBT, is almost as long as the list of countries with their own nuclear reactors. These nations could also be said to possess the most virtual of military nuclear capabilities.

The debate becomes even more complex if, for example, Japan's nuclear expertise, its declared capabilities, and its possession of potential long-range delivery systems (satellite launchers) are all considered in the context of its overall technical capabilities, although not of its ambitions. Almost the same assessment could be made of Germany, which only lacks its own satellite launcher to serve as the basis of a long-range ballistic missile.

There can be no real doubts about the sincerity of Japan's commitment not to develop nuclear weapons in the light of both Hiroshima, Nagasaki, numerous treaty commitments and its general nuclear phobia. But the suspicions which have been persistently aired, sometimes coupled with an unfair assessment of Japan's defence strategy, demonstrate how easy it is to confuse capabilities with intentions. The same might be said of Germany, only that the doubts over the former West Germany's ambitions were more persistent—and perhaps better founded—than in the Japanese case.

Examination of the ptincipal historical models for VND shows that there are indeed many methodologies useful to the would-be 'virtual nuclear guardian'. The central issue over the credibility of VND is whether a country's ambitions and real capabilities together represent a true virtual deterrent, or only invite derision. A Ruritanian dictator can drop as many hints as he likes, but if his country lacks the appropriate industrial infrastructure and expertise, such claims will be hard to credit, thereby defeating the desired purpose of a VND posture—despite the potential which could be offered by a very simple programme, as described in the introduction to this paper.

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[22] See Donald Mackenzie and Graham Spinardi, 'Tacit Knowledge, Weapons Design and the Uninvention of Nuclear Weapons', *American Journal of Sociology*, vol. 101, no. 1, July 1995, pp. 44-99, for a highly influential examination of the issue of tacit knowledge and nuclear weapons.

But if Germany or Japan ever dropped the mildest hint of any equivocation about their commitment to the NPT, the political damage to the treaty could be immense, with unpredictable consequences. In the last analysis, states have generally chosen not to develop nuclear weapons either because it is against their interests or because the costs of doing so—financial, material and political—are insupportable.

India

Despite India's 12 kiloton so-called 'peaceful nuclear explosion' on 18 May 1974, India claimed from that time, until its tests in 1998, that it had not manufactured nuclear weapons, but only retained the 'option' to do so. Even before the 1998 tests, there was no doubt about the technical purpose of the 1974 explosion. It was a principles test for a military nuclear fission warhead, a modernised derivative of which was tested in the Shakti-2 blast of 11 May 1998. Raj Ramanna, former director of India's nuclear programme, was unequivocal about the 1974 blast: 'The Pokhran test was a bomb. I can tell you now. An explosion is an explosion, a gun is a gun, whether you shoot at someone or shoot at the ground... I just want to make clear that the test was not all that peaceful'.[23]

Following the 1998 parliamentary elections, the BJP-led government said it planned to 'induct' nuclear weapons, although without setting a precise timescale. This was an apparent retreat from the BJP's previous hard line, assisted by the use of the curious verb 'induct'. Combined with very successful deception work at the Pokhran site, this stance successfully hoodwinked diplomats and analysts alike. On 11 May 1998 the world learned the truth as a result of three underground nuclear tests conducted at Pokhran with claimed yields of 43-45, 12 and 0.2 kilotons respectively. On 13 May two sub-critical tests were carried out in a sand dune; they appear to have been successful safety tests of what would have been 0.5 and 0.3 kiloton devices.

So, how can India still be a relevant model for VND? Its continuing relevance lies in what previous Indian governments felt was achieved by the opaque nuclear stance of the 1974-1998 period, as evidenced by the pained protests of the Congress (I) opposition immediately following Pakistan's tests. Congress (I) felt that the tests had not only provoked Pakistan to test and thereby threatened India's security, but had also needlessly threatened the Chinese at the same time.

It was claimed that the previous ambiguous stance, combined with the evidence of the 1974 test, was aimed at demonstrating what India could do if it wanted, but not necessarily what it had done. (The poor safety record of some Indian reactors and the stop-go funding of the military research programme in previous years also had the effect of spreading doubt about an operational arsenal).

The Indian public stance prior to the 1998 tests convinced many (this writer included) that India might not actually have an operational nuclear arsenal or, at most, only a few dismantled weapons or pits.

The evidence to suggest this was relatively plentiful. In 1993 the US Central Intelligence Agency concurred with India's former stance that it had not assembled weapons, but

[23] See Carey Sublette (ed.), 'India's Nuclear Weapon Program', 1997, The High Energy Weapons Archive, accessible at: http:/www.envirolink.org/issues/hew/India/index.html

said that it could quickly do so. Various estimates were made of the amount of fissile material which might be available to India. The Stockholm International Peace Research Institute (SIPRI) estimated that by the end of 1995 India had amassed 420-450 kg of weapons-grade plutonium, sufficient for 70-100 warheads.[24]

There was also earlier evidence which suggested that India's ambitions had been expanded to include thermonuclear weapons[25], as eventually proven by the 11 May 1998 Shakti-1 blast. But in the immediate aftermath of the 1998 explosions, it was still thought that India's operational arsenal comprised no more than 20 weapons,[26] and there were articles suggesting that India deliberately maintained only a small operational arsenal, out of range of Pakistani aircraft.

Moreover the instances when the US did find evidence of preparations for further Indian tests in the past (in the early 1980s and in 1995), themselves conferred a sort of VND status on India. Preparations to test can get the message across just as well as actually performing a test. This subtlety plainly eluded the BJP, which had a more frightening purpose in mind.

Before the 1998 tests, there were credible hints about an operational free-fall nuclear bomb (or one that could be rapidly assembled) and the 'stop-go' Prithvi and Agni missile programmes were conducted in a relatively open fashion, suggesting that the demonstration of delivery system capabilities was more important to India than a permanently 'ready-to-go' arsenal of warheads and missiles. The known or suggested conduct of the programme implied that, after pulling away from nuclear weapons acquisition a few years after the 1974 Pokhran test, India resurrected the programme by the early 1980s once there was credible evidence of Pakistan's nuclear programme. But even after the Shakti explosions, India was still maintaining a far smaller operational arsenal than its plutonium production capacity suggested was theoretically feasible.[27]

India's declarations about its nuclear option before the 1998 tests can be regarded as a clever and practical example of VND in action, albeit one outside the regulated international framework of an arms control treaty and, hence, inherently less safe, as was to be proven in 1998.

