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Verifying the Elimination of Nuclear Weapons and Providing Assurance against Breakout

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Summary

Effective verification will be absolutely essential to achieving nuclear disarmament. Developing effective verification may seem an impossible challenge, but there is substantial experience to build on, including IAEA safeguards and bilateral arms control processes. Examining the specific steps required to progress disarmament, we are not starting with a blank sheet, many verification missions are similar to those existing or under development today. International collaboration in developing new verification applications will contribute to the confidence and trust required to achieve the elimination of nuclear weapons.

1. The elimination of nuclear weapons is probably the single most important challenge facing the world today. Since the end of the Cold War political leaders and the public have lost sight of the dangers presented by nuclear weapons. The avoidance of nuclear war to date has been due in no small measure to good luck, but this cannot be expected to last indefinitely. As long as nuclear weapons exist there is the risk they will be used, if not intentionally then by mistake, miscalculation or rogue action. And while these weapons exist additional states are motivated to acquire them, increasing the risk they will be used.

2. Nuclear weapons are not simply a bigger, better weapon: even a "limited" nuclear war will have global consequences, well beyond the protagonists, and a major nuclear war could result in human extinction. The International Court of Justice (ICJ), when asked to rule on the legality of nuclear weapons, concluded that the indiscriminatory nature, destructive force and environmental consequences of nuclear weapons are such that their use would generally be contrary to the rules of international law, particularly humanitarian law.[1]

3. The 1968 Nuclear Non-Proliferation Treaty (NPT) obliges all NPT parties to pursue negotiations on effective measures for cessation of the nuclear arms race and for nuclear disarmament.[2] The ICJ found unanimously that this is an obligation not only to negotiate but to achieve nuclear disarmament. There are thus moral, legal and existential imperatives to find a way to reduce and eventually eliminate nuclear weapons. The challenge is how to do this in a way that does not lead to instability and increased risk –

[1] 1996 Advisory Opinion on the legality of nuclear weapons, http://www.icj-cij.org/docket/files/95/7495.pdf. The ICJ was unable to conclude definitively whether use of nuclear weapons *could* be lawful (only) in *an extreme circumstance of self-defence*, but emphasized the obligation to comply with humanitarian law.

[2] NPT Article VI.

but the nuclear-armed states cannot keep saying disarmament is too difficult or unrealistic, time is not on our side.

Trust but Verify

4. Effective verification will be absolutely essential to any disarmament process. No state will commit to deep reductions in nuclear weapons, and to eventual elimination, without sufficient confidence that other states are meeting the same commitments. Each state will need confidence that others have not cheated or will not cheat in the future. Specifically, confidence is needed that no state has concealed significant numbers of nuclear weapons from the disarmament process, and that any attempt to produce new nuclear weapons will be detected in time for effective action to be taken against the state concerned.

5. What is considered *sufficient confidence* is a judgment each state will have to make for itself. This is likely to be based on the state's assessment of a mix of factors – the verification system that applies, the state's analysis of national intelligence and other information, the level of transparency other states provide, and the level of trust between states. Verification is central – it is essential in its own right and it contributes to transparency and trust. Also essential, but outside the scope of this paper, will be credible *enforcement* arrangements, that is, mechanisms for enforcing compliance with treaty commitments.

6. Verification can be described as the confirmation of facts through technical measures performed by personnel independent of the state being verified. The subject matter – objects (items), materials, facilities, activities – needs to be defined so as to be effectively and meaningfully verifiable, that is, verification will lead to valid conclusions. The technical measures can include: on-site inspections and observations; sample-taking and measurements; installation of cameras, instruments and seals; confirmation of building and container designs (for example, number of entry and exit points); and so on. Verification personnel can be bilateral/mutual (each party inspects the other), or multilateral (an international inspectorate, such as the International Atomic Energy Agency – IAEA).

7. Developing effective verification for nuclear arms control and disarmament may seem an impossible challenge, but there is substantial experience to build on, including: IAEA safeguards pursuant to the NPT; bilateral (United States/Russia) arms control inspections; CTBT (Comprehensive Nuclear Test-Ban Treaty) monitoring; and collaborative projects on nuclear warhead and fissile material verification by United States/Russia/IAEA and United Kingdom/Norway. IAEA safeguards and CTBT monitoring will be essential complementary regimes supporting disarmament verification.

