1. Introduction

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I. Towards nuclear disarmament?

With the end of the cold war and the successful implementation of nuclear arms control treaties, the risk of a large-scale nuclear confrontation has been drastically reduced. A number of bilateral, regional and multilateral agreements—from the 1963 Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water (Partial Test Ban Treaty, PTBT) to the 1987 Soviet/Russian–US Treaty on the Elimination of Intermediate-Range and Shorter-Range Missiles (INF Treaty) and the 1991 Russian–US Treaty on the Reduction and Limitation of Strategic Offensive Arms (START I Treaty)—have curbed and effectively stabilized the nuclear arms race. Several countries have abandoned their nuclear weapon ambitions, nuclear arsenals have been reduced by about half, nuclear weapon deployment has been excluded from large geographical regions, and international norms against nuclear weapon proliferation and testing have been established.[1]

The most dramatic reductions in nuclear arms occurred in the 1990s, although competing tendencies could also be discerned. The euphoria that prevailed in the early part of the decade was absent during the second half. Although the aggregate number of nuclear weapons continued to decline slowly but steadily, the prospects for further successes in nuclear arms control diminished, as exemplified by the stagnation of the START process, the US Senate's decision in 1999 not to ratify the 1996 Comprehensive Nuclear Test-Ban Treaty (CTBT) and the inability of the Conference on Disarmament (CD) to proceed with substantive work on nuclear issues. India, Israel and Pakistan continued to remain outside the framework of the 1968 Treaty on the Non-proliferation of Nuclear Weapons (Non-Proliferation Treaty, NPT), largely because of regional rivalries, and India and Pakistan conducted nuclear tests in 1998. The first wave of the enlargement of NATO, in 1997, and the NATO intervention in Yugoslavia in 1999 led to the further deterioration of Russian–US relations and resulted in a near-halt to their bilateral security dialogue. There was also growing tension on many fronts between China and the United States.

Opposing perceptions of the nature of the threat posed by the proliferation of long-range ballistic missiles capable of carrying non-conventional weapons have caused additional strain in the relations between Russia and the USA. The December 2001 decision of the USA to withdraw unilaterally from the 1972

[1] United Nations, *United Nations Disarmament Yearbook*, vol. 24: 1999 (UN: New York, 2000), p. viii.

Treaty on the Limitation of Anti-Ballistic Missile Systems (ABM Treaty), effective as of 13 June 2002, in order to pursue an unproven missile defence technology may also have destabilizing implications. Several countries, notably China and Russia, may feel compelled to develop new missiles with improved capabilities and sophisticated countermeasures, further increasing global and regional tensions.[2] In the years to come, the deployment of missile defences will shape world strategic and military balances and thus directly influence the course of arms control and disarmament.

Despite the likelihood that there will be a turn away from arms control and a drift towards unilateral action, a distinct feature of recent years has been the continued Russian–US cooperation in efforts to strengthen the safety and security of nuclear warheads and materials and to promote transparency. The principal aim of the programmes has been to address the proliferation threats posed by the break-up of the Soviet Union. The most noteworthy bilateral initiatives are the unprecedented commercial deal to down-blend and transfer to the USA hundreds of tonnes of highly enriched uranium (HEU) from dismantled Russian warheads, the agreement to dispose of large quantities of weapon-grade plutonium, and the sustained efforts to prevent the theft, ensure the security and halt the further production of fissile material for military purposes in Russia. International projects funded by the European Union, Japan, the USA and other countries have aimed to engage Russian and other nuclear weapon scientists from the former Soviet Union in non-military activities. Other initiatives include plans for downsizing and consolidating Russia's nuclear weapon complex and for building a storage facility for surplus Russian plutonium and HEU.

Russia and the USA have continued to make progress in reducing their nuclear arsenals. The paramount achievements in nuclear reductions include the successful implementation of the INF and START I treaties and the substantial body of accumulated technical, legal and organizational experience gained from it. More recently, and in spite of the negative expectations at the start of this decade, in May 2002 Russia and the USA signed the Strategic Offensive Reductions Treaty.[3]

China, France and the United Kingdom have not been involved in multilateral arms control, primarily because of the relatively small size of their nuclear assets compared with those of Russia and the USA. However, in the late 1990s, both France and the UK proceeded to make substantial unilateral reductions in their nuclear weapon arsenals and to close and dismantle nuclear material production and weapon testing facilities. In addition, the UK, like the USA, took serious steps towards increasing transparency in its nuclear holdings.