This demonstrates a key point about the type of explicit VND in which a nation retains a few weapons (disassembled or not) and a larger quantity of fissile material and warhead paraphernalia to rapidly construct a larger arsenal. Such an overt VND

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[24] 'India's Nuclear Weapon Program'. See also 'The Bomb Makers', *India Today*, 22 June 1998, for a statement (p. 31) that each of the 1998 Indian test devices used between 5 and 10 kg of 'explosive grade plutonium'. The SIPRI estimate can be modified to take account of this information, which seems to confirm that India's weapons rely on conservative designs which use more fissile material than weapons in the NWS. SIPRI estimate quoted in David Albright, Frans Berkhout and William Walker, *Plutonium and Highly Enriched Uranium 1996, World Inventories, Capabilities and Policies*, Oxford University Press, Oxford, 1997, pp. 268-9. See also Mark Hibbs, 'India made about 25 cores for nuclear weapons', *Nucleonics Week*, 11 June 1998, p. 15, for corroboration of previously-mentioned stockpile estimates.

[25] T.S.Gopi Rethinaraj, 'Tritium breakthrough brings India closer to an H-bomb arsenal', *Jane's Intelligence Review*, January 1998, pp. 29-35. Such a future arsenal might be even larger than expected, if one analysis of the Indian programme following the 1998 blasts is correct. This suggested that India might rely on its relatively plentiful reactor grade plutonium to produce a gargantuan arsenal. See 'India goes thermonuclear' www.envirolink.org/issues/nuketesting/hew/ India/IndiaNuke98.html

[26] Private communication with the author, May 1998.

[27] Private communication with the author, May 1998.

posture will never be controllable outside the supranational control regime of a nuclear disarmament treaty. Hence, a more tacit VND posture might keep the Indias of the future much farther than a screw-turn away from an operational arsenal.

One of the difficulties in assessing the Indian nuclear weapons programme was the way in which very tight and evidently effective control was exercised by the Indian Atomic Energy Commission. It has even been suggested that only three or four people, other than technicians, may have been directly involved with the programme in the past.[28]

Interestingly, this assessment was also in accordance with the previously mentioned view of the US Congressional Office of Technology Assessment in 1977 of how many people would be needed by a sub-national group to construct a nuclear device, although this is not to suggest that Indian nuclear weapons are in any way crude.

Regardless of the details of the Indian nuclear weapons programme between 1974 and 1998 which have emerged since the 1998 tests, until those blasts India had a credible opaque nuclear status which was commensurate with its known capabilities and resources. In future, there may be more people in India who will rue the day that the BJP decided to abandon the previous Indian pretence of maintaining an opaque nuclear option and instead opt for what is now described as a 'minimum deterrent'.

Pakistan

Pakistan's five nuclear tests in the Chagai Hills on 28 May 1998 and its sixth on 31 May ended a long period of nuclear ambiguity which had extended back into the 1970s. Their yields, and number, are, however, matters of continuing debate.

Pakistan probably possesses, at the very least, fissile material and warhead components to have produced 8-13 U-235 implosion nuclear warheads up to the end of 1991, when the programme was supposed to have been 'capped' at US insistence. Following the 1998 tests, it was thought by one US analyst that Pakistan might only have four warheads left, although this figure may have been a serious underestimate given that Pakistan has now admitted that it never halted U-235 output.

The remaining warheads, apparently free-fall bombs (although warheads for the Hatf 5 and/or M-11 missiles may have been built), are reportedly based on a design derived from that of the warhead used in China's fourth nuclear test in 1966.[29] Doubts over the yields of the Pakistani tests does not detract from Pakistan's basic capability to construct workable nuclear devices.

The most interesting feature of the Pakistani nuclear weapon programme is not the fact of its existence, but its credibility before the Indian test series in 1998. Pakistan's nuclear capabilities may have been so obviously exaggerated that they did not serve to adequately 'deter' India.[30] The likely small size of the arsenal is such that it is also now vulnerable to an Indian first strike. India has stated that it would not be the first to use nuclear weapons, but a conventional first strike may be another option if India has accurate information about the location of Pakistan's arsenal. This factor, combined

[28] Frank Barnaby, in an interview with the author, March 1990.

[29] Albright, Berkhout and Walker, p. 276.

[30] See 'Top Pakistan [scientist] says claims of bomb are exaggerated and tragic', *Nucleonics Week*, 19 March 1998, pp. 17-18.

with Pakistan's weakness in conventional armaments when compared with India, has created the very real threat of a Pakistani nuclear first-strike postute, on the basis of the 'use it, or lose it' tationale.

Regardless of the details of the Pakistani 'deterrent', about which there are now fewer doubts following the May 1998 nucleat tests and the April 1998 test of the Ghauti missile, a question arises: would Pakistan have served its interests better by not assembling nuclear devices from the 1980s, not conducting and then trumpeting its hydronuclear testing, and certainly not performing its 1998 tests?

Had Pakistan opted for a quieter, less public stance, would it have raised the same misgivings, or provided the US and India with concrete political ammunition against it? To the uninitiated, such a stance might have had less credibility, but it would still have occupied the thoughts of the cognoscenti, and Pakistan would have known it would have this deterrent, or rather cautionary, effect.

From the point of view of VND, Pakistan's experience after its tests is, together with India's, an object lesson in the greater benefits of an opaque nuclear stance which does not invite international opprobrium and sanctions. As such, both these countries, therefore, provide valuable VND models.

Israel

Israel is widely assumed to be an advanced nuclear power which possesses anything from 100 to 200 nuclear weapons of several types. But it has never formally admitted rhe fact, despite the revelations of Mordechai Vanunu in 1986 and despite a wealth of evidence of a sophisticated weapons programme.[31] It may have performed clandestine tests from the 1960s onwards, notably in 1979, but these have nevet been proven beyond any doubt.

Israel's public stance has been that it would not be the first country to 'introduce' nuclear weapons into the Middle East. The precise meaning of what constitutes a 'nuclear weapon' and what constitutes the 'Middle East' ('the region' has also been used) may assume considerable importance in the minds of those who routinely issue this linguistically pedantic denial of the 'bomb in the basement'. But it does not detract from the reality of the arsenal.

Yet an absolute denial it is, despite former Israeli Prime Minister Shimon Peres' suggestions that Israel might one day give up the 'atom'. These denials sit very uneasily with the sheer size and scale of the estimated Israeli nuclear weapon stockpile. Current estimates of the size of Israel's arsenal vary from 100-200 weapons. The high estimate assumes that the country has manufactured up to 300 warheads since the first was produced in 1967-68, although some have since been dismantled.