Developing a Framework for Disarmament Verification

8. The disarmament verification challenge is too diverse and complex to be addressed usefully in the abstract, instead it must be broken down into discrete and manageable tasks or missions. In broad terms a framework for developing disarmament verification needs to take into account:

(a) the formal structure – defining verification objectives, commitments, institutions and mechanisms;
(b) the subject matter – exactly what is to be verified. This would include developing the specific steps required to achieve the goal of eliminating nuclear weapons.

9. A step-wise approach is anticipated by the NPT, which requires negotiations on cessation of the nuclear arms race, nuclear disarmament, and a treaty on general and complete disarmament. Clearly these diverse objectives cannot be addressed in a single treaty, there will need to be a series of treaties. The NPT is not prescriptive and leaves it to the parties to decide on the specific treaties required.

10. On structure, IAEA safeguards and other existing treaty verification systems operate on a model involving a treaty, declarations and inspections. Future disarmament verification arrangements are expected to take a similar approach:

(a) a treaty, stating the fundamental legal commitment – for example, that the parties will not use subject materials to produce nuclear weapons;

(b) an obligation for parties to accept verification measures, to verify they are meeting treaty commitments;

(c) definition of materials, items, facilities and activities subject to the treaty;

(d) establishment of a treaty inspectorate (likely to be multilateral, but some aspects could be bilateral);

(e) declarations – an obligation for parties to declare to the inspectorate relevant materials, items, facilities and activities, and to make available supporting documentation (records, etc.);

(f) inspections – application by the inspectorate of verification measures, including regular on-site inspections and monitoring, to confirm parties' declarations;

(g) inspection procedures in case of suspected undeclared materials, facilities and activities (investigations and challenge inspections);

(h) procedures to deal with treaty breaches and non-compliance.

11. With several decades of experience, the IAEA safeguards system has been developed to address two fundamental concepts, *correctness* and *completeness*. Disarmament verification can be expected to build on this experience:

(a) correctness refers to confirmation that declarations are consistent with the facts – that declared quantities of nuclear items and materials are as described;

(b) completeness refers to confirmation that declarations include everything that is required to be declared – that there are no *undeclared* (concealed) items or materials. Since it is not possible to prove a negative – the *absence* of something – confirming completeness involves determining the indicators or observables expected to be present if there *are* undeclared items or materials, and conducting verification activities that have a high probability of detecting any such indicators.

12. On subject matter, there are three broad areas to be covered:

(a) nuclear material and facilities – requiring all relevant material and facilities to be declared and verified, with ongoing verification that declared materials/facilities are not used to produce nuclear weapons;

(b) nuclear weapons – requiring declaration of weapons in accordance with agreements (number and type of weapons allowable to be deployed, number to be retired and dismantled, and so on), monitoring of dismantlement, and transfer of ex-weapons material to verified stocks. These transfers should be *irreversible*, that is, nuclear material recovered from weapons and transferred to verified stocks cannot be transferred back to weapons. There could also be verified limits on delivery systems and weapon-related materials;

(c) activities to provide assurance there are no undeclared materials or weapons (weapons concealed from declaration, and production of new weapons either from materials concealed from declaration or from production of new materials) – including monitoring, challenge inspections, transparency measures, information analysis and so on.

Dimensions of Fissile Material Verification – Some Figures

13. Although the NPT and safeguards agreements are expressed in terms of *nuclear materials*, the term commonly used in discussion of nuclear weapons is *fissile materials*. There is no standard definition of fissile materials, but generally the term applies to highly enriched uranium (HEU) and *separated* plutonium (that is, plutonium separated from irradiated fuel through reprocessing). Fissile materials are not necessarily *weapon-grade*, but fissile materials are considered weapons-usable or, in the case of HEU at lower enrichment levels, easily re-enriched to higher enrichment levels.