[2] Biden, J. R., 'Missile defense delusion', *Washington Post*, 19 Dec. 2001, p. A39; and Lewis, G., Gronlund, L. and Wright, D., 'National missile defense: an indefensible system', eds J. Cirincione *et al*., *Nuclear Tensions in a New Era* (Carnegie Endowment for International Peace: Washington, DC, 2000), pp. 32–33.

[3] The full text of the Strategic Offensive Reductions Treaty (SORT) is available at URL <http://www.fas.org/nuke/control/sort/sort.htm>. The treaty will enter into force when it has been ratified by both signatories. For evaluations of SORT see chapters 2 and 4 in this volume.

After the indefinite extension of the NPT in 1995, the nuclear weapon states (NWS) joined in an 'unequivocal undertaking to accomplish the total elimination of their nuclear arsenals leading to nuclear disarmament' at the May 2000 NPT Review Conference.[4] This was a fresh commitment to their obligation under Article VI of the treaty 'to pursue negotiations in good faith on effective measures relating to cessation of the nuclear arms race at an early date and to nuclear disarmament'.[5] However, since a specific time frame was not agreed and the NWS have made little progress towards achieving the aims of the 1995 NPT Review and Extension Conference, a speedy move beyond statements of intent is anything but assured. Arms control and the eventual elimination of nuclear weapons can only be advanced within a stable and well-functioning global non-proliferation regime. While the overwhelming majority of the non-nuclear weapon states (NNWS) parties to the NPT, with the exception of Iraq and North Korea, have over the years honoured the letter and the spirit of the treaty and demonstrated full compliance with their International Atomic Energy Agency (IAEA) safeguards agreements, the continued support of the NNWS for the NPT regime will depend on tangible actions leading to disarmament being taken by the NWS.

In marked contrast to the deadlock in arms control, a serious, intense and stimulating debate about the complete elimination of nuclear weapons has been under way since the mid-1990s. Governments, international commissions and influential individuals have made concerted efforts to address the possibility of a world free of nuclear weapons and have put forth concrete proposals for measures to achieve this goal. A few deserve special mention. The Canberra Commission on the Elimination of Nuclear Weapons, established in 1995 by the Australian Government, issued a report which concluded: 'The end of the Cold War has created a new climate for international action to eliminate nuclear weapons, a new opportunity'.[6] After the 1998 Indian and Pakistani nuclear tests, the Japanese Government convened the Tokyo Forum for Nuclear Nonproliferation and Disarmament. The forum stated in a set of recommendations in 1999 that the NWS should eliminate nuclear weapons through phased reductions.[7] Such calls were eloquently echoed in statements by former senior military officers and civilian leaders from many countries.[8]

[4] Final Document of the 2000 Review Conference of the parties to the Treaty on the Non-Proliferation of Nuclear Weapons, NPT/CONF.2000/28, 24 May 2000, available at URL <http://www.iaea.org/worldatom/Press/Events/Npt/npt-2000.shtml>.

[5] The text of the NPT is available at URL <http://www.iaea.org/worldatom/Documents/Legal/npttext.shtml>.

[6] *Report of the Canberra Commission on the Elimination of Nuclear Weapons* (Australian Ministry of Foreign Affairs and Trade: Barton, Aug. 1996), p. 10, available at URL <http://www.dfat.gov.au/cc/cchome.html>.

[7] Tokyo Forum for Nuclear Non-Proliferation and Disarmament, *Facing Nuclear Dangers: An Action Plan for the 21st Century* (Ministry of Foreign Affairs of Japan: Tokyo, 25 July 1999), available at URL <http://www.fas.org/news/japan/forum.htm>.

[8] E.g., 'Statement on nuclear weapons by international generals and admirals', 5 Dec. 1996, URL <http://www.nuclearfiles.org/docs/1996/961205-admirals.html>; and Green, R. D., *Fast Track to Zero Nuclear Weapons*: *The Middle Powers Initiative* (Middle Powers Initiative: Cambridge, Mass., 1999), pp. 47–48, available at URL <http://www.stopthebombs.org/nuke/middle-powers.pdf>.