SIPRI estimated in 1996 that Israel may have produced 66-116 warheads up to 31 December 1995, based on production of 330-580 kg of weapons grade plutonium. The extreme production estimates are that Israel has produced between 190 and 880 kg of

[31] Seymour M. Hersch, *The Samson Option: Israel, America and the Bomb*, Faber and Faber, London, 1991, provides perhaps the best account of the politics and intrigue behind the Israeli nuclear weapon programme.

Pu-239.[32] SIPRI's estimate assumes that the Israelis use 5 kg of plutonium per warhead, more than required by modern US weapons, which average 3-4 kg each. (If the assumption about the material needed by each warhead is conservative by a factor of, say, 1 kg, this might help validate some of the higher estimates of the arsenal's size).

The actual arsenal is composed of free-fall bombs deliverable by F-15 and F-16 aircraft, possibly air-to-surface missiles (Popeye) and ballistic missiles (Jericho-1, Jericho-2 and Lance), and possibly nuclear demolition munitions. It remains an open question whether Israel has deployed enhanced radiation (neutron) warheads as assumed. Israel is highly likely to have deployed boosted fission and thermonuclear fusion warheads, a model of the former having being photographed by Mordechai Vanunu before 1986. There is nothing 'virtual' about this capability, about which too much is now known to have any doubts.

In the context of getting to 'zero' and a future true VND posture, Israel is a special case for two reasons. First, because it is not 'partnered' by a nuclear-armed adversary, as in the case of India and Pakistan. Israel's adherence to a nuclear disarmament treaty requiring the dismantlement of existing warheads would require a special political security regime with tailor-made guarantees, possibly from all the former NWS and certainly from the United States, if Israel was to tely on the security of VND for only a limited time thereafter.

The second reason why Israel is a special case is that because it possesses a major arsenal and weapons infrastructure which would have to be dismantled before going to 'zero', the country is really closer to Britain in the nuclear stakes than to India or Pakistan.

In common with the other DFNWS, it would have to declare its broad capabilities as part of the implementation process of a nuclear disarmament treaty. In this respect, Israel and the other DFNWS could take a leaf out of South Africa's book. This is discussed in the section on Verification, Virtual Capabilities and Deterrence below. Thus the DFNWS would either have to unilaterally dismantle their weapons and weapons infrastructure before signing the treaty, or do so after signature under supervision and verification.

Iraq

A perverse current example of VND might, ironically enough, be provided by Iraq, which, although it cannot now assemble a nuclear device, almost certainly retains the intellectual and perhaps the documentary foundations of a future weapon programme. Iraq maintained a multi-path weapons programme from the 1970s, which was severely interrupted by the Israeli air raid on the Osirak reactor in 1981. Despite this setback, the reconstituted nuclear weapons effort might have yielded a U-235 device by 1993 had the 1991 Gulf War not led to the programme's abtupt termination.

Iraq has since been subject to an intrusive IAEA and UN Special Commission (UNSCOM) inspection regime, but the general consensus is that the current Iraqi regime retains long-term ambitions to acquire nuclear weapons. Iraq's efforts to prevent the

[32] Albright, Berkhout and Walker, p. 263. See also Carey Sublette (ed.), 'Israel Nuclear Weapons Program', 1997, High Energy Weapons Archive, accessible at: http:/www.envirolink.org/issues/hew

disposal of all its remaining Al-Hussein or R-11/17 ('Scud')-derived ballistic missiles, (never mind its vigorous efforts to keep its chemical and biological warfare capabilities), represent a continuing and more than virtual threat. So, in this context, ambitions + technical competence = crude capability, even if the road is blocked to Iraq for now.

Iraq remains under continuing control and monitoring. In early 1998 war almosr returned because of its obstruction of UNSCOM monitoring of Presidential sites. Any assumed VND effect might seem futuristic for now, and not comparable to, say, South Africa's virtual deterrent. But the history of the programme shows a tenacity which cannot be ignored.

Iraq's ability to swing its nuclear weapon programme sharply in a different direction, aiming for a U-235 implosion weapon following the Israeli raid on the Osirak pluronium reactor in June 1981, shows what a centralised dictatorship can achieve with the required application. This was done while Iraq was pledging compliance with the NPT.

The outstanding question of course is: what official stance would a nuclear-armed Iraq have adopted had rhe programme been successful? Would ir have gone public with its capabilities and defied the world, with the attendant risk of major sanctions? Would it have tested? If Iraq had adopted an opaque nuclear stance, what form might this have taken?

Sweden

Between 1945 and 1972 Sweden maintained a secret nuclear weapons project.[33] Alrhough practical and reportedly quite advanced fission weapon designs were developed, an actual arsenal was not manufactured for two reasons: the lack of fissile material and a dearth of political will. As historians have pointed out, rhe latter was more significant in the 1958-72 period. Bur since then Sweden has retained, despite its adherence to the NPT, a degree of 'virtual' nuclear capability.

The Swedish programme was notable for the degree of deliberate deception of the public. This stance was adopted by government once the programme was recognised as being too controversial to be pursued as simply just another weapons development project.

From 1945 to 1958 the project proceeded slowly, wirhour exciting too much public attention. But in 1958, following relatively intense public debate, the Swedish government obliged the Supreme Commander and the civil/military nuclear bureaucracy to shift to the quasi-fiction of maintaining a programme for research into defence against nuclear weapons, while secretly continuing with research into their manufacture.

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[33] For a summary of the Swedish nuclear weapon programme, see Paul M. Cole, 'Atomic Bombast: Nuclear Weapon Decisionmaking in Sweden 1945-72', *Occasional Paper* no. 26, The Henry L. Stimson Center, Washington DC, April 1996. See also Marvin Miller's and Jack Ruina's study of break-out in *A Nuclear Weapon-Free World: Desirable? Feasible?* Steinberger, Udgaonkar & Rotblat (eds.), Westview Press, Boulder, Co., 1993, pp 83-118. A key source for students of the Swedish nuclear weapon programme is Christer Larsson, *Historien om en svensk atombomb, 1945-72*, Ny Teknik: Stockholm, April 1985, translation by Library of Congress, Congressional Research Service, Washington DC, 1985.

It was during this final period of Sweden's nuclear ambitions (1958-72), that the country came close to being able to build a nuclear device—had the required fissile material (Pu-239) been available. There might even have been preparations for an accompanying underground nuclear test programme. During its research Sweden also fell back on considering reactor-grade material when it became apparent that it would not have access to sufficient Pu-239.