14. Today most HEU is held in military programs, there is relatively little in civilian programs. For separated plutonium, however, over half is in civilian programs, though not necessarily under IAEA safeguards – one of the issues

for disarmament verification is going to be the need to extend IAEA safeguards coverage to civilian programs in nuclear-armed states. Total global fissile material holdings are shown in Table 1. Only 17 per cent of all fissile materials are in civilian programs. The process of disarmament will require that the 83 per cent of fissile materials currently in military programs will be progressively transferred to civilian programs, or disposed of (placed in a waste form such as borosilicate glass or synroc and buried), or in the case of fissile materials in naval propulsion programs, monitored to ensure they are not diverted to nuclear weapons.

Table 1: Global Holdings of Fissile Materials (2014)

	Separated Plutonium (tonnes)	HEU (tonnes)	Total Fissile Materials (tonnes)
Military Programs	233 (46%)	1,319 (96%)	1,552 (83%)
Civilian Programs	271 (54%)	50 (4%)	321 (17%)
Total	**504**	**1,369**	**1,873**

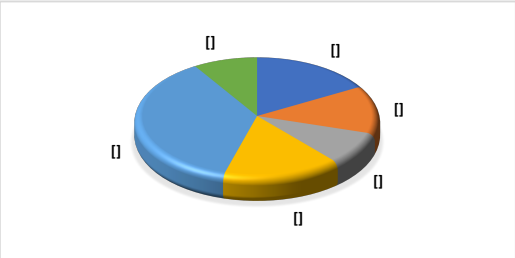
Source: International Panel on Fissile Materials (IPFM), *Global Fissile Material Report 2015*.[3]

15. Global fissile material holdings are broken down further in Figure 1:

- Active warheads contain 13 per cent of total fissile materials – this quantity will decrease with nuclear weapon reductions, as warheads are transferred progressively to retired status.
- Retired warheads contain 9 per cent of fissile materials – this quantity will fluctuate, increasing with warheads transferring from the active category, and decreasing as weapons are dismantled and fissile materials are transferred to excess stocks.
- Stocks declared excess comprise 9 per cent of total fissile holdings – this quantity will fluctuate, increasing as materials are transferred from dismantlement and decreasing as materials are transferred to civilian programs or disposal.
- Naval programs contain 16 per cent of total fissile materials – these materials will require monitoring.
- The largest category – 37 per cent – is *other government material*. Every effort should be made to declare these materials excess – where this is not possible verification or monitoring will be required.

Figure 1: Global Holdings of Fissile Materials

Estimated percentages (2013)



Source: NTI, *Global Dialogue on Nuclear Security Priorities: Building an Effective Global Nuclear Security System*,[4] 2016, based on IPFM data.

Step-wise Approach to Disarmament

16. A step-by-step approach to nuclear disarmament is implicit in the NPT and has been elaborated in successive NPT Review Conferences, notably in the "13 Steps" set out in the Final Document of the 2000 Review Conference.[5] It has become a subject of major political contention that currently no such steps are taking place – this was a key factor behind the majority of states supporting the negotiation of the Treaty on the Prohibition of Nuclear Weapons.[6] Notwithstanding the level of support for this treaty, however, not a single nuclear-armed state participated in the negotiations and it is clear that a step-by-step approach is the only realistic way of achieving disarmament.

[3] http://fissilematerials.org/library/gfmr15.pdf.

[4] http://www.nti.org/media/pdfs/Global_Dialogue_Report_final.pdf?_=1458780838.

[5] www.armscontrol.org/act/2000_06/docjun.asp

[6] http://undocs.org/A/CONF.229/2017/8.

17. As yet there is no agreement on what these steps should be. In broad terms, something along the following lines can be expected (though not necessarily in this order). This list is not the same as the 13 Steps but has many elements in common:

(a) Declarations on *no first use* (NFU), leading to a treaty on NFU. Nuclear-armed states would affirm that the sole purpose of nuclear weapons is to deter the use of nuclear weapons by others. NFU is already the stated policy of China and India.

(b) De-alerting – removing nuclear weapons from immediate readiness and launch-on-warning status.

(c) Agreement by the United States and Russia to extend NewSTART and initiate negotiations on a successor (START IV?).