Although the NWS have raised political objections and substantial obstacles to initiatives for the abolition of nuclear weapons, international support has been growing. The New Agenda Coalition (NAC), launched in 1998 by eight countries sharing the objective of a world free of nuclear weapons, stated in its declaration: 'The international community must not enter the third millennium with the prospect that the maintenance of these weapons will be considered legitimate for the indefinite future, when the present juncture provides a unique opportunity to eradicate and prohibit them for all time'.[9]

Initiatives of this kind, although important for generating public support and legitimizing the goal of the abolition of nuclear weapons, have had little immediate impact on the deeply embedded nuclear policies of the NWS. Alarmingly, the prominence of nuclear weapons, including their potential first use, has been reinforced in recent years in the military doctrines and perceptions of most NWS as well as by NATO.[10] Russia and the USA continue to deploy thousands of strategic nuclear weapons on a state of high alert and at enormous expense.[11] Nuclear war planning in Russia and the USA continues to be similar in many respects to their planning during the cold war.[12] China, France and the UK also appear to be committed to retaining their nuclear forces indefinitely.[13] Tactical nuclear weapons, a difficult issue, remain outside arms control regimes. They rank low on the political agenda, and significant uncertainties exist about their numbers and deployment.

In summary, events during the past decade have demonstrated a mix of successes, setbacks, delays and uncertainties. There are clear and worrying signs that the web of instruments for furthering arms control and disarmament will face increasingly difficult challenges. As recent trends have indicated, the prospects for the complete elimination of nuclear weapons in the short term are not good. Favourable circumstances for cooperation between the NWS, such as those that emerged after the terrorist attacks against the United States on 11 September 2001, may nevertheless arise again, allowing them to pursue deeper nuclear reductions. Some of the prerequisites for achieving deeper cuts are the improvement of relations between the dominant powers, the resolution of armed conflicts, enlightened leadership, political will, the preservation of arms control accomplishments and the sustainment of efforts to counter nuclear proliferation.

[9] Joint Declaration by the Ministers for Foreign Affairs of Brazil, Egypt, Ireland, Mexico, New Zealand, Slovenia, South Africa and Sweden, Conference on Disarmament document CD/1542, 11 June 1998, available on the Acronym Institute Internet site at URL <http://www.acronym.org.uk/27state.htm>. Slovenia later withdrew from the NAC.

[10] China is the only NWS to have made a no-use pledge with regard to the NNWS and a no-first-use pledge with regard to the other NWS.

[11] Butler, L., 'Zero tolerance', *Bulletin of the Atomic Scientists*, vol. 56, no. 1 (Jan./Feb. 2000), p. 72.

[12] Younger, S. M., *Nuclear Weapons in the Twenty-first Century*, LA-UR-00-2850 (Los Alamos National Laboratory: Los Alamos, N. Mex., 27 June 2000), p. 2.

[13] Rogers, P., Memorandum submitted to the Foreign Affairs Committee, Weapons of Mass Destruction, Eighth Report, House of Commons, Session 1999–2000, 25 July 2000, pp. 1–12. See also United Nations (note 1).

II. Nuclear warheads and fissile materials

The NPT-recognized NWS—China, France, Russia, the UK and the USA—possess sophisticated nuclear weapons.[14] Three other states have nuclear capabilities: India and Pakistan conducted nuclear explosions in 1998, and Israel is widely believed to possess nuclear weapons.

It has been estimated that about 128 000 warheads were built between 1945 and 2000.[15] In 1986, the world nuclear stockpile peaked at close to 70 000 warheads. According to published estimates, in 2001 about 17 150 nuclear warheads were deployed by these eight states. If all nuclear warheads are counted—including non-deployed spares, those in both active and inactive storage, and 'pits' (plutonium cores) held in reserve—the total world stockpile consisted of about 36 800 warheads in early 2002.[16] Approximately 97 per cent of these warheads were in the Russian and US arsenals, and a significant fraction of them, several thousand, were warheads for tactical nuclear weapons.[17] It is not known how many warheads India, Israel and Pakistan possess.