The surviving historical record of the programme shows how this small, wealthy and technically competent nation might have been able to construct a small arsenal of fission weapons if the political will had existed. It also shows that there is no reason why such a country might not consider that secret military nuclear research might still remain a valid policy option even after becoming party to arms control agreements such as the NPT. In this context, such a programme would represent a form of VNC.

Switzerland

Switzerland's former nuclear weapon ambitions are particularly interesting in the context of VNC and VND, not because the research programme was so different from Sweden's (collaboration with Sweden was even considered), but because after explicit Swiss rejection of nuclear weapons and signature of the NPT, it adopted the concept of threshold nuclear deterrence as its fall-back position. The Swiss can therefore be said to have pioneered a form of prototype VND posture, based on their quite significant VNC.

Switzerland went public with a plan to examine the issue of procuring nuclear weapons for the Swiss forces in 1958 and from then until 1969 the research programme and the political, financial and material preparations followed a pattern similar to Sweden's. But Switzerland signed the NPT in November 1969, eventually ratifying it in March 1977.

It was in 1969 that the Swiss began to adopt a form of VND. The Swiss government report on its nuclear weapon programme said that following its NPT signature:[34]

> ...the only conceivable option now was to provide Switzerland with the necessary specialist knowledge to be considered a threshold country, which at the same time safeguarded the freedom of activity for the event of the treaty being broken.

To this end, a Working Committee for Nuclear Issues (AAA) with a Scientific Advisory Council, was created in 1969 by the Federal Military Department) in consultation with other Swiss federal bodies. The AAA met 27 times between April 1969 and December 1988 or less than twice a year on average. This proves that the 'issues' at stake—the AAA report said—'could not have been more than preparatory measures to keep open the option of a (nuclear weapon) purchase decision for the Federal Council of Ministers, should an entirely different international situation arise; such as a nuclear armament of Germany in conjunction with a failure of the non-proliferation treaty'.

From 1969 the Swiss nuclear 'option' initially comprised just two physicists employed by the AAA. Interestingly, the Swiss Chief of the General Staff, Johann Jakob Vischer, said that the will to become a nuclear threshold power, 'did not seem clearly

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[34] For a reliable account of Switzerland's military nuclear ambitions and Swiss ideas of relying on the security of being a 'threshold nuclear power', see Jurg Stussi, *Historical Outline on the Question of Swiss Nuclear Armament*. Swiss Government Report, 1996, accessible at: http:/www.envirolink.org/issues/nuketesting/hew/Library/Swissdoc.html

distinguishable to him, at least not on government level'. The Scientific Advisory Council was eventually disbanded in 1977.

The theoretical basis for the work of the AAA from 1977 to 1988 was contained in a 1977 document entitled 'Swiss Politics in the Question of Nuclear Armament', edited by Lower Chief of Staff, Front, Josef Feldmann, who concluded that: 'Switzerland has a vested interest in taking all measures permitted in the framework of the NPT which are suited to secure its status as a nuclear threshold power, and maintain it on a long-term basis'.

The Swiss government report records that from 1977 until 1988 the basic requirements of a threshold nuclear power 'stood in incessant competition for scarce finance, against other projects... such as measures for protection against the nuclear electro-magnetic impulse (NEMP)'. Following this, the Chief of Armament and his group for armament services '... were steering the discussions in the AAA away from questions on the (nuclear weapon) triggering mechanism and other concrete arms-technological issues to other matters, with verve and finally with success. Naturally, this in no way prevented the completion of such AAA-tasks as the edition of a technical study on the rise of Switzerland to a threshold power, which the AAA had to update periodically'.

When this task was set out by the new Chief of General Staff, Hans Senn, in September 1979, the instruction read: 'In the event that the political or technological development leads to an entirely new evaluation of the situation, the AAA shall in good time apply for the measures to be taken.' With the winding up of the AAA in 1988, Switzerland's efforts to maintain even a very basic threshold nuclear capability apparently came to an end. But a decade later the Swiss Defence Ministry still employed a core of nuclear scientists.[35]

Japan

As the one victim of military nuclear attacks in 1945, Japan has very personal and tragic reasons for not pursuing, or considering pursuing, a nuclear weapon programme.

But Japan has that option today, as the only non-NWS which operates uranium enrichment and reprocessing plants. The existence of these plants, despite Japan's very public compliance with its obligations under the NPT, gives Japan a nuclear weapon option. As such, Japan already 'benefits' from a form of back-up VND, should its reliance on the US nuclear umbrella ever fail.[36]

Japan also possesses the technology required to carry a postulated Japanese nuclear warhead to distant targets, in that it has its own satellite launchers, one of which has even been able to despatch a probe to the moon. A Japanese medium-range or

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[35] 'Three French experts are in Iraq to test warheads for nerve gas', *International Herald Tribune*, 9 July 1998, p. 7. This stated that: 'Three experts from a Swiss laboratory who are specialised in atomic and chemical armamenrs will soon Iraq on a similar mission, the Swiss Defence Ministry has announced'.

[36] See Motoya Kitamura, 'Japan's Plutonium Program: A Proliferation Threat?', *The Non-Proliferation Review*, winter 1996, pp. 1-16. A Japanese Foreign Minstry Official was reportted to have said in 1992 that 'My personal opinion is thar Japan should nor abandon the nuclear oprion as backing for its diplomatic strength. Japan should possess a nuclear weapons-capability bur keep the non-nuclear policy for rhe moment. For this reason, Japan should acculmulate plutonium and develop rocket technology rhat could be converted ro missiles.' (*Asahi Shimbun*, 29 November 1992).

intercontinental ballistic missile capability might take, at most, a few years to test and make operational. Japanese politicians know that the world knows of Japan's capabilities, even if they are only theoretical, and some may privately derive comfort from this stance.

Other industrialised countries

South Africa is presently the sole example of a country which developed nuclear weapons but which voluntarily decided to abandon them— announcing the fact in March 1993. While fissile material has been safely accounted for by the IAEA, and relevant weapons documentation allegedly destroyed, the country nevertheless retains skills and technology which could still be regarded as a 'virtual' deterrenr of sorts.

The history of the South African nuclear weapon programme is considered in more detail below, as it provides a direct example of how a nuclear arsenal might be dismantled and verified, a procedure which would also be relevant to the verification of future explicit VND capabilities.

As previously described, most industrialised countries which are non-nuclear weapon states with their own civil nuclear power and in some cases reprocessing infrastructures could produce nuclear weapons in, at most, a matter of years.