(d) Bringing the CTBT into force.

(e) Establishing a multilateral negotiating process including all the NPT and non-NPT nuclear-armed states.

(f) Negotiating a fissile material cut-off treaty (FMCT). The general view is this would apply to future production but not existing fissile material stocks. Fissile material production facilities (enrichment and reprocessing facilities) would be shut down or would operate under verification to ensure future production is not diverted to nuclear weapons.

(g) Reduction of deployed nuclear weapons, and progressive dismantlement of excess nuclear weapons. There would be a series of agreements on numbers and types of nuclear weapons in deployment, with excess weapons being progressively declared and transferred to dismantlement. Recovered fissile materials would be declared as excess materials and transferred or disposed of in accordance with step (i).

(h) Ensuring nuclear materials in naval propulsion programs are not diverted to nuclear weapons.

(i) Transfers of excess military fissile material to civilian use, or disposal, under *irreversibility* arrangements. There would be a series of agreements by the various parties, under which specified quantities of fissile material would be declared and transferred to monitored storage, then progressively transferred to civilian use or disposal.

18. This list is not intended to represent definitive and discrete steps, the steps actually agreed by states could be different, and there could be further steps within the steps described here. For example, reduction and dismantlement of deployed weapons is likely to involve a series of separate agreements. At a broad level, the International Commission on Nuclear Non-Proliferation and Disarmament (ICNND), in its 2009 report,[7] recommended a two-phased approach, with *minimization* as the immediate goal and *elimination* as the ultimate goal. A series of specific steps would be required within each phase. The *minimization point*, considered to be achievable by 2025, would be characterized by low numbers of weapons (500 each for the United States and Russia, and no more than 1,000 in total held by the other nuclear-armed states), agreement on no first use, and force deployments and alert status reflecting a no first use posture.

Verification Considerations

19. As discussed, the various steps outlined above do not constitute an agreed or definitive list, but the steps taken are likely to be along these lines. The verification requirements for the various steps can be summarized as follows.

20. **No first use, de-alerting**. Some steps either do not lend themselves to verification or do not require verification. For example, whether a state can be relied upon to honour a no first use commitment is not verifiable – the state's com-

[7] *Eliminating Nuclear Threats: A Practical Agenda for Global Policymakers*, www.icnnd.org/.

mitment is reinforced by mutual deterrence, rather than verification. However, some transparency and confidence-building measures might be helpful: states could consider whether there are indicators that would provide confidence that others are acting consistently with a commitment to no first use, for example, the nature of weapon and delivery system deployments. Likewise, while de-alerting is not readily verifiable, some form of confidence-building may be helpful.

21. **"START IV," deployment limits**. For a START IV or similar agreement the United States and Russia can be expected to apply bilateral verification arrangements similar to those implemented under NewSTART and preceding agreements. Similar agreements negotiated by other states are expected to build on US and Russian experience.

22. **Dismantlement of nuclear weapons**. Because specific data on warheads – shape, mass, isotopic composition – is classified, there is a need to develop verification measures to provide the necessary assurance without revealing classified information. These special verification measures will apply until the fissile material from warheads has been altered in form and composition such that it is no longer classified, and more conventional verification, similar to IAEA safeguards, can apply.

23. Initially nuclear weapons retired from service pursuant to reduction agreements would be placed in storage pending dismantlement. Verification will have to show that an item declared to be a warhead meets certain parameters (*attributes*) consistent with the declaration – mass within a certain range, radiation signature, and so on. The Trilateral Initiative[8] between the United States, Russia and the IAEA has demonstrated techniques for this kind of verification, and provides a good basis for further development.

24. Once in storage, warheads would be monitored to ensure they remain in storage, and are not removed except under verification. In due course each warhead would be moved into the dismantlement process. Here too verification will be required to provide assurance without revealing classified information. It is expected dismantlement will be carried out in specially constructed facilities, where an item entering the process can be authenticated (that it has expected attributes), there is assurance material cannot be removed from the process without the knowledge of the verifiers, and an appropriate material balance can be established – material leaving the process corresponds to the material that entered the process. This overall verification approach is described as ensuring *chain of custody* or *continuity of knowledge*. Verification procedures along these lines have been demonstrated in collaborative work by the United Kingdom and Norway.