The downward trend in the number of nuclear warheads is likely to continue as Russia and the USA further reduce their stockpiles. However, both countries plan to retain large reserve inventories of intact warheads and warhead components. It has been suggested that Russia will not be in a position to maintain more than 1500 warheads by 2010 because of the technical obsolescence of its systems and because of its financial situation.[18]

There are no official statistics on the exact total numbers, categories and types of warhead in the inventories of the NWS.[19] The NWS are not legally obliged to declare the production or destruction of their warheads or to submit them to any kind of control. Moreover, bilateral agreements, such as the INF and START I treaties, do not specifically require the elimination of warheads after they have been removed from their delivery platforms. Nevertheless, following the implementation of these treaties and unilateral pledges, thousands of redundant and technically obsolete warheads have been dismantled. In the

[14] Existing bilateral arms control treaties and agreements, as well as multilateral treaties of global application such as the NPT and the CTBT, do not provide definitions of the terms 'nuclear warhead' or 'nuclear weapon'. A nuclear warhead can be defined as a mass-produced, reliable, predictable nuclear device capable of being carried by missiles, aircraft or other means. A nuclear weapon is a nuclear warhead mated and fully integrated with a delivery platform. Cochran, T. B., Arkin, W. M. and Hoenig, M. M., *Nuclear Weapons Databook, vol. I: US Nuclear Forces and Capabilities* (Ballinger: Cambridge, Mass., 1984), p. 2.

[15] Norris, R. S. and Arkin, W. M., 'Global nuclear stockpiles, 1945–2000', *Bulletin of the Atomic Scientists*, vol. 56, no. 2 (Mar./Apr. 2000), p. 79, available at URL <http://www.thebulletin.org/issues/nukenotes/ma00nukenote.html>.

[16] Kristensen, H. and Handler, J., 'World nuclear forces', *SIPRI Yearbook 2002: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2002), p. 525. It should be noted that significant uncertainties are associated with such estimates.

[17] See, e.g., Potter, W. C. *et al*. (eds), *Tactical Nuclear Weapons: Options for Control*, UNIDIR 2000/20 (United Nations Institute for Disarmament Research (UNIDIR): Geneva, Dec. 2000).

[18] 'Putin to cut nuclear spending', *New York Times*, 13 Aug. 2000.

[19] The 5 parties to the START I Treaty—Belarus, Kazakhstan, Russia, Ukraine and the USA—exchange data, semi-annually, on their deployed treaty-accountable strategic nuclear warheads. The UK has announced that it has fewer than 200 operationally available warheads.

USA alone, almost 12 000 warheads have been eliminated since 1990 and there are plans to finish disassembling the current backlog of retired warheads by the end of 2005.[20] The former Soviet Union reportedly began dismantling its warheads in the mid-1980s, after it began to consolidate its weapons complex; some sources claim that Russia is dismantling about 2000 warheads each year.[21]

Starting in the 1940s, countries with military nuclear programmes produced vast quantities of fissile material.[22] A total of about 242–267 tonnes of weapon-grade plutonium is held in operational, reserve or retired warheads, warhead components, solutions and scrap or waste material.[23] The aggregate military HEU inventory is about 1700 tonnes (not including submarine fuel or waste). Most of this material is believed to be held outside nuclear warheads, varying, for example, between 75 per cent for the Russian stockpile and 65 per cent for the US stockpile. As in the case of warheads, Russia and the USA possess the largest stockpiles of fissile material, exceeding by at least one order of magnitude the combined stockpiles of the other three NWS. Both countries have designated hundreds of tonnes of fissile material as excess to their military needs and have agreed to dispose of some of it.[24] The UK has also declared a quantity of military plutonium as excess material.

With the exception of China, the NWS have officially declared moratoria on the production of plutonium and HEU. However, it is believed that none of them produces fissile material for weapon purposes.[25] This is not likely to be the case for India, Israel or Pakistan. The USA has released detailed information on its past production and use and its current holdings of weapon-grade plutonium.[26] A similar exercise, but of a more limited scope, was conducted in the UK.[27] In addition, the USA has published figures on its total production of HEU.[28]

[20] Statement of Brigadier General Thomas F. Gioconda, US Air Force, Acting Deputy Administrator for Defense Programs, National Nuclear Security Administration, US Department of Energy, to the Fiscal Year 2001 Appropriations Subcommittee, p. 6.