As stated in the introduction to this section, the number of countries which have at least considered nuclear weapons is larger than many observers realise. In Europe, besides Sweden and Switzerland they also include Poland, with its scientifically questionable fusion bomb project of the 1970s, and Romania, with its stillborn ambitions for a fission bomb which might have been developed with Pakistani assistance had Ceaucescu's regime survived. There have also been major question marks over Germany's position both before and after it acceded to the NPT, although there is no firm evidence of any secret reliance on an assumed threshold nuclear status.

In Asia, while South Korea and Taiwan abandoned their nuclear weapon programmes at US insistence, the mere fact that these countries are known to have researched nuclear weapons might be presumed to provide a form of continuing deterrence. The same could be said of Argentina and Brazil, despite their apparent and verified moves away from the nuclear option.

All of these countries could claim to observe some form of VND stance, or threshold nuclear deterrence stance along Swiss lines, if they so wished. As such, their past military nuclear efforts represent different, yet relevant models for VND. But the fact that they have forsworn such ambitions means that their current positions are better defined as differing forms of VNC.

5. Verification and Virtual Nuclear Capabilities and Deterrence

The verification of an explicit VND posture, or virtual nuclear arsenal (VNA), as it has been described by Michael Mazzarr, might present unusual challenges. He proposes that reassembly of a small number of nuclear weapons would only take place 'under very narrow and clearly agreed circumstances in which states would declare a justification for rearmament and its outline, scope and duration'.[37]

An explicit VND posture might only prove useful after the full implementation of a nuclear disarmament treaty and against the background of effective verification and compliance measures. For this reason, explicit VND would, as described earlier, be an immensely more complex proposition than an implicit or tacit VND posture.

Although the IAEA would play a leading verification role in monitoring general nuclear disarmament, under any temporary explicit VND regime its role would be circumscribed in respect of the disarming NWS because of proliferation concerns and the desire not to share sensitive warhead design information.

This role could instead be performed by inspectors who would be citizens of the NWS, attached to the nuclear disarmament treaty's verification regime. However, the IAEA could certainly play a key role in verifying the fissile material retained by both the NWS or DFNWS. It could also play a key verification role in respect of the DFNWS.

India's bald statement after its nuclear tests in May 1998 that it was a nuclear weapon state, and Pakistan's declared preparations to put a nuclear warhead on its Ghauri missile, threaten to reduce the NPT's formal definition over what is and is not a nuclear weapon state ro farce. Because of this, the formal status quo of NPT-based definitions of which countries are recognised as nuclear weapons states could well be changed before any nuclear disarmament treaty is implemented.

In order to specifically verify an overt VND posture, many of the same technologies for verifying nuclear disarmament would be used. These would include all the same intrusive warhead verification techniques (bar codes, tags, intrinsic surface fingerprints, perimeter-portal surveillance systems, etc), and also the equally intrusive fissile material monitoring which the nuclear disarmament treaty itself would require.

Furthermore, these verification technologies would include 'national technical means' (NTM) and other covert methods used to support existing arms control inspection regimes. It would not be difficult to modify these same arrangements to provide for verification techniques appropriate to an overt 'virtual' nuclear capability.

Another reason for intrusive, on-site verification to monitor an overt VND posture is that the NTM capabilities of some of the former NWS/DFNWS are likely to be relatively weak compared to those of the United States. This factor strongly militates against the choice of an overt VND posture, as it might be very difficult for some treaty parties to monitor such postures effectively using their own NTM and covert methods.

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[37] Mazzarr, 'Virtual Nuclear Arsenals', *Survival*, p. 14.

An implicit VND stance may be easier to monitor because the central issue will be a counrry's general capabilities, which all the treaty parties may be able to monitor on a more equal basis. Just as 'breakout' from the nuclear disarmament treaty and an overt VND posture may be easy for the United States (and any similarly well-equipped power) to quickly identify, 'breakout' from an implicit VND posture may be quickly obvious to all the other ex-NWS/DFNWS treaty parties. The latter assumption is predicated on the majot steps a former nuclear power would have to take before transforming an implicit VND posture into an actual nuclear arsenal.

Work done by, and in support of, the Canberra Commission on the Elimination of Nucleat Weapons provides valuable guidance on verification techniques.[38] The assumptions about what needs to be verified, as they would apply before reaching 'zero', would obviously also apply during and following implementation of a nuclear disarmament treaty and its accompanying verification arrangements.

The essence of the central verification problem is that nuclear warheads are nor large. On the contrary, 'The weapons are often small, readily transportable, and thus readily concealable'.[39] The related hurdle of the neat impossibility of adequately verifying a fissile material stockpile and production infrastructure without a clear-cut fissile material production ban, and accounting for the remaining permitted fissile material, is also a key problem. The Washington Council on Non-Proliferation background paper for the Canberra Commission thetefore assumed that the nuclear powers would have to have already halted production of weapons material and accepted appropriate safeguards before a nuclear disarmament agreement was implemented and had entered into force. More than this, 'They should also be prepared to close down production of highly-entiched uranium fot naval vessels or any civil marine uses and also to stop tritium production for military purposes'.[40] The former may be quite a tall order politically, given that all five NWS to a greatet or lesser extent rely on nuclear-powered submarines armed with conventional weapons.

Only Russia and China are likely to be long-term operators of conventional diesel-electric submarines. The United States and United Kingdom now rely entirely on nuclear submatines, while France will adopt the same policy once its last conventional submarine leaves service in the next decade. All of the DFNWS currently operare conventional submarines, but India once leased a nuclear-powered submarine from the former Soviet Union and has plans to build a nuclear submarine early next century.

Most of the NWS have so far invested in the development of the sophisticated air-independent propulsion (AIP) systems which might one day replace nuclear reactors in strategic submatines in their own navies. France, Britain and Russia have looked at AIP technologies, but these are not currently planned for their fleets, though a French-designed submarine with AIP is to enter service with the Pakistani Navy. The known shortcomings of AIP systems will require a great deal more research before the NWS' navies can develop the confidence to place reliance on them.

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[38] See Canberra Commission on the Elimination of Nuclear Weapons, Report and Background Papers, Australian Government Printing Service, Canberra, ACT., Aug. 1996.

[39] James Leonard, 'Verificarion Arrangements', Canberra Commission Background Papers, p. 157.

[40] Leonard, p. 159.

Similarly, there remain doubts over the use of low-enriched uranium (LEU), unsuitable for weapons use, in nuclear submarines. The French use LEU, as do some Russian submarines and possibly also Chinese vessels, but the core lives of submarine reactors which use LEU are much shorter than those using HEU.[41] Therefore, one key desired element of a post-treaty technical and verification environment may well not be in place even if a nuclear disarmament treaty is agreed.