25. After dismantlement, nuclear components would be processed (altering shape and composition) to remove classified attributes, and the recovered nuclear material would be transferred to excess stocks, where it would be monitored until it is transferred to civilian programs or disposed of.

26. **Nuclear materials declared excess to military requirements**. Some of the disarmament steps will involve verification measures similar to established IAEA safeguards. Verification of excess materials is an example of this. The initial issue will be whether materials declared excess have classified form or composition. If so, they will have to be authenticated and quantified without revealing classified attributes, as described above. When these materials have been declassified (for example, by blending), or for materials that are not classified when transferred to excess stocks, standard IAEA safeguards or something like them can be applied. Subsequently the materials would be transferred into civilian programs with safeguards to ensure *irreversibility*, that is, that they are not returned to weapons use, or they would be conditioned and disposed of in a repository.

27. There is already experience with bilateral agreements on the disposition of excess fissile

[8] See T. E Shea, "The Trilateral Initiative: A Model for the Future?," *Arms Control Today* (May 2008), https://www.armscontrol.org/act/2008_05/PersboShea.asp%23Sidebar1.

materials, notably the Megatons to Megawatts program of 1993–2013 under which the United States purchased 500 tons of HEU from the Russian nuclear weapon program and down-blended it to fuel US power reactors. Another example is the 2000 Plutonium Management and Disposition Agreement (PMDA) under which the United States and Russia each agreed to the disposition of 34 tons of excess military plutonium (the latter agreement has yet to be implemented). Under the Megatons to Megawatts program there were bilateral inspections to verify implementation.

28. **FMCT**. This is another example where verification measures would be similar to established IAEA safeguards. Verification of an FMCT would require safeguards measures on enrichment and reprocessing facilities, and on fissile material produced after the treaty's entry into force. The treaty is expected to allow enrichment of HEU and reprocessing (separation of plutonium) for non-explosive purposes. There is limited civilian requirement for HEU, any further production is likely to be mainly for naval propulsion, raising verification issues as discussed below. As with IAEA safeguards, verification activities would also be required to provide assurance that there are no undeclared enrichment or reprocessing facilities.

29. **Naval programs**. As Figure 1 indicates, there is more fissile material in naval programs than in active warheads. This material is almost entirely HEU (though not all weapon-grade). Some is in the form of fuel loaded in reactors (submarines and other vessels), some is held in reserves for future fuel requirements. Clearly having such large quantities of HEU outside verification arrangements could present a risk to disarmament efforts. Accordingly, monitoring or confidence-building measures are required to provide assurance that naval programs do not provide an opportunity for diversion of fissile material to nuclear weapons.

30. The complication here is that the details of naval fuel design are classified, so intrusive verification will not be accepted. Novel verification approaches will have to be developed. These might be complemented by transparency arrangements, for example, it is easy to check that a vessel is at sea (and therefore that its reactor contains fuel). A substantial portion of naval material however is in reserves where sensitivities should not apply and established monitoring measures could be used.

31. **Nuclear archaeology**. In principle it is possible to establish the nuclear materials flows and balances for a nuclear weapon program, that is, to establish how much HEU and plutonium was produced historically, how much was lost in processing, how much was consumed in testing, how much is in weapons and reserves today, and an explanation for inventory differences. This information could be used to cross-check declarations and verification results as disarmament proceeds, to provide assurance that no fissile material, whether in weapons or as bulk material, is being concealed from the verification process.

32. In practice confirming historic nuclear material flows is not straightforward, particularly for the older and larger nuclear programs (United States and Soviet Union/Russia) where rigorous records were not always kept. As a consequence, *nuclear archaeology* – comprising technical methods for auditing and substantiating historical production, losses and consumption – has been developed. These methods include examining facility operating characteristics and records, analyzing radiation effects on facility components and related materials, and analyzing radioactive wastes. Studies into the historic production of fissile materials in the United States and the United Kingdom are encouraging and show that nuclear archaeology could have an important role in disarmament verification.