[21] E.g., Woolf, A. F., *Nuclear Weapons in Russia: Safety, Security, and Control Issues*, CRS Issue Brief for Congress, IB98038 (Congressional Research Service: Washington, DC, 21 Nov. 2000).

[22] The main fissile materials used in nuclear weapons are the isotopes plutonium-239 and uranium-235. Highly enriched uranium is uranium containing over 20% uranium-235. See chapter 7 in this volume. For a detailed discussion see Albright, D., Berkhout, F. and Walker, W., SIPRI, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford University Press: Oxford, 1997).

[23] Norris, R. S. and Arkin, W. M., 'World plutonium inventories, 1999', Natural Resources Defense Council (NRDC), 'Nuclear Notebook', *Bulletin of the Atomic Scientists*, vol. 55, no. 5 (Sep./Oct. 1999), p. 71, available at URL <http://www.bullatomsci.org/issues/nukenotes/so99nukenote.html>.

[24] Bunn, M., *The Next Wave: Urgently Needed New Steps to Control Warheads and Fissile Material* (Carnegie Endowment for International Peace: Washington, DC, and Harvard University: Cambridge, Mass., 2000), pp. 54–55, available at URL <http://www.ceip.org/files/projects/npp/pdf/NextWave.pdf>.

[25] Albright, D. *et al.*, 'Inventories of fissile materials and nuclear weapons', *SIPRI Yearbook 1995: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 1995), pp. 320, 325.

[26] US Department of Energy (DOE), *Plutonium: The First 50 Years*: *United States Plutonium Production*, *Acquisition, and Utilization from 1944 through 1994*, DOE/DP-0137 (DOE: Washington, DC, Feb. 1996), available at URL <http://www.osti.gov/osti/opennet/document/pu50yrs/pu50y.html>.

[27] British Ministry of Defence (MOD), 'Plutonium and Aldermaston: an historical account', Apr. 2000, URL <http://www.mod.uk/publications/nuclear_weapons/aldermaston.htm>.

[28] See, e.g., Bunn (note 24) and chapter 7 in this volume.

III. Transparency: definitions and characteristics

The term 'transparency' is vague and is used in diverse ways, but almost always pointing to the principles of openness and accountability—the opposite of secrecy. Transparency can be defined as 'the quality or condition of being easily seen through, recognized, understood or detected, manifest, evident, obvious, clear'.[29] In the context of arms control, transparency is usually linked with confidence building and cooperation. Transparency measures result in greater predictability with regard to the intentions and capabilities of states, thus facilitating mutual understanding, easing tensions and reducing misperceptions.

In its simplest form, transparency is the disclosure of information that was previously kept secret, but the concept also includes the accessibility and reliability of such information. It is fundamentally a voluntary and unilateral undertaking by states for an international audience, neighbouring countries or their own citizens.[30] However, there are also cooperative and negotiated forms of transparency. During the 1990s, in the context of the bilateral nuclear security cooperation between Russia and the USA, the term was commonly employed to generically address measures that provided confidence that a declared activity was taking place.[31] In this regard, transparency is not synonymous with, but is intricately related to, the concept of verification.

Although there is no universally accepted definition of verification, there is a common understanding of its meaning as 'an activity whose purpose is to establish the degree of compliance with, or violation of, the specific terms of an agreement'.[32] Verification encompasses the technical elements of monitoring and inspection as well as information processing and evaluation. The aim of verification is to increase confidence that an agreement is being fully implemented by providing parties with the opportunity to convincingly demonstrate their compliance and to detect non-compliance, thereby deterring parties which may be tempted to cheat.[33]

Transparency is an essential precondition for accountability and effective verification.[34] There is usually a sliding scale of transparency, including: (*a*) a statement of intent; (*b*) the provision of information; and (*c*) the verification of

[29] *The Oxford English Dictionary,* vol. 11 (Clarendon Press: Oxford, 1978), p. 273.