The Natural Resources Defence Council (NRDC), in another Canberra Commission Background Paper, analysed the techniques and procedures which might be required for verifying the elimination of nuclear weapons.[42] In so doing, the NRDC outlined the resources (NTM) available to the NWS and DFNWS. Mentioned are sundry types of satellites plus various airborne, ship borne and ground-based sensors.

The NRDC proposed both declarations and co-operative verified data exchanges, including even exchanges of nuclear weapon serial numbers and random on-site inspections. The NRDC also considered a model data exchange, based on the 1994 agreement between the US and Russia to initiate an exchange of data related to warheads and weapons-usable fissile material.

Also considered was the issue of 'nuclear archaeology', the inspection of production records and access to physical evidence of a past programme's nature. The example of North Korea was cited in connection with the importance of irradiation histories of reactor components and also of enrichment plant records and tails assays.

Warhead verification techniques considered included the use of bar codes, tags, seals and tamper-indicating tape, intrinsic surface 'fingerprints', monitoring the weights and dimensions of warheads, radiation detection (active included) and radiation fingerprints. The usefulness of portal perimeter safeguards was also mentioned in the context of the application of the Intermediate-range Nuclear Forces (INF) treaty. Existing IAEA safeguards, including those provided for under the '93+2' programme, were also considered.

The NRDC came to the conclusion that:[43]

> The ultimate ease or difficulty in safeguarding nuclear-related facilities will depend to a significant degree on whether the continued use of HEU, particularly for naval reactor fuel, and separation of plutonium for commercial reactor fuel, is permitted or banned. If either of these activities is permitted, monitoring and safeguarding of nuclear fuel activities may never be accomplished with the high degree of confidence that national security authorities are likely to demand for the transition to a nuclear weapon-free world.

One advantage that a future world without nuclear weapons will probably still have is ever-improving, openly available commercial satellite imagery, which civilians and the less technically advanced states can have access to in order to check on the activities of a former NWS or DFNWS. The usefulness of this today has been shown by a landmark

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[41] Antony Preston, Editor of *NAVINT*, in an interview with the author, June 1998.

[42] Christopher Paine, Thomas B. Cochran and Robert S. Norris, 'Techniques and Procedures for Verifying Nuclear Weapon Elimination', Canberra Commission Background Paper, pp. 167-178.

[43] Paine, Cochran and Norris, p. 178.

paper on how commercial surveillance satellites were used to check on allegations about preparations for an Indian nuclear test in 1995.[44]

But in another Canberra Commission Background Paper, Marvin Miller delivers the prescient warning about virtual nuclear arsenals that:[45]

> As the US and the other declared weapons states 'ratchet down' to a virtual nuclear weapons status, other states may decide that it is in their national security interest to 'ratchet up' to a similar research status, including ambiguous 'research' activities.

Miller concludes that because of this, designing a verification regime for VND/VNA would be a daunting task, especially if the allowed fissile material production infrastructure was permitted too great a freedom to produce the raw materials of nuclear weapons. This report of course assumes that fissile material production would have been halted under a fissile material production ban, subject to the caveat about nuclear submarine fuel.

One clear conclusion about the VND/VNA debate must therefore be that, in the context of underpinning any future nuclear disarmament treaty, VND postures will need the additional support of a fissile material production ban for weapons purposes, without which meaningful verification may be unduly difficult, if not impossible.

In any case, the task of verification would be replete with multiple technical challenges, as Steve Fetter has concluded.[46] But a possibly alarming conclusion is reached when he says that the manufacture of warhead components other than those using fissile material, such as high explosive implosion assemblies, should only 'perhaps [be] subject to inspection'.[47]

By leaving open the possibility that the production of key components central to nuclear weapons would only *perhaps* be subject to inspection, wide latitude is allowed to the prospective user of an explicit VND posture.

This VERTIC report suggests that the credibility of that posture will not be critically undermined by the provision of intrusive verification measures specific to non-nuclear, nuclear weapon components and their manufacture, including laser and/or electronic neutron initiators.

Fetter is however correct in assuming that another key problem for verification of the dismantling of nuclear arsenals would be the difficulties presented by inaccurate or incomplete technical records, assuming that these are made available in the context of the verification of a nuclear disarmament treaty. Model data exchanges based on previous arms control treaty examples could go some way towards resolving the likely inadequacies of the historical record in all the NWS and DFNWS.

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[44] Vipin Gupta and Frank Pabian, 'Investigating the Allegations of Indian Nuclear Test Preparations in the Rajasthan Desert', *Science & Global Security*, vol. 6, 1997, pp. 101-188.

[45] Marvin Miller, 'Verification Arrangements', Canberra Commission Background Papers, p. 187.

[46] Steve Fetter, 'Verifying Nuclear Disarmament', *Occasional Paper*, no. 29, The Henry L. Stimson Center, Washington D.C., Oct. 1996.

[47] Fetter, p. 13.

Perhaps the most transparent way out of the warhead verification impasse before the implementation of a nuclear disarmament treaty would be the boldest, a nuclear weapon register of the type mentioned by the NRDC. Harald Mueller concluded in 1994 that even if this was not yet an idea whose time had come, 'it is at least a suggestion whose merits and disadvantages deserve serious examination, rather than contemptuous rejection by the nuclear "haves".'[48]

There are various approaches to warhead transparency. One of the easiest, and least ambitious for strategic weapons would be simply to count missiles—delivery systems—and on the basis of a declaration of the number of warheads they carry, assume a total for the number of warheads particular missiles carry. This is no different from the START arrangements, which also circumvented problems over warheads on bombers by simply assuming, whether or not on the basis of open declarations, that particular strategic aircraft were allowed to carry a given number of weapons.

For a nuclear disarmament treaty's verification arrangements, let alone those of an overt VND regime, the imprecision of such an approach will be entirely unacceptable.

An alternative approach to physical verification of an overt VND regime would be to ensure that no assembled nuclear warheads exist in a particular place or on a particular missile or aircraft. Estimates have been made by Fetter and colleagues of the detectability of neutron emissions from warheads, based on knowledge of the likely basic characteristics of weapons in the US and former Soviet arsenals.[49] These emissions are detectable within identifiable constraints, although the detection of gamma-ray emissions is a greater problem. There are also other challenges, as this study's authors explain:[50]

> Passive detection is not foolproof. Some possible weapon types, such as those that contain neither plutonium nor depleted uranium, but use a heavy-meral tamper (like tungsten) and WgU [weapons-grade uranium] uncontaminated with reprocessed uranium, could be undetectable by portable devices.