33. **Verification problem areas**. The greatest problem for verification will be addressing the possibility of undeclared nuclear weapons or materials, discussed below. Another practical problem will be delay in the opportunity to fully verify materials – for example, where classified items or materials enter monitored storage via attribute verification, it could take some years before dismantlement and conversion to unclassified form are completed and the quantity of material can be finally confirmed. Procedures will be needed to maximize confidence that a state could not use this delay to conceal incomplete declarations.

34. A further practical problem will be the resources – human, technical and financial – required for verification. In addition to verification of the various disarmament steps, resources will be required to extend IAEA safeguards into the nuclear-armed states, which will progressively become non-nuclear-weapon states. It will take time to train verification personnel, whether national or multilateral. Currently nuclear weapon programs require very substantial resources. As disarmament progresses these will be available for reallocation to other purposes – the highest priority should be supporting the disarmament effort.

Verification against Breakout

35. Assurance against the possibility of breakout – a state unexpectedly producing nuclear weapons – is by far the greatest challenge facing disarmament verification. In any agreement on deep nuclear reductions – particularly reductions to zero – states will require a high degree of confidence that no other state has undeclared nuclear weapons or fissile material.

36. Of course the risk of breakout is not confined to states that had nuclear weapons. Paradoxically, in a nuclear weapon-free world a rogue state might feel *more* motivated to pursue nuclear weapons – a minor state might hope to become a superpower. A robust non-proliferation regime, applying to *all* states, is absolutely essential to achieving and maintaining disarmament.[9] This not only involves IAEA safeguards – also important, but outside the scope of this paper, will be institutional and technical measures to reduce breakout potential, such as proliferation-resistant fuel cycle technologies and multilateral control over proliferation-sensitive stages of the fuel cycle.

37. Breakout could take two forms:

(a) a state concealing existing nuclear weapons from the disarmament process;

(b) a state producing new nuclear weapons. Fissile material for this purpose could have three sources:

(i) existing material concealed from the disarmament process;

(ii) material diverted from safeguarded or monitored activities (civilian programs or naval programs) in the future;

(iii) material produced with secret facilities in the future.

38. In all three cases, in addition to fissile material the state will require a secret nuclear weapon fabrication facility. The state will also require related materials – electronics, high explosives, tritium – and also nuclear-capable delivery systems. None of these would present insurmountable problems to a state that had a nuclear weapon program (or still has nuclear weapons – breakout could occur not only after nuclear weapons have supposedly been eliminated, but during progress towards elimination).

39. To counter these different pathways it will be necessary to analyze the indicators for each – what are the observables that verifiers and national intelligence agencies should be looking for? It is not simply a question of whether a state could conceal nuclear weapons, the state will also need delivery systems (missiles or nuclear-capable aircraft), personnel for guarding, maintaining and launching nuclear weapons, a command and control structure, and so on – a whole range of things that would have to be hidden, and for which there will be indicators or observables. The key will be establishing procedures that will detect these.

40. It is important to remember this is not a new problem, we are not starting with a blank page. The IAEA safeguards system has long faced the same problem of how to detect undeclared nuclear facilities, items or materials. The IAEA's efforts are a work in progress, but they present a substantial body of experience to build on. It is also important to appreciate that detection is

[9] One major problem with the nuclear weapon prohibition treaty is that it compromises safeguards standards, see J. Carlson, *The nuclear weapon prohibition treaty – a safeguards debacle*, http://www.vertic.org/media/assets/TV/TV158.pdf

not solely reliant on the verification system. National intelligence programs will also be important. So too will be complementary regimes and arrangements – IAEA safeguards, the CTBT, nuclear-weapon-free zones, transparency and confidence-building measures such as information exchanges, communication hotlines, Open Skies-type overflights, exchange of observers, open-source information and so on.

41. Ultimately, verification will never be able to absolutely prove the negative – that there is nothing hidden away. But by combining a broad range of information from many sources (what has been termed *a web of confidence*), over time the verification system, complementary measures and states' own efforts can build greater and greater confidence that the overall picture presented in declarations is complete, and that the risk that anything substantial is hidden is small.