[30] Maerli, M. B. and Johnston, R. G., 'Nuclear husbandry functions', Paper presented at the Symposium on International Safeguards: Verification and Nuclear Material Security, IAEA, Vienna, Austria, 29 Oct.–1 Nov. 2001, p. 5, available on CD from the IAEA; and de Klerk, P., 'Transparency, confidence-building and verification and the peaceful use of nuclear energy', Paper presented at the Topical Workshop on Proliferation-Resistance in Innovative Reactors and Fuel-Cycles, Landau Network–Centro Volta, Como, Italy, 2–6 July 2001, pp. 2–3, available at URL <http://lxmi.mi.infn.it/~landnet/Doc/Reactors/klerk.pdf>.

[31] US Department of Energy (DOE), *Warhead and Fissile Material Transparency Program: Strategic Plan* (DOE: Washington, DC, May 1999), p. 10.

[32] Kokoski, R. and Koulik, S. (eds), SIPRI, *Verification of Conventional Arms Control in Europe* (Oxford University Press: Oxford, 1990), p. 5.

[33] Findlay, T., 'The verification and compliance regime for a nuclear weapon-free world', International Security Information Service, *Special Briefing Series on UK Nuclear Weapons Policy,* no. 2 (Nov. 1999), p. 1, available at URL <http://www.isisuk.demon.co.uk/0811/isis/uk/nuweapons/no2.html>.

[34] Johnson, R., 'Implications of the outcome of the NPT review conference', International Security Information Service, *Special Briefing Series on UK Nuclear Weapons Policy*, no. 5 (Jan. 2001), p. 5, available at URL <http://www.isisuk.demon.co.uk/0811/isis/uk/nuweapons/no5.html>.

information.[35] The voluntary provision of information need not always be subject to verification. Moreover, in practice, transparency in nuclear affairs is controlled and limited.[36] As experience is gained and confidence increases in step with the application of particular measures, however, parties may become inclined to share more information.

The arms control agreements implemented during the cold war have gradually introduced transparency into the relations of the two nuclear superpowers and helped reduce mutual distrust. The dissolution of the Soviet Union and the resulting changes in the international security system improved the prospects for institutionalizing and expanding the scope of transparency. High-level calls for and commitments to transparency and a variety of unilateral or bilateral actions, although limited, point in this direction. Examples include the declarations of inventories of fissile material and quantities made excess to military needs, the efforts that are under way to cooperatively dispose of part of the inventories and monitor the closure of plutonium production reactors, and the 1996 IAEA–Russian–US Trilateral Initiative.[37]

In the future, greater transparency could be brought about as part of a framework that, at least conceptually, encompasses the full accounting of nuclear assets, the agreed verification of warhead dismantlement and the irreversible disposal of surplus fissile material, as well as a prohibition on the manufacture of new warheads and fissile material. The elaboration of such a framework would require both negotiated agreements and voluntary decisions and is likely to be a very long and incremental process. If successful and supported by political goodwill, it could progressively lay the basis for nuclear disarmament verification. To this end, the accumulated experience and the technical means for verifying bilateral arms control treaties and implementing international safeguards are indispensable. Indeed, the scope, complexity and intrusiveness of verification techniques have progressively increased over time, as has confidence in their accuracy.[38]

IV. Is transparency in nuclear warheads and materials needed?

Military nuclear activities have traditionally been shrouded in secrecy. All aspects of nuclear warheads and materials—numbers, deployments and capabilities—were, and to a great extent continue to be, closely guarded national secrets.[39] During the cold war in particular, secrecy was considered to be a vital

[35] For a useful discussion of the meaning of transparency see Berkhout, F. and Walker, W., 'Transparency and fissile materials', *Disarmament Forum*, no. 2 (1999), pp. 73–84, available at URL <http://www.unidir.org/pdf/articles/pdf-art247.pdf>.

[36] See chapter 2 in this volume.

[37] See chapters 4, 5, 10 and 11 in this volume for discussion of the Trilateral Initiative.

[38] Schaper, A., 'Verifying nuclear arms control and disarmament', ed. T. Findlay, VERTIC, *Verification Yearbook 2000* (Verification Research, Training and Information Centre (VERTIC): London, Dec. 2000), pp. 57–60.

[39] In contrast, civilian nuclear programmes in the NNWS are fully transparent, largely because of the application of international safeguards administered by the IAEA.

element of security because it prevented the two superpowers from having a clear picture of each other's capabilities and strategies. In the post-cold war period, however, a wealth of information has come to light and is readily available owing to arms control, the implementation of voluntary initiatives, the contributions of the academic community and the media, and steady pressure from civil society. Rapid scientific advances and technological innovations have made a critical contribution to this end.