Even if plutonium-based warheads are easier to spot using available technology for portable detectors, they could escape detection by either shielding or isotopic purification. But one way round efforts to evade detection might be induced fission, in which fissile isotopes in a nuclear warhead could be caused to fission with low energy neutrons. Another technique might be photo-induced fission, in which high-energy photons induce uranium and plutonium to fission.

Information on current and past nuclear warhead designs is mostly secret and unavailable to the general public although, as we have seen, there is a surprising amount of general information available in open sources. For instance, in an appendix to the above-mentioned paper, a useful guide is provided on fissile materials and weapon design, which shows that there is enough information available to allow reasonable assessments to be made of the kind of warheads, and their characteristics, that a nuclear

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[48] Harald Mueller, 'Transparency in Nuclear Arms: Toward a Nuclear Weapons Register', *Arms Control Today*, Oct. 1994, p. 3.

[49] Fetter, Frolov, Miller, Mozley, Prilutsky, Rodionov and Sagdeev, 'Detecting Nuclear Warheads', *Science & Global Security*, vol.1, 1990, pp. 225-302.

[50] Fetter, Frolov, Miller, Mozley, Prilutsky, Rodionov and Sagdeev, p. 239.

disarmament verification regime, and hence also an overt VND verification regime, would have to be able to detect.[51]

The South African Case

Steve Fetter's examination of South Africa as a 'case study in disarmament'[52] shows that despite the Indian and Pakistani nuclear tests of May 1998 there are grounds for even the most jaded sceptic to accept that nuclear disarmament is possible. That being the case, it can be seen that there is indeed a model for ensuring that there are no nuclear weapons in given places in a given territory.

The South African case might provoke questions about how an explicit VND verification regime might check that a VND capability had not been transformed into an actual arsenal. Pretoria built six U-235 gun-assembly nuclear weapons in the 1980s and had begun work on a seventh when the programme was halted in 1990.

Within a year, South Africa disarmed in secret, dismantling the weapons, decommissioning production and assembly facilities (notably the Advena laboratories and the Valindaba enrichment plant), casting HEU weapon components into standard shapes for storage and international inspection, and allegedly destroying documents.

The IAEA was then given a history of the weapon programme and was allowed to interview personnel involved. A special team of inspectors, briefed on the design and production of the bombs, verified that enough HEU for six weapons had indeed been placed under safeguards. However, as Fetter observes, a key issue was nor that the HEU in question had been put in safe keeping, but that South Africa had put all of its U-235 under safeguards.

Though the IAEA gave South Africa a clean bill of health after its inspections, questions persist to this day about uncertainty over the operating records of the South African nuclear facilities, even though the 'tails' from South African U-235 output have apparently been accounted for.

As Fetter observes, the positive side of the South African case for the verifiability of nuclear disarmament is that with a government as forthcoming as former President De Klerk's apparently was, it is much easier to verify that a given capability or weapon has been disposed of. The negative side is that the South African example shows with daunting clarity how the disposal of even a tiny arsenal can be very difficulr to verify with absolute certainty—something which the IAEA inspectors never claimed to have achieved.

But taking Fetter's final questions to their logical conclusion for VND, if the IAEA had problems verifying the production of a few hundred kilograms of HEU, how on earth could it cope with the quantities involved in the overt VND verification regime of weapon components and fissile materials retained by a former NWS/DFNWS? If accurate records were not available (and there are major douhts about Russian records,

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[51] Fetter, Frolov, Prilutsky and Sagdeev, 'Fissile Materials and Weapon Design, Detecting Nuclear Warheads', *Science & Global Security*, vol.1, 1990, Appendix A, pp. 255-263.

[52] Fetter, 'Verifying Nuclear Disarmament', pp. 20-22; a key source quoted is David Albright, 'South Africa's Secret Nuclear Weapons', *ISIS Report*, Institute for Science and International Security, Washington, DC., May 1994.

for instance), or if a government suddenly takes an uncooperative stance and emulates Iraq, how could overt VND be verified with relative certainty?

This evidence and these questions point even more powerfully to the safer stance of relying on implicit VND for security guarantees after a nuclear disarmament treaty. By definition, this state will be far easier to verify. Schell argues also that the former nuclear powers will also have the advantage of switching their technical expertise from offensive to defensive systems, further limiting the room for manoeuvre for a state which is considering violating the treaty.[53] Of course South Africa, as the only nation so far to have crossed the nuclear threshold both ways, is still a 'virtual' nuclear power because of the knowledge of its scientists and the fact of what it has done in the past—even if all the documentation was destroyed and the fissile material accounted for. From the above, it is clear that it will always be less problematic to verify an implicit VND posture than an explicit one.

[53] Schell, p. 116.

6. Conclusion: A Double-Edged Sword or the Path to 'True Zero'?

While the non-nuclear weapon parties to the NPT are already obliged not to develop nuclear weapons, any VND regime might have risks, and precedents, which could leave VND—especially overt VND—as a permanent international state of affairs after the implementation of a nuclear disarmament treaty.

There are those who have taken a surprisingly sanguine view of nuclear proliferation, even considering it a possible guarantee of a safer world. They might take solace in a VND posture in future, as this might achieve substantially the same ends, especially if one's allies also have some virtual nuclear capability.

The risk must be faced that if the NWS and DFNWS can be persuaded to abandon their nuclear weapons under a disarmament treaty on the basis that they could still retain some form of verified 'virtual' nuclear capability for a period thereafter, non-nuclear weapon states with nuclear capabilities might quietly construct similar 'virtual deterrents' or openly claim the right to do so. This could be well within the technical and industrial capabilities of a large number of them. This is the main rationale for preferring an implicit, rather than overt, VND posture.

Another danger is that the political landscape might not favour a sharp response to a NNWS developing a VND posture if that state can invoke international sympathy for the argument that VND represents nothing more than the retention of a nuclear weapon capability by the nuclear 'haves' by other means, while denying those capabilities to the nuclear 'have-nots'. This would effectively be a variant of India's present arguments against the nuclear 'discrimination' practised by the NWS. It is this threat which provides perhaps the strongest argument against endorsing an explicit VND posture and in favour of a strong defence of a quieter, less threatening implicit virtual alternative.

The NWS and DFNWS will therefore be obliged to address the fear of the nuclear 'have nots', namely, that the NWS and DFNWS would retain their military nuclear capabilities for ever under a VND regime.