International Collaboration on Disarmament Verification

42. There have been several collaborative projects on verification, particularly between the United States and Russia and the United Kingdom and Norway. The Nuclear Threat Initiative's (NTI) 2014 report *Verifying Baseline Declarations of Nuclear Warheads and Materials*[10] recommended, amongst other things, the establishment of new programs for international technical collaboration on developing disarmament verification. This recommendation has been taken up by the International Partnership for Nuclear Disarmament Verification (IPNDV),[11] a group of over 25 states, with and without nuclear weapons.

43. Currently IPNDV has working groups on Verification of Nuclear Weapon Declarations, Verification of Reductions, and Technologies for Verification. This collaboration is important both to demonstrate that effective verification in support of nuclear reductions and elimination is available or can be developed, and to build expert-level networks that will contribute to the confidence and trust needed to proceed down the path to elimination.

Conclusions

44. Nuclear-armed states will not be expected to disarm immediately, as proposed by the nuclear weapons prohibition treaty. Clearly this is unrealistic – moving to zero will require high levels of confidence and trust that will take time to develop. This will require a step-by-step approach to disarmament, accompanied by the progressive development and implementation of verification systems.

45. As outlined above, a number of the required verification methods and capabilities are already established, but others need substantial research and development. Today the robust verification required for progressing to zero has yet to be demonstrated. The step-by-step approach takes this into account. If the two-phased approach recommended by ICNND (paragraph 18 above) is adopted, the *minimization* phase is not critically dependent on the performance of the verification system (numbers of weapons, while low, would be above a minimum credible deterrent) and this phase can proceed while the verification system is developing. The minimization phase provides a period for building systems and networks, developing procedures, and so on. It is in the elimination phase that verification will become increasingly critical as reductions progress. By then there will be years of experience with verification, transparency and confidence-building, all contributing to the high levels of confidence and trust required.

46. It is a mistake to think of a future world where nuclear weapons have been eliminated as being like *today's world minus nuclear weapons*. Thinking in these terms could reinforce a sense of pessimism whether elimination can ever be achieved. Rather, we must work to

[10] http://www.nti.org/analysis/reports/innovating-verification-verifying-baseline-declarations-nuclear-warheads-and-materials/. This is part of NTI's set of reports *Innovating Verification: New Tools and New Actors to Reduce Nuclear Risks,* http://www.nti.org/analysis/reports/innovating-verification-new-tools-new-actors-reduce-nuclear-risks/.

[11] https://www.ipndv.org/

achieve a new world, where states are committed to collective security and the peaceful settlement of disputes, and international institutions are strengthened accordingly. The collaborative effort required to achieve substantial reductions will help to build the institutions, trust and confidence needed to take reductions all the way to zero. Verification will make an essential contribution to these efforts.

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APLN Policy Briefs

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APLN and Toda Peace Institute

The **Asia Pacific Leadership Network (APLN)** comprises around ninety former senior political, diplomatic, military and other opinion leaders from fifteen countries around the region, including nuclear-weapons possessing states China, India and Pakistan. The objective of the group, founded by former Australian Foreign Minister and President Emeritus of the International Crisis Group Gareth Evans, is to inform and energize public opinion, and especially high level policy-makers, to take seriously the very real threats posed by nuclear weapons, and do everything possible to achieve a world in which they are contained, diminished and ultimately eliminated. The co-Convenors are Professors Chung-in Moon and Ramesh Thakur. The Secretariat is located at the East Asia Foundation in Seoul, Republic of Korea. See further www.apln.org.

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APLN and the Toda Peace Institute are publishing a series of Policy Briefs together in a partnership on a project entitled "Bridging the Gap: Harmonizing the NPT and Ban Treaties." The objective of the project is to link global efforts to protect and strengthen international mechanisms for advancing nuclear non-proliferation and disarmament by harnessing the NPT and the Ban Treaty. A key will be to identify ways to improve cooperation between the 122 countries that voted to adopt the Ban Treaty on the one hand and, on the other, the nuclear-armed states and allies under the nuclear umbrella in the North Atlantic and the Asia Pacific.

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