Although there are legitimate reasons for maintaining confidentiality in military nuclear inventories, there are a number of important reasons to increase transparency in these inventories. The overriding argument stems from the need to demonstrate that the NWS are moving forward to meet their pledges and obligations to reduce and eliminate their nuclear forces. At present no treaty obliges the NWS to declare, directly limit or accept controls on their nuclear warheads. Under the START I Treaty, Russia and the USA destroyed hundreds of strategic nuclear delivery vehicles—long-range bombers, intercontinental ballistic missiles and submarine-launched ballistic missiles—in accordance with the strict monitoring and verification provisions of the treaty. Similarly, the INF-mandated elimination of all Soviet/Russian and US intermediate- and shorter-range ground-based missiles was carried out. These reductions in delivery systems were irreversible. However, the nuclear warheads that were removed from delivery vehicles scheduled for elimination were not subject to any agreed regulation or control. Many of these warheads have already been voluntarily destroyed but, owing to the lack of transparency, there is no publicly available information on how many warheads remain in stockpiles. In addition, it is known that Russia and the USA both possess large inventories of reserve and inactive warheads, and this may also be the case in the other NWS. The potential exists for non-deployed warheads to be used to quickly reconstitute nuclear arsenals. Knowledge of the exact size of the warhead stockpiles is essential in itself and, in addition, as a precondition for proceeding with deeper reductions.

The elimination of tactical nuclear weapons also raises important issues. The delivery systems for these weapons are essentially dual-capable, that is, capable of delivering both nuclear and conventional warheads. Traditional strategic arms control measures focusing on delivery systems cannot therefore be applied to them. The only meaningful way to verify the implementation of the 1991–92 informal initiatives of presidents George H. W. Bush, Mikhail Gorbachev and Boris Yeltsin (the Presidential Nuclear Initiatives, PNIs[40]) to withdraw from active service and destroy large numbers of tactical nuclear weapons would be to apply methods of control directly to their warheads. Moreover, since the nuclear reductions undertaken by France and the UK are not constrained by legally binding agreements, it is not possible to gain assurances about their implementation.

[40] Fieldhouse, R., 'Nuclear weapon developments and unilateral reduction initiatives', *SIPRI Yearbook 1992: World Armaments and Disarmament* (Oxford University Press: Oxford, 1992), section II, pp. 66–73; appendix 2A (pp. 85–92) provides excerpts of the PNIs.

Transparency in military fissile materials is also limited. Knowledge of the inventories of the NWS remains incomplete. Statements about fissile material holdings and declarations about production moratoria are only politically binding. Although such statements are valuable first steps indicating the intentions of the NWS, they will have limited practical impact unless they can be effectively verified. In addition, fissile material designated excess to military needs can easily be used again to manufacture warheads unless it is permanently withdrawn from national stocks and stored under international supervision.[41] More importantly, the widespread uncertainties surrounding fissile material inventories must be reduced to a minimum in order to establish a basis for meaningful reductions.

Transparency is vitally important for a variety of other reasons. Scarcity of information about a country's nuclear capabilities may foster doubts about the willingness of the country to engage in arms control and advance disarmament. This is typically the case for the three de facto NWS—India, Israel and Pakistan—which remain outside the NPT. Conversely, the availability of information results in a well-informed civil society which, in turn, can support national strategies for both containing proliferation and reducing nuclear forces. Indeed, public debate about and scrutiny of government activities, which are essential elements of democratic societies, should also take up transparency in nuclear warheads and materials.[42]

Lifting secrecy reduces tensions and nuclear dangers. Accountability is an effective barrier against the theft and diversion of nuclear warheads and material. The ensuing cooperation at the political and technical levels builds both domestic and international confidence, thereby gradually creating the conditions in which new initiatives can be effectively negotiated and pursued.

The preamble to the NPT calls for 'the elimination from national arsenals of nuclear weapons and the means of their delivery pursuant to a Treaty on general and complete disarmament under strict and effective international control'. The commitments agreed in the Final Document of the 2000 NPT Review Conference highlighted for the first time, albeit in an abstract way, the importance of transparency and irreversibility in nuclear disarmament efforts. The conference agreed that a programme of action for nuclear disarmament will comprise, *inter alia*, 'the principle of irreversibility to apply to nuclear disarmament, nuclear and other related arms control and reduction measures' and 'increased trans-

[41] E.g., the higher estimates of Russia's excess fissile material holdings indicate that Russia could field a force 4 times the size of its current deployed strategic arsenal. 'The Wassenaar Arrangement and the future of multilateral export controls', Hearing before the Committee on Governmental Affairs, United States Senate, 106th Congress, 2nd session, 12 Apr. 2000, p. 84.

[42] E.g., in the USA an estimated total of $5.5 trillion has been spent over nearly 50 years on the production of nuclear weapons. The current cost for sustaining and operating the nuclear weapons complex is $25 billion a year. See Cirincione, J., 'The assault on arms control', *Bulletin of the Atomic Scientists*, vol. 56, no. 1 (Jan./Feb. 2000), p. 32, available at URL <http://www.thebulletin.org/issues/2000/jf00/jf00cirincione.html>. Other principal concerns include the not always well-understood environmental and public health impacts of producing, stockpiling, deploying and retiring nuclear weapons. Dhanapala, J., 'The environmental impacts of manufacturing, storing, deploying and retiring weapons', Speech at the University of Tulsa College of Law, 9 Dec. 1999, available at URL <http://disarmament.un.org/speech/9Dec99.htm>.

parency . . . with regard to the nuclear weapons capabilities and the implementation of agreements pursuant to Article VI and as a voluntary confidence-building measure to support further progress on nuclear disarmament'.[43] Other forums have also called for greater transparency in the stocks of warheads and fissile materials held by the NWS.[44]

V. Scope and objectives

The general requirements for establishing a verification regime in the context of moving towards a nuclear weapon-free world were the subject of numerous deliberations and studies during the 1990s. However, very few of them specifically addressed the technical means and procedures for introducing transparency in nuclear warheads and materials in the NWS. The main purpose of this volume is to contribute to a better understanding of the range, strengths and limitations of such technical approaches, including the necessary preconditions for their application. It surveys transparency initiatives and measures that have been implemented or proposed and analyses the factors that are impeding them. Inevitably, the main focus is on technologies developed in the framework of the Russian–US nuclear cooperation and related research and development exchanges. The two overarching considerations that are kept in focus are the depth and the irreversibility of the nuclear reductions which need to be achieved.

The emphasis of this volume is on the five NWS, principally among them Russia and the USA. Wherever relevant, observations are made on the three de facto NWS. No systematic attempt has been made to collect or review recent information on inventories of plutonium, HEU or nuclear warheads.[45]

VI. The structure of this volume

This volume consists of three parts. The chapters in Part I discuss the political implications of transparency. They examine the links between transparency and international security and the approaches followed by the NWS to increase the transparency of their nuclear assets. The evolution of transparency in Russian–US nuclear relations, arms control and security cooperation is described specifically, and the concerns of the NNWS are addressed.

The chapters in Part II focus on the technical means and procedures that have been utilized, are under development or have been proposed for introducing, building and strengthening transparency in nuclear warheads and materials.

[43] Final Document (note 4).

[44] E.g., the Tokyo Forum noted that 'irreversible reductions in nuclear forces require great transparency'. Tokyo Forum for Nuclear Non-Proliferation and Disarmament (note 7).

[45] See Albright, Berkhout and Walker (note 22) for data on the inventories of plutonium and HEU as of 1996. For warhead inventories see the estimates in, e.g., the *SIPRI Yearbook*, the NRDC 'Nuclear Notebook' section of *The Bulletin of the Atomic Scientists* and *The Military Balance* of the International Institute for Strategic Studies.

They analyse arrangements for establishing stockpile declarations, verifying warhead status and dismantlement, storing and disposing of fissile materials, and monitoring the closure or conversion of material production facilities. This part of the volume examines the challenges faced by the Russian and US nuclear warhead complexes in undertaking irreversible warhead elimination as well as a possible future role for the IAEA in institutionalizing transparency in the NWS.

Part III, the concluding chapter, summarizes the main findings of this study and presents proposals for enhancing transparency as an indispensable means for proceeding with deeper nuclear reductions.