Either an explicit or an implicit VND arrangement would hence require the simultaneous adoption of measures to prevent either form of VND from becoming a permanent state of affairs. This could best be achieved by the inclusion in the nuclear disarmament treaty of time-limited controls on particular nuclear weapons-related capabilities and technologies. These need make no specific mention of virtual nuclear deterrence.

VND would therefore become instead a practical, implicitly understood milestone on the road to a new international security environment. This could only be achieved if the NWS and DFNWS show the political maturity and will to make the nuclear disarmament treaty and its preferably implicit temporary VND posture work and then replace it by a world in which the capability to construct nuclear weapons is unnecessary for a nation's security.

There is also another danger, a serious pitfall which will have to be avoided if VND is not to become a hindrance rather than a help to the post-nuclear disarmament security regime. This is represented by the use of actual or presumed nuclear or delivery system capabilities as a public means of threatening an actual or possible adversary.

Unfortunately, current wottying instances of this destabilising practice abound. The very public propaganda 'war' between India and Pakistan over their respective missile technologies (Agni vs Ghauri) is an example of how deterrence can be confused with a form of posturing thar can only eventually rebound against these countries' true security inrerests. Equally, North Korea's 1998 declarations about its nuclear aspirations and attitude to the NPT may well be designed to serve interests other than those related to military security, but they could yet prove to be highly counterproductive to that stare's long-rerm security.

For an explicit VND posture to work successfully after a nuclear disarmament treaty is signed, it will be preferable, if not essential, that countries adopting this stance publicly accept much greater discipline over the content and tenor of official public statements about their actual nuclear capabilities and potential warhead delivery systems—missiles, aircraft and unmanned air vehicles (UAVs).

To this end, it might be very useful for a nuclear disarmament treaty to include an unambiguous codicil on the need for discretion and disciplined restraint in all official public statements abour parties' technical capabilities, including those relating to both civil nuclear power, retained fissile material stocks and sophisticated potential warhead delivery systems.

It is perhaps ironic that the best and most helpful example which comes to mind is Israel, which has never gone public with its indigenous ballistic missile capabilities, developed since the 1960s. These have only been demonstrated over the past decade through the use of the Shavit-2 launcher, based on the Jericho-2 missile, to put Israeli satellites into orbit since 1988.

If the real world of the late 1990s is anything like the world when nuclear disarmament and an accompanying, temporary implicit VND posture are in place, VND could serve several important political functions.

One of these might be to reduce the sense of insecurity which Russia has felt since the collapse of the USSR, enabling it to more easily move away from its current reliance on nuclear weapons as a 'shield' in an uncertain world. This will become more important if Russia is perceived to be at an unacceptable technological disadvantage in the development of the information warfare and other technologies which are central to the US realisation of what is described as 'the revolution in military affairs'.

Implicit VND could provide technology triumphalists with a porent reminder that less advanced former nuclear powers will retain options which will be temporarily valuable in sustaining other countries' perceptions of their military potential. In any event ABM technologies will still be available to any former NWS or DFNWS, perhaps reinforcing a general deterrent posture.

Equally, VND could help settle India-Pakistan security concerns as long as reliable conventional arms reduction measures and confidence-building instruments are implemented on the India-Pakistan border and the Line of Control in Kashmir. It is

assumed that India's concerns over the NWS's nuclear dominance would anyway be addressed by the treaty. The inclusion of the aforementioned codicil on restraint on statements about nuclear capabilities would also serve to underline the temporary, implicit security guarantee of a tacit VND posture.

As far as the US is concerned VND could provide insurance against perhaps the greatest American fear—'breakout'. Implicit VND, supported by what would presumably continue to be the world's most technologically advanced cybernetics base, might allow the conservatives of the future to accept nuclear disarmament with fewer reservations.

The same could be said of Britain, France and China, which might rely on VND to provide them with the same tempotary reassurance. It may be presumed that the two European nuclear powers would retain close defence relations with the US, though it will be necessary in the nuclear disarmament treaty to make special efforts to address Chinese security concerns.

Perhaps this could be accomplished by adapting China's 'No First Use' policy to the first use of new advanced and previously unused military technologies after the treaty is signed. In this way, the nuclear disarmament treaty might not only remove a particular weapon of mass destruction as a class, and facilitate a shift to implicit VND, but also provide a first stepping stone towards containing the challenges of the future through arms control.

Adoption of an implicit VND posture could therefore provide an alternative and temporary form of security for the former NWS and DFNWS after they conclude a nuclear disarmament treaty. It could provide today's nuclear weapon decision-makers with an alternative to their present rigid view that nuclear disarmament is impractical and hence impossible. It could give them the confidence that a reliable form of security can be maintained during the final disarmament phase—after the weapons have been eliminated from arsenals, but when the capacity to manufacture them remains.

Given that the conceptual framework of any VND posture in the context of a nuclear disarmament treaty assumes a world which is immeasurably safer than today, the political environment of that future world which has embraced literal nuclear disarmament should be able to address all the concerns outlined above, especially if the chosen model is implicit VND.

Implicit virtual nuclear deterrence need therefore not be a double-edged sword, but rather serve a very useful role as a temporary guarantee against 'break-out' following the signature of a nuclear disarmament treaty. Implicit VND would also underline and reinforce the protection of the most immediate security concerns of the former nuclear weapons states— de facto and actual.

Because it is assumed that the treaty would include measures to eliminate certain residual nuclear capabilities after a period, implicit VND could ease the path towards 'true zero', when no country possesses the immediate ability to construct a nuclear device. When that state is reached, as Schell has defined it,[54] humanity will have made its decisive move to choose survival.

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[54] Schell, p. 4.

About the Author

George Paloczi-Horvath is a freelance journalist who has specialised in defence, engineering and energy for fifteen years. He holds a BA (Hons) in history from University College, London and, for his degree, also attended the War Studies Department, Kings College, London.

A former editor of *Defence* magazine, he is now defence correspondent for *The Engineer* and deputy editor of the naval newsletter *NAVINT*. He has written on nuclear weapons and defence for several publications and gave written evidence to the UK Parliamentary Foreign Affairs Committee study on UK Policy on Weapons Proliferation and Arms Control in the Post-Cold War Era. He also wrote a UK Defence Forum report on the future of Trident, submitted for consideration under the UK's Strategic Defence Review.

He is now researching British nuclear weapons history for a PhD at the University of Hull.

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- verification of the Chemical Weapons Convention (CWC).
- monitoring of implementation of the Landmine Ban Treaty by means of the Landmine Monitor.